

**LATEST
EDITION**



SST SCIENCE

Secondary School Teacher (BS-17)



**Complete MCQs Practice Book
with Smart Notes & Quick Revision**

SUBJECTS

- English
- Pedagogy
- Biology
- Chemistry
- Physics
- Computer
- Mathematics

BEST BOOK FOR

BALOCHISTAN
PUBLIC SERVICE COMMISSION



**ACCORDING TO LATEST
SYLLABUS AND PAPER PATTERN**



ONLINE ORDER NUMBER

0310-7750306

MK PREPARATIONS
— LET'S MAKE IT HAPPEN! —

☎ 0333-2605045 | 0342-4470091

🌐 mkpublications.pk

FOLLOW MK PREPARATIONS



Table of Content

English

- The Noun
- The Pronoun
- The Verb
- Tenses And Conditionals
- Subject Verb Agreement
- The Adverb
- The Adjective
- The Preposition
- Sentence, Phrase & Clause
- Active Voice & Passive Voice
- Direct & Indirect Narration
- Idioms & Phrasal Verbs
- Synonyms & Antonyms
- Letter Writing

Pedagogy

- Introduction Of Pedagogy
- Methods Of Teaching
- ICT In Education
- Teaching Of Mathematics
- School Management
- Testing, Measurement & Evaluations
- Classroom Assessment & Management
- Curriculum Development
- Educational Guidance & Counseling
- Critical Thinking & Reflective Practices
- Human Development & Learning
- Educational Management & Leadership
- Early Childhood Education
- Policies Of Education In Pakistan
- Inclusive Education
- Presentation Skills

Biology

- Introduction To Biology
- Biodiversity & Classification
- Biological Molecules
- Enzymes
- Cell Structure & Functions
- Cell Cycle
- Chromosome & DNA
- Variation & Genetics
- Evolution
- Ecology
- Plant Systems
- Human Digestive System
- Human Respiratory System
- Support & Movement
- Coordination & Control
- Homeostasis
- Reproduction

Chemistry

- Fundamentals of chemistry
- Experimental techniques
- Atomic structure
- Physical state of matter
- Acids Bases & Salts
- Chemical Bonding
- Chemical Equilibrium
- Chemical Kinetics
- Environmental Chemistry
- Chemical Industries
- Periodic Table
- Fundamentals of Organic Chemistry
- Hydrocarbons
- Alkyl Halides
- Alcohols Phenols & Ethers
- Aldehyde and Ketones



- Chemical Energetics
- Electrochemistry
- Analytical Chemistry

- Carboxylic Acids
- Biochemistry

Physics

- Classical Mechanics
- Vector Analysis
- Motion & Force
- Work And Energy

- Rotational And Circular Motion
- Fluid Mechanics
- Heat, Thermodynamics & Statistical Mechanics
- Electromagnetism

Computer Science

- Computer Fundamentals & History
- Introduction to Computer
- Computer Software & Operating System

- Microsoft Office
- Internet, Networking & Email
- AI as a Teaching Tool

General Knowledge

- Pakistan History & Constitution
- Baluchistan Geography, Cultural Endowment & Social Development
- Personal & Collective Health
- Management Principals
- Personal Hygiene for Diseases Prevention & Clean Environment

- Prohibition Of Physical Touch of Any Person in Islam Except Grace and Faith of Mahram
- Medical Doctors/Resources in Case of Emergency

Mathematics

- Logarithms
- Factorization And Algebraic Manipulation
- Trigonometry And Bearing
- Coordinate Geometry
- Geometry Of Straight Line
- Mathematical Logics and Polygons
- Basic Statistics and Probability

- Quadratic Equations
- Variations
- Partial Functions
- Sets And Functions
- Basic Statistics
- Introduction To Trigonometry
- Tangent To A Circle
- Angel in A Segment of A Circle



BALUCHISTAN PUBLIC SERVICE COMMISSION

Samungli Road, Quetta Cantt,
(Research Branch)

Syllabus For the Post of Secondary School Teacher (Science)(Bs-17) In Different
Department of Government of Baluchistan

Mode Of Exam: MCQs

Total Marks: 100

English (10 MCQs)	Parts of Speech, Idioms and Phrases, Methods of Letter Writing, Fill in the Blanks, Active and Passive Voice, Direct and Indirect Speech, Word Translation (English to Urdu)
Pedagogy (10 MCQs)	Difference between Pedagogy and Andragogy, Methods of Teaching, Instructional and Communication Technology (ICT), Teaching of Mathematics, School Management, Test Development and Evaluation, Classroom Assessment, Curriculum Development, Critical Thinking and Reflective Practices, Human Development and Learning, Educational Management and Leadership, Early Childhood Education, Inclusive Education, Presentation Skills
Basic Computer Knowledge (10 MCQs)	MS Word, MS Excel, MS PowerPoint, Artificial Intelligence as a Tool of Teaching Science
General Knowledge (10 MCQs)	Pakistan History and Constitution, Balochistan Geography, Cultural Endowment and Social Development, Personal and Collective Health Management Principles, Personal Hygiene for Disease Prevention and Clean Environment, Prohibition of Physical Touch of Any Person in Islam Except with Grace and Faith of Mehram and Medical Doctors or Rescuers in Emergency Situation
Chemistry (Intermediate Level) (15 MCQs)	Atomic Structure, Chemical Bonding, States of Matter, Chemical Energetics, Reaction Kinetics, Acid-base and Chemical Equilibrium, Periodic Table and Periodicity, Environmental Chemistry (Atmosphere and Water), Organic Synthesis, Organic Compounds, Hydrocarbons, Alcohols, Phenols and Ethers, Carboxylic Acids and Their Functional Derivatives, Biochemistry, Industrial Chemistry, Environmental Chemistry, Analytical Chemistry
Physics (Intermediate Level) (15 MCQs)	Measurement, Vectors and Scalar Quantities, Mechanics, Rotational Motion, Physics of Solids, Fluid Dynamics, Thermodynamics, Electromagnetism
Biology (Matric Level) (15 MCQs)	Nature of Science in Biology, Molecular Biology, Cell and Subcellular Organelles, Tissues, Organs and Systems, Metabolism, Biodiversity, Forms and Function in Plants, Evolution and Natural Selection, Gaseous Exchange, Homeostasis, Coordination and Control, Support and Movement, Reproduction, Inheritance, Man and His Environment
Mathematics (Matric Level) (15 MCQs)	Logarithms, Factorization and Algebraic Manipulation, Trigonometry and Bearing, Coordinate Geometry, Geometry of Straight Lines, Mathematical Logic and Polygons, Basic Statistics and Probability, Quadratic Equations, Variations, Partial Function, Sets and Function, Basic Statistics, Introduction to Trigonometry, Tangent to a Circle, Angle in a Segment of a Circle,

M
K

P
R
E
P
A
R
A
T
I
O
N
S

M
K

P
R
E
P
A
R
A
T
I
O
N
S



ENGLISH



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>



Chapter 1

The Noun

Definition of Noun

A noun is a word that functions as the name of a:

- **Person:** child, woman, Ali, teacher
- **Place:** city, Lahore, park
- **Thing:** table, car, money
- **Animal:** dog, elephant, bird
- **Idea, Quality, or State:** happiness, bravery, knowledge, poverty
- **Action:** (Gerunds) swimming, reading, driving

In simple terms, a noun is a naming word. The name of everything is a noun.

Types of Nouns

Nouns can be categorized into eight primary types for a clearer understanding of their usage.

1. Proper Noun

A proper noun is the specific name of a particular person, place, or thing.

- **Rule 1:** It always begins with a **capital letter**.
- **Rule 2:** It can not be changed into a plural form (e.g., *There are two Ali's in my class*).

2. Common Noun

A common noun is a general name that is common to all persons, places, or things of the same kind. It denotes no particular entity.

Proper Noun	Common Noun
Ali	boy
Lahore	city
Badshahi Mosque	mosque

3. Material Noun

A material noun is the name of a substance or matter from which things are made. These often exist in different states of matter: solid, liquid, gas, and plasma. Things in a solid state are sometimes called concrete nouns.

- **Examples:** wood, gold, water, air, plastic, cement.

4. Abstract Noun

An abstract noun is the name of an idea, quality, state, or feeling that does not exist in a physical or material form.

Examples: love, honesty, anger, childhood, poverty, wisdom.

Material Noun	Abstract Noun
Water	Honesty
Iron	Strength
Milk	Whiteness

5. Countable Noun

Countable nouns refer to objects or items that can be counted. They have both singular and plural forms.

- **Examples:** an egg, three oranges, many chairs, several ideas.

6. Uncountable Noun

Uncountable nouns (or mass nouns) refer to substances, concepts, or masses that cannot be counted as separate items. They are generally treated as singular.

- **Examples:** sugar, milk, flour, advice, information, furniture, luggage.

Countable Noun	Uncountable Noun
an egg	sugar
three chairs	some flour
several problems	important information

7. Collective Noun

A collective noun is a single word that denotes a group or collection of similar individuals, considered as one complete whole. It shows a collective identity.

- **Examples:** team, committee, class, herd, fleet, crowd, jury.

8. Compound Noun

A compound noun is formed by joining two or more words together to create a single noun with a new meaning.

- **Examples:**
 - **One word:** toothpaste, bedroom, haircut
 - **Hyphenated:** mother-in-law, check-in, well-being
 - **Separate words:** swimming pool, post office, driving license

Noun Correction Rules

Rule 1: Countable Nouns and Articles

Countable nouns can be used in both singular and plural forms. When used in the singular, they typically require an article (a, an, the) or another determiner (like 'this' or 'my').

- He is a **good man**. They are good **men**.
- She is a **kind lady**. They are kind **ladies**.

Rule 2: The Basic Rule for Uncountable Nouns

Uncountable nouns have no plural form. They take a singular verb, a singular pronoun, and generally no indefinite article (a/an).

- Her **hair is** black and **it** looks beautiful.
- **Jealousy is** a destructive emotion.
- **Music entertains** people.

Rule 3: Using "The" with Specified Uncountable Nouns

Uncountable nouns may take the definite article "the" when they are specified or defined in a particular context.

- **The jealousy** of people can check our progress.
- **The water** in the jug is not drinkable.
- **The air** in the room is not fresh.

Rule 4: Using "A/An" with Specified Abstract Nouns

Some uncountable nouns, especially abstract ones like *experience*, *honour*, *knowledge*, and *fear*, can take the indefinite article "a/an" when they are used in a particular sense to mean "a kind of" or "an instance of."

- **Experience** comes with time. (General sense)
 - I had a **bitter experience** yesterday. (Particular instance)
- We prefer **honour** to everything else. (General sense)
 - It is an **honour** for us to go there. (A particular honour)

Rule 5: Nouns That Are Always Plural (I)

Some nouns have only a plural form and always take plural verbs and pronouns. These often include words ending in "-s".

- Your **belongings are** safe here.
- The **surroundings are** beautiful.
- Give him my **congratulations**.

Rule 6: Nouns That Are Always Plural (II) - Objects with Two Parts

When two or more singular nouns are connected by "and" and refer to the same person or thing, they take a singular verb. Otherwise, they take a plural verb.

- **Bread and butter** is my favorite breakfast. (Treated as a single item)
- The **principal and secretary** has arrived. (One person holding both positions)
- The **principal and the secretary** have arrived. (Two different persons)

Practice MCQ

1. Identify the type of noun for the word "team" in the sentence: "The team won the championship."

- A. Common Noun
- B. Collective Noun
- C. Abstract Noun
- D. Compound Noun

Answer: B

2. Which of the following is an abstract noun?

- A. Water
- B. Honesty
- C. Lahore
- D. Chair

Answer: B

3. Choose the correct sentence according to noun rules.

- A. The scissor is on the table.
- B. The scissors is on the table.
- C. The scissors are on the table.
- D. A scissor are on the table.

Answer: C

4. The noun "poultry" in the sentence "The poultry are being fed" is an example of a noun that:

- A. Is always singular
- B. Appears singular but takes a plural verb
- C. Is a material noun
- D. Is uncountable

Answer: B

5. Which of the following nouns is always plural in form and takes a plural verb?

- A. News
- B. Economics
- C. Trousers
- D. Politics

Answer: C

6. Identify the compound noun.

- A. Beautifully
- B. Swimming pool
- C. Quickly
- D. Happiness

Answer: B

7. Select the sentence where an uncountable noun is used correctly.

- A. She gave me some good advices.
- B. The furnitures in this room are new.
- C. Her hair are long and black.

D. The information provided was incorrect.

Answer: D

8. The word "people" in "Many people attend the fair" is a noun that:

- A. Is singular
- B. Appears singular but takes a plural verb
- C. Is a collective noun
- D. Is a proper noun

Answer: B

9. The use of the indefinite article 'a' with the normally uncountable noun 'experience' in the sentence "I had a bitter experience" is justified because:

- A. The noun is used in a general sense to refer to the concept as a whole.
- B. The noun is specified and particularized, referring to a single instance or kind of that concept.
- C. All abstract nouns can take indefinite articles.
- D. The noun is being used as a proper noun in this context.

Answer: B

10. Identify the material noun from the list below.

- A. Anger
- B. Love
- C. Wood
- D. Crowd

Answer: C

11. The sentence "The committee _____ divided in their opinions" requires a plural verb because:

- A. The collective noun "committee" is always treated as plural.
- B. The focus is on the individual members within the group acting separately, not as a single unit.
- C. The word "opinions" that follows forces the verb to be plural.
- D. It is preceded by the definite article "the".

Answer: B

12. Which of the following is a common noun?

- A. Ali
- B. Badshahi Mosque
- C. Boy
- D. Lahore

Answer: C

Chapter 2

The Pronoun

Definition of Pronoun

A pronoun is a word used in place of a noun or a noun phrase to avoid repetition. It refers to a noun that has been mentioned before or is clearly understood from the context.

- *Example:* "Ali is a doctor. **He** works in a hospital." (The pronoun "He" replaces the noun "Ali").

Types of Pronouns

Pronouns can be categorized into nine main types:

1. Personal Pronoun
2. Possessive Pronoun
3. Reflexive Pronoun
4. Demonstrative Pronoun
5. Indefinite Pronoun
6. Relative Pronoun
7. Interrogative Pronoun
8. Distributive Pronoun
9. Reciprocal Pronoun

1. Personal Pronoun

Personal pronouns refer to specific people or things and change form based on person (first, second, third), number (singular, plural), case (subject, object), and gender (he, she, it).

Person	Subject Pronoun	Object Pronoun	Possessive Adjective	Possessive Pronoun	Reflexive Pronoun
First (Singular)	I	me	my	mine	myself
First (Plural)	we	us	our	ours	ourselves
Second (Singular/Plural)	you	you	your	yours	yourself / yourselves
Third (Masc.)	he	him	his	his	himself
Third (Fem.)	she	her	her	hers	herself
Third (Neutral)	it	it	its	its	itself
Third (Plural)	they	them	their	theirs	themselves

2. Possessive Pronoun

A possessive pronoun shows ownership and is used **when the noun is not expressed**.

- *Examples:* **mine, his, hers, ours, yours, theirs.**
- This is my book. That one is **yours** (your book).
- Their house is big, but **ours** (our house) is more comfortable.

3. Reflexive Pronoun

A reflexive pronoun ends in **-self** or **-selves** and is used when the subject and the object of a verb are the same person or thing.

- *Examples:* myself, ourselves, yourself, yourselves, himself, herself, itself, themselves.
- She taught **herself** how to play the guitar.
- The cat cleaned **itself**.

4. Demonstrative Pronoun

A demonstrative pronoun points to a specific noun (its antecedent) and replaces it.

- *Examples:* **this, that, these, those, such.**
- I love **these** flowers. **These** are my favorite.
- **That** was a remarkable achievement.

D. This

Answer: C

3. Identify the sentence with the correct use of a relative pronoun.

- A. The man which called is my uncle.
- B. The man, that called, is my uncle.
- C. The man who called is my uncle.
- D. The man whom called is my uncle.

Answer: C

4. Fill in the blank: She is smarter than ____.

- A. me
- B. I
- C. myself
- D. mine

Answer: B

5. The grammatical error in the sentence "She told her mother that she was wrong" is related to:

- A. The misuse of a possessive adjective.
- B. The omission of a reflexive pronoun.
- C. The use of an ambiguous pronoun.
- D. The incorrect case of a personal pronoun.

Answer: C

6. Select the correct possessive form: That book is ____.

- A. your's
- B. yours
- C. your
- D. you're's

Answer: B

7. In the sentence "One should always respect ____ elders," the correct pronoun is:

- A. his
- B. one's
- C. their
- D. your

Answer: B

8. The pronoun in "The two rivals blamed each other" is a/an:

- A. Reciprocal pronoun
- B. Reflexive pronoun
- C. Indefinite pronoun
- D. Demonstrative pronoun

Answer: A

9. Choose the sentence with the correct pronoun order for a positive context.

- A. I, you, and he must collaborate on the project.
- B. You, I, and he must collaborate on the project.
- C. You, he, and I must collaborate on the project.
- D. He, you, and I must collaborate on the project.

Answer: C

10. Identify the interrogative pronoun in the following sentence: "Whose is this notebook?"

- A. Whose
- B. this

C. is

D. notebook

Answer: A

11. Which of the following sentences uses a reflexive pronoun correctly?

- A. He bought himself a new car.
- B. He bought hisself a new car.
- C. He bought him a new car.
- D. He bought he a new car.

Answer: A

12. Select the correct sentence:

- A. Whom do you think will win the election?
- B. Who do you think will win the election?
- C. Which do you think will win the election?
- D. Whose do you think will win the election?

Answer: B

13. The pronoun "who" in the sentence "The student who studies hard will succeed" is a:

- A. Interrogative Pronoun
- B. Relative Pronoun
- C. Demonstrative Pronoun
- D. Personal Pronoun

Answer: B

14. Fill in the blank: Neither of the boys has finished ____ homework.

- A. their
- B. his
- C. our
- D. them

Answer: B

15. The sentence "I myself will oversee the project" uses 'myself' as a/an:

- A. Reflexive Pronoun
- B. Emphatic Pronoun
- C. Object Pronoun
- D. Personal Pronoun

Answer: B

16. Identify the sentence that follows the rule for using possessive adjectives with gerunds.

- A. I appreciate you helping me.
- B. I appreciate your helping me.
- C. I appreciate yours helping me.
- D. I appreciate yourself helping me.

Answer: B

17. Which of the following pronouns is always singular?

- A. Many
- B. Few
- C. Several
- D. Each

Answer: D

18. Choose the option that correctly completes the sentence: "It was ____ who volunteered."

- A. her

Chapter 3

The Verb

Definition of Verb

A verb is fundamentally a word that denotes an **action** (*run, synthesize*), indicates a **state of being** (*is, exist*), or describes an **occurrence** (*happen, become*). It forms the essential predicate that tells something about the subject.

A Conceptual Classification of Verb

Understanding verb types is crucial for mastering sentence structure, tense usage, and voice.

1. Transitive Verbs: The Action Transferers

A transitive verb requires one or more objects to complete its meaning. The action originates with the subject and is transferred to an object.

- **Example 1:** The scientist **conducted** *the experiment*.
- **Analysis:** The verb "conducted" is meaningless without its object "the experiment." It answers "conducted what?"
- **Example 2:** The author **wrote** *a compelling novel*.
- **Analysis:** "Wrote" requires the object "a compelling novel" to complete the thought.

2. Intransitive Verbs: The Self-Contained Actions

An intransitive verb expresses a complete action without transferring that action to an object. It may be followed by an adverb, a prepositional phrase, or nothing.

- **Example 1:** The results **emerged** *slowly*.
- **Analysis:** The verb "emerged" is complete in itself. "Slowly" merely modifies the action; it is not an object.
- **Example 2:** All the guests **arrived** *before noon*.
- **Analysis:** "Arrived" does not need an object; "before noon" is a prepositional phrase indicating time.

3. Ditransitive Verbs: The Double Object Handlers

A subset of transitive verbs that take two objects: a **direct object** (the thing that is given/told) and an **indirect object** (the person/thing that receives it).

- **Structure:** Subject + Verb + Indirect Object + Direct Object
- **Example 1:** She **gave** *the student* *a book*.
- **Analysis:** "A book" (Direct Object - what was given), "the student" (Indirect Object - to whom it was given).
- **Example 2:** The manager **offered** *his team* *a new proposal*.
- **Analysis:** "A new proposal" (Direct Object), "his team" (Indirect Object).

4. Linking (Copular) Verbs: The Connectors

Linking verbs do not express action. Instead, they link the subject to a **subject complement**—a word or phrase that renames or describes the subject.

- **Common Linking Verbs:** *be, become, seem, appear, feel, look, sound, smell, taste, remain, stay, grow, turn, prove.*
- **Example 1:** His hypothesis **proved** *correct*.
- **Analysis:** "Proved" connects the subject "hypothesis" to the adjective "correct," which describes it.
- **Example 2:** She **became** *a renowned scientist*.
- **Analysis:** "Became" links the subject "She" to the noun phrase "a renowned scientist," which renames her.

5. Causative Verbs: The Instigators

Causative verbs indicate that the subject causes someone else to perform an action. The three primary causatives (*make, have, get*) differ in force and structure.

- **Make + Agent + Base Form:** Implies force or compulsion.
- **Example 1:** The manager **made** the team **work** overtime.
- **Example 2:** The strict regulations **made** the company **change** its policy.
- **Have + Agent + Base Form:** Implies delegation or arrangement.
- **Example 1:** I **had** the technician **install** the software.
- **Example 2:** She **had** her assistant **draft** the report.
- **Get + Agent + To-Infinitive:** Implies persuasion or effort.
- **Example 1:** She **got** her brother **to help** her move.
- **Example 2:** They finally **got** the government **to listen** to their demands.

6. Auxiliary (Helping) Verbs: The Tense and Mood Formers

Auxiliary verbs are used in conjunction with a main verb to express grammatical nuances of tense, mood, and voice.

- **Primary Auxiliaries:** *be, have, do*. They can also function as main verbs.
 - **Example (Tense):** They **are** discussing the proposal. (Present Continuous)
 - **Example (Voice):** The proposal **was** discussed by them. (Passive Voice)
- **Modal Auxiliaries:** *can, could, will, would, shall, should, may, might, must*. They express ability, permission, possibility, necessity, or obligation.
 - **Example (Obligation):** Candidates **must** submit the form by Friday.
 - **Example (Possibility):** It **might** rain later today.

Verb Forms:

Base Form (V1)	Past Simple (V2)	Past Participle (V3)	Present Participle (V4)
abide	abode	abode	abiding
arise	arose	arisen	arising
awake	awoke	awoken	awaking
be	was/were	been	being
bear	bore	borne	bearing
beat	beat	beaten	beating
become	became	become	becoming
begin	began	begun	beginning
bend	bent	bent	bending
bet	bet	bet	betting
bid	bid	bid	bidding
bind	bound	bound	binding
bite	bit	bitten	biting
bleed	bled	bled	bleeding
blow	blew	blown	blowing
break	broke	broken	breaking

3. The Verb



- **Correct:** He enjoys **reading** historical fiction.
- **Correct (Reflexive):** We really **enjoyed ourselves** at the concert.
- **Correct (Reflexive):** Did you **enjoy yourself** at the party?

Rule 3: Verbs That Typically Exclude Reflexive Pronouns

In English, many actions are inherently understood as being performed by the subject upon themselves. Adding a reflexive pronoun is often redundant and unidiomatic. Such verbs include: *bathe, concentrate, dress, hide, qualify, relax, rest, shave, spread, stop, wake.*

- **Unidiomatic:** He **hid himself** behind the tree.
- **Idiomatic:** He **hid** behind the tree.
- **Unidiomatic:** You need to **prepare yourself** for the exam.
- **Idiomatic:** You need to **prepare** for the exam.
- **Unidiomatic:** She **dressed herself** quickly.
- **Idiomatic:** She **dressed** quickly.

Rule 4: Distinguishing Tricky Verb Pairs

Master the distinction between these commonly confused pairs:

- **Lie vs. Lay :**
 - *Lie* means to recline. (lie, lay, lain). *Please lie down. / He lay on the bed yesterday. / He has lain there for hours.*
 - *Lay* means to put or place something. (lay, laid, laid). *Please lay the files on the desk. / She laid the baby in the crib. / They have laid the foundation.*
- **Rise vs. Raise :**
 - *Rise* means to move upward on its own. (rise, rose, risen). **The sun will rise at 6 AM. / Prices rose significantly. / The dough has risen well.**
 - *Raise* means to lift something else up. (raise, raised, raised). *Please raise your hand. / They raised their voices. / We have raised enough funds.*
- **Sit vs. Set:**
 - *Sit* means to be seated. (sit, sat, sat). *Please sit here. / She sat on the chair. / He has sat there all day.*
 - *Set* means to place something. (set, set, set). *Please set the timer. / He set the book on the table. / She has set the rules.*

Rule 5: The Principle of Subject-Verb Agreement

The verb must agree with its subject in number (singular/plural), regardless of intervening phrases.

- **Intervening Phrases:** Ignore phrases beginning with *as well as, along with, together with, in addition to*.
Example: The CEO, along with her advisors, **is** attending. (Subject is "CEO")
- **Example:** The **project**, in addition to all its sub-tasks, **requires** approval. (Subject is "project")
- **Indefinite Pronouns:** *Each, every, either, neither, anyone, everybody, someone* are singular.
Example: Each of the candidates **has** submitted a portfolio.
- **Example:** Everybody in the offices **has** a computer.
- **Collective Nouns:** Treat as singular if the group acts as one unit; plural if members act individually.
Example (Unit): The ****committee has** reached its decision.
- **Example (Individuals):** The ****committee are** divided in their opinions.

Rule 6: Sequence of Tenses in Complex Sentences

The tense in a subordinate clause is often dependent on the tense in the main clause.

- If the main clause verb is in the past, the subordinate clause verb is usually in a past form.
 - **Incorrect:** He **said** that he **is** the manager.
 - **Correct:** He **said** that he **was** the manager.
 - **Incorrect:** She **knew** that she **has** a chance.
 - **Correct:** She **knew** that she **had** a chance.
- An exception is made for universal truths.
 - **Correct:** The teacher **taught** that the earth **revolves** around the sun.
 - **Correct:** He **knew** that water **boils** at 100 degrees Celsius.

Practice MCQs

1. Identify the type of verb in: "She became a doctor after years of study."

- A. Transitive Verb
- B. Intransitive Verb
- C. Linking Verb

Tenses – Concept Based Quick Review

Definition

Tenses are verb forms that indicate the **time** of an action (past, present, future) and its **aspect** (simple, continuous, perfect, perfect continuous), showing whether the action is completed, ongoing, or repeated.

The Twelve Tenses: Structure and Usage

1. Simple Present Tense/Present Indefinite

Concept: Used for habits, routines, universal truths, and fixed arrangements.

Formation: Subject + V1 (add 's' or 'es' for third person singular) + Object

Signal Words: always, often, usually, sometimes, never, every day, generally

Examples:

- She **teaches** English at the college. (Habit/Routine)
- My father **goes** for a walk every morning. (Habit/Routine)
- The sun **rises** in the east. (Universal Truth)
- Water **boils** at 100 degrees Celsius. (Universal Truth)
- Our flight **leaves** at 8 PM tomorrow. (Fixed Arrangement)

Interrogative: Do/Does + Subject + V1 + Object?

- **Do** you **work** here?
- **Does** she **live** in London?
- Negative:** Subject + do not/does not + V1 + Object
- They **do not like** coffee.
- He **does not play** tennis.

2. Simple Past Tense/Past Indefinite

Concept: Indicates a completed action at a specific time in the past.

Formation: Subject + V2 + Object

Signal Words: yesterday, ago, last week, in 1990, once, then

Examples:

- I **finished** my work an hour ago.
- She **graduated** from university in 2020.
- They **visited** Paris last summer.
- He **bought** a new car yesterday.
- Interrogative:** Did + Subject + V1 + Object?
- **Did** you **see** that movie?
- **Did** they **complete** the project?
- Negative:** Subject + did not + V1 + Object

- She **did not attend** the meeting.
- We **did not receive** your message.

3. Simple Future Tense/Future Indefinite

Concept: Expresses a future plan, prediction, or instant decision.

Formation: Subject + will/shall + V1 + Object

Signal Words: tomorrow, next week, soon, later

Examples:

- We **shall complete** the project by Monday. (Plan)
- She **will arrive** at 9 PM tomorrow. (Plan)
- I think it **will rain** later. (Prediction)
- They **will probably win** the match. (Prediction)
- Someone is at the door. I **will open** it. (Instant Decision)
- It's cold in here. I **will close** the window. (Instant Decision)

Practice MCQs - Tenses

1. Identify the correct sentence that properly uses the Future Perfect tense.

- A. By the time the guests arrive, we will finish the decorations.
- B. By the time the guests arrive, we will have finished the decorations.
- C. By the time the guests arrive, we will be finishing the decorations.
- D. By the time the guests arrive, we have finished the decorations.

Answer: B

2. Which sentence correctly uses a stative verb in a continuous form?

- A. This soup is tasting delicious.
- B. I am having a brother who lives abroad.
- C. She is appearing tired today.
- D. None of the above.

Answer: D

3. Choose the option that correctly completes the sentence: "If he ___ more carefully, he ___ the accident."

- A. drove, would avoid
- B. had driven, would have avoided
- C. drives, will avoid
- D. was driving, would avoid

Answer: B

4. The sentence "The committee has been reviewing applications all week" implies:

- A. The review process is now complete.
- B. The review process started and ended in the past.
- C. The review process is ongoing and began in the past.
- D. The review process will start next week.

Answer: C

5. Identify the sentence that is grammatically incorrect.

- A. I have been knowing him since childhood.
- B. I have known him since childhood.
- C. I knew him when we were children.
- D. I have known him for ten years.

Answer: A

6. Which of the following sentences uses the Past Perfect Continuous tense correctly?

- A. She had been working here for five years before she got promoted.
- B. She has been working here for five years before she got promoted.
- C. She was working here for five years before she got

promoted.

D. She worked here for five years before she had been promoted.

Answer: A

7. Select the sentence that demonstrates the correct sequence of tenses.

- A. She said that she is feeling unwell.
- B. She said that she was feeling unwell.
- C. She says that she was feeling unwell.
- D. She had said that she is feeling unwell.

Answer: B

8. The phrase "I will have been working here for a decade next year" is an example of:

- A. Future Continuous Tense
- B. Future Perfect Tense
- C. Future Perfect Continuous Tense
- D. Simple Future Tense

Answer: C

9. Which conditional type is used in the sentence: "Were I the president, I would prioritize education."

- A. Zero Conditional
- B. First Conditional
- C. Second Conditional
- D. Third Conditional

Answer: C

10. Identify the sentence with no error in tense usage.

- A. When I saw him, he has already finished the report.
- B. When I saw him, he had already finished the report.
- C. When I saw him, he already finished the report.
- D. When I saw him, he was already finishing the report.

Answer: B

11. The sentence "The train leaves at 9 PM sharp" is in the Present Simple tense because it expresses:

- A. A habitual action
- B. A fixed timetable
- C. A current action
- D. A future possibility

Answer: B

12. Choose the correct sentence:

- A. He has been ill since last Monday.
- B. He is ill since last Monday.
- C. He was ill since last Monday.

Set 2 – Choose the correct form of Verb

1. By the time he arrived, the meeting _____ already _____.

- A. has, begun
- B. had, begun
- C. was, begun
- D. would, begin

Answer: B

2. She _____ for the company for five years before she got promoted.

- A. has worked
- B. had been working
- C. is working
- D. works

Answer: B

3. If I _____ you, I would accept the job offer.

- A. am
- B. was
- C. were
- D. have been

Answer: C

4. The committee _____ its decision by tomorrow afternoon.

- A. will announce
- B. will have announced
- C. announces
- D. is announcing

Answer: B

5. He _____ to the market every day.

- A. go
- B. goes
- C. is going
- D. has gone

Answer: B

6. I _____ this book since morning.

- A. am reading
- B. have been reading
- C. read
- D. was reading

Answer: B

7. When I called, she _____ dinner.

- A. cooks
- B. cooked
- C. was cooking
- D. has cooked

Answer: C

8. They _____ in London since 2010.

- A. live
- B. are living

C. have been living

D. were living

Answer: C

9. By next year, she _____ her degree.

- A. completes
- B. will have completed
- C. has completed
- D. is completing

Answer: B

10. If he _____ harder, he would have passed the exam.

- A. studied
- B. had studied
- C. has studied
- D. was studying

Answer: B

11. The sun _____ in the east.

- A. is rising
- B. rises
- C. has risen
- D. rose

Answer: B

12. I _____ a strange dream last night.

- A. have
- B. had
- C. am having
- D. have had

Answer: B

13. She _____ for a new job for three months.

- A. looks
- B. is looking
- C. has been looking
- D. looked

Answer: C

14. When we reached the station, the train _____.

- A. already left
- B. had already left
- C. has already left
- D. was already leaving

Answer: B

15. I _____ to the party if I had been invited.

- A. would go
- B. would have gone
- C. went
- D. had gone

Answer: B

16. He _____ his homework when the lights went out.



Chapter 5

Subject-Verb Agreement

Introduction

Subject-verb agreement is a fundamental rule of English grammar. It states that the verb in a sentence must agree in number with its subject. A singular subject requires a singular verb, and a plural subject requires a plural verb. This chapter outlines the key rules and exceptions to ensure grammatical accuracy in your writing and speech.

Subject Verb Agreement Correction Rules

Rule 1: The Interrupting Phrase

When the subject is followed by a phrase like *as well as*, *along with*, *together with*, *in addition to*, *including*, *besides*, or *accompanied by*, the verb agrees with the **original subject**, not the noun in the phrase.

- The **manager**, as well as the team members, **is** attending the conference.
- My **parents**, along with my uncle, **are** visiting us.

Rule 2: Compound Subjects with "And"

- **General Rule:** Two or more subjects joined by **and** take a **plural verb**.
 - Ali and Sana **are** studying for the exam.
- **Exception:** When the compound subject refers to a **single idea or item**, use a **singular verb**.
 - Bread and butter **is** a common breakfast. (One food item)
 - My friend and mentor **has** left the company. (One person)

Rule 3: Indefinite Pronouns

The following indefinite pronouns **always take a singular verb**:

each, either, neither, anyone, anybody, anything, everyone, everybody, everything, someone, somebody, something, no one, nobody, nothing.

- **Everyone** in the office **has** a assigned parking space.
- **Neither** of the answers **is** correct.
- **Each** of the students **has** passed the test.

Note on "None": "None" can be singular or plural. However, it is often treated as singular, especially in formal writing.

- **None** of the information **was** useful. (Singular)
- **None** of the options **are** acceptable. (Plural, implying "not any")

Rule 4: Flexible Quantity Words

The pronouns *all*, *any*, *more*, *most*, and *some* can be singular or plural, depending on whether they refer to a countable or uncountable noun.

- All the **water** **has** evaporated. (Uncountable = Singular Verb)
- All the **students** **have** left. (Countable = Plural Verb)
- Some of the **advice** **was** helpful. (Uncountable)
- Some of the **books** **were** missing. (Countable)

Rule 5: Collective Nouns

A collective noun (e.g., *team*, *jury*, *crowd*, *committee*, *family*) can be singular or plural.

- Use a **singular verb** when the group acts as a **single unit**.
 - The **jury** **has** reached its verdict.
- Use a **plural verb** when the members of the group are **acting individually**.
 - The **jury** **are** still debating their opinions.

Rule 6: "A Number" vs. "The Number"

- A **number of...** means "many" and takes a **plural verb**.
 - A **number of students** **were** absent today.
- **The number of...** refers to a specific figure and takes a **singular verb**.
 - **The number of absent students** **was** surprisingly high.

Rule 7: Amounts and Quantities

When a plural noun refers to a **single amount, quantity, or unit**, it takes a **singular verb**.

- **Fifty dollars** **is** too much to pay for that.
- **Three years** **seems** like a long time to wait.
- **Two-thirds of the city** **was** without power.

Chapter 6

The Adverb

Definition of Adverb

An adverb is a word that modifies (qualifies) a verb, an adjective, another adverb, a preposition, a conjunction, or even an entire sentence. It provides additional information about time, manner, place, frequency, degree, and certainty.

Core Function: To add descriptive detail to show how, when, where, why, or to what extent something happens.

The Versatile Roles of an Adverb

Adverbs can modify various parts of speech:

➤ Modifying a Verb:

She sang **beautifully**.

He runs **quickly**.

➤ Modifying an Adjective:

She is **extremely** intelligent.

This is a **very** interesting book.

➤ Modifying Another Adverb:

He works **incredibly** efficiently.

She spoke **almost** inaudibly.

➤ Modifying a Preposition:

The ball landed **just** inside the boundary.

He arrived **shortly** after noon.

➤ Modifying a Conjunction:

I like him, **simply** because he is honest.

She left **soon** after the meeting began.

➤ Modifying an Entire Sentence:

Fortunately, the weather remained clear.

Types of Adverb

Adverbs can be categorized based on the specific information they provide.

1. Adverbs of Manner

Describe *how* an action is performed.

Questions Answered: How? In what manner?

Examples: quickly, slowly, carefully, beautifully, well, fast

He solved the problem **efficiently**.

They danced **gracefully**.

2. Adverbs of Place

Describe *where* an action occurs.

Questions Answered: Where? Where to?

Examples: here, there, everywhere, somewhere, inside, outside

Please wait **outside**.

The children are playing **upstairs**.

3. Adverbs of Time

Describe *when* an action occurs.

Questions Answered: When? How long? How often?

Examples: now, then, today, yesterday, soon, already, yet

I will call you **tomorrow**.

She has **already** finished her work.

4. Adverbs of Frequency

Chapter 8

Preposition

Introduction

A preposition is a word that shows a relationship between a noun (or pronoun) and another word in a sentence. This relationship can be one of time, place, direction, manner, or agency. Prepositions are essential for providing context and clarity.

Common Prepositions: in, on, at, with, under, above, into, by, of, to, for, from, about, between, among.

Prepositions of Time

Preposition	Usage	Example
At	Specific times, night, holidays	At 5 o'clock, at night, at Eid
On	Days, specific dates	On Monday, on 25th March
In	Months, seasons, years, centuries, long periods, parts of the day (except 'night')	In August, in winter, in 2006, in the morning
Since	From a specific point in time (past until now)	She has lived here since 2010.
For	A duration of time (past until now)	He studied for two hours.
From...to	Start and end of a period	The shop is open from Monday to Friday.
Until/Till	Up to a certain time	He is on holiday until Friday.
By	At the latest; a deadline	I will finish by noon.
Before	Earlier than a certain time	Before 2004
After	Later than a certain time	After the meeting
Ago	A time in the past from now	He left ten minutes ago .
Past/To	Telling the time	Ten past six (6:10), Ten to six (5:50)

Prepositions of Place and Location

These prepositions tell us where something is located.

Preposition	Usage	Example
In	Enclosed spaces, countries, cities, streets, books	In the kitchen, in Pakistan, in a book, in the car
On	Surfaces, public transport, rivers, floors, attached	On the wall, on the bus, on the Thames, on the 2nd floor
At	Specific points, addresses, events, tables	At the door, at 21 Main Street, at a concert, at the table
By/Beside/Next to	Adjacency (left or right of something)	She stood by the car.

- **Ask for** information.
- **Belong to** me.
- **Blame** someone **for** a mistake | **Blame** a mistake **on** someone.
- **Complain to** someone **about** something.
- **Concentrate on** your work.
- **Congratulate** someone **on** a success.
- **Consist of** several parts.
- **Decide on** a plan.
- **Hear about** an event | **Hear from** a person (receive a call/letter) | **Hear of** something (be aware of its existence).
- **Laugh at** a joke.
- **Pay for** a product. (But: **pay** a bill - no preposition)
- **Protect** someone **from** danger.
- **Provide** someone **with** something.
- **Rely on** a friend.
- **Remind** someone **about** an appointment | **Remind** someone **of** a person/thing (cause to remember).
- **Search for** your keys.
- **Speak / Talk to** someone **about** something.
- **Spend** money **on** something.
- **Suffer from** an illness.
- **Think about** an idea (consider) | **Think of** an idea (have an idea).
- **Warn** someone **about / of** a danger.
- **Thank** someone **for** something.

Word + Preposition Combinations Table

Word	Preposition	Meaning (Word + Preposition)
A		
Absorbed	in	کسی کام میں محو ہونا
Accuse	of	کسی چیز کا الزام لگانا
Accustomed	to	کسی چیز کا عادی ہونا
Adapt	to	کسی چیز کے مطابق ڈھل جانا
Add	to	کسی چیز میں اضافہ کرنا
Adept	at	کسی کام میں ماہر ہونا
Admit	to	کسی بات کا اعتراف کرنا
Advise	on	کسی معاملے پر مشورہ دینا
Afraid	of	کسی چیز سے ڈرنا
Agree	with	کسی شخص سے متفق ہونا
B		
Base	on	کسی چیز پر مبنی ہونا
Beg	for	کسی چیز کی التجا کرنا

Chapter 9

Sentence, Phrase and Clause

The Sentence

Definition

A **sentence** is a grammatically complete set of words that expresses a clear thought. It typically contains a subject and a predicate. A sentence begins with a capital letter and ends with a terminal punctuation mark: a period (.), a question mark (?), or an exclamation mark (!).

Examples:

- He goes to school.
- She is eating an apple.
- Who are you?
- What a beautiful flower!

Parts of a Sentence

Every sentence can be divided into two essential parts:

1. **Subject:** The person, place, thing, or idea that is performing an action or being described. It tells us *who* or *what* the sentence is about.
2. **Predicate:** The part of the sentence that contains the verb and tells us something about the subject. It describes the action or state of being.

Sentence	Subject	Predicate
The sun shines brightly.	The sun	shines brightly.
She is writing a letter.	She	is writing a letter.
Allama Iqbal is our national poet.	Allama Iqbal	is our national poet.

Other Elements in a Sentence

- **Object:** A word or group of words that receives the action of the verb.
 - **Direct Object:** Answers "what?" or "whom?" after the verb.
 - Example: I threw **the ball**.
 - **Indirect Object:** Answers "to whom?" or "for whom?" the action is done. It comes before the direct object.
 - Example: She gave **me** the book.
- **Complement:** A word or group of words that completes the meaning of the subject or object.
 - **Subject Complement:** Follows a linking verb (e.g., is, am, are, seem, become) and describes the subject.
 - Example: He is **a teacher**. (Noun) | He seems **tired**. (Adjective)
 - **Object Complement:** Follows and describes the direct object.
 - Example: They made him **the captain**. (Noun) | The news made her **happy**. (Adjective)

Types of Sentences by Function

Sentences can be categorized based on their purpose and the emotion they convey.

Type	Function	Punctuation	Example
Declarative	Makes a statement or expresses an opinion.	Period (.)	The sky is blue.
Interrogative	Asks a question.	Question Mark (?)	Where do you live?
Imperative	Gives a command, makes a request, or offers advice.	Period (.) or Exclamation (!)	Please close the door. Stop!



Chapter 10

Active and Passive Voice

Introduction

Voice is a form of a verb that indicates whether the subject performs the action or receives the action. There are two voices in English: Active and Passive.

- **Active Voice:** The subject performs the action.
○ Example: **The chef** cooked the meal.
- **Passive Voice:** The subject receives the action.
○ Example: **The meal** was cooked by the chef.

Key Principle: Only transitive verbs (verbs that take an object) can be changed from active to passive voice.

Rules for Converting Active to Passive Voice

1. The **object** of the active verb becomes the **subject** of the passive verb.
2. The **subject** of the active verb becomes the **agent** in the passive sentence, usually introduced by the preposition "by." The agent can be omitted if it is unknown or unimportant.
3. The main verb is changed into its **past participle** form (V3).
4. An appropriate **helping verb** (a form of 'be' or modals) is added, which must agree with the new subject in number and person.

Tense-wise Conversion Charts

1. Present Indefinite Tense

- **Active Structure:** Subject + V1(s/es) + Object
- **Passive Structure:** Subject + is/am/are + V3 + by + Agent

Active Voice	Passive Voice
She writes a letter.	A letter is written by her.
They do not play hockey.	Hockey is not played by them.
Does he respect his teachers?	Are his teachers respected by him?

2. Present Continuous Tense

- **Active Structure:** Subject + is/am/are + V-ing + Object
- **Passive Structure:** Subject + is/am/are + being + V3 + by + Agent

Active Voice	Passive Voice
I am reading a book.	A book is being read by me.
Why are you blaming me?	Why am I being blamed by you?

3. Present Perfect Tense

- **Active Structure:** Subject + has/have + V3 + Object
- **Passive Structure:** Subject + has/have + been + V3 + by + Agent

Active Voice	Passive Voice
The police have caught the thief.	The thief has been caught by the police.



- *Example:* The new policy was implemented in January.
- 3. In scientific or formal writing, to maintain an **objective tone**.
 - *Example:* The solution was heated to 100°C.
- 4. To be **tactful** and not place blame.
 - *Example:* A mistake was made in the report.

Practice MCQs

1. **Given the active voice sentence: "They are building a new suspension bridge over the river." Which passive voice transformation is correct?**
 - (a) A new suspension bridge is built over the river by them.
 - (b) A new suspension bridge was being built over the river by them.
 - (c) A new suspension bridge is being built over the river by them.
 - (d) A new suspension bridge has been built over the river by them.**Answer: (c) A new suspension bridge is being built over the river by them.**
2. **"Someone has stolen my confidential files from the server." The most appropriate passive voice is:**
 - (a) My confidential files were stolen from the server by someone.
 - (b) My confidential files have been stolen from the server.
 - (c) Someone has been stolen my confidential files from the server.
 - (d) My confidential files are stolen from the server by someone.**Answer: (b) My confidential files have been stolen from the server.**
3. **The active sentence "The board of directors will have made a decision by the next quarter" becomes in the passive:**
 - (a) A decision will be made by the board of directors by the next quarter.
 - (b) A decision will have been made by the board of directors by the next quarter.
 - (c) A decision is being made by the board of directors by the next quarter.
 - (d) A decision had been made by the board of directors by the next quarter.**Answer: (b) A decision will have been made by the board of directors by the next quarter.**
4. **Identify the correct passive form for the modal perfect: "You should have handled**

that sensitive matter with more discretion."

- (a) That sensitive matter should be handled with more discretion by you.
- (b) That sensitive matter should have been handled with more discretion by you.
- (c) That sensitive matter had been handled with more discretion by you.
- (d) That sensitive matter was handled with more discretion by you.

Answer: (b) That sensitive matter should have been handled with more discretion by you.

5. **The imperative sentence "Do not reveal the secret under any circumstances" is best transformed into the passive as:**
 - (a) The secret was not revealed under any circumstances.
 - (b) Let the secret not be revealed under any circumstances.
 - (c) You are ordered not to reveal the secret under any circumstances.
 - (d) The secret should not be revealed under any circumstances.**Answer: (b) Let the secret not be revealed under any circumstances.**
6. **Which of the following sentences cannot be converted into a passive voice form?**
 - (a) She sleeps peacefully.
 - (b) The chef prepared a magnificent feast.
 - (c) Someone rang the doorbell.
 - (d) They are discussing the merger.**Answer: (a) She sleeps peacefully.** (Intransitive verb 'sleeps' has no object)
7. **Choose the correct passive voice for the sentence with a double object: "The committee awarded him the 'Researcher of the Year' prize."**
 - (a) He was awarded the 'Researcher of the Year' prize by the committee.
 - (b) The 'Researcher of the Year' prize was awarded him by the committee.

Chapter 11

Direct and Indirect Narration

1. Introduction

Speech or narration can be reported in two ways:

1. **Direct Narration:** We quote the exact words of the speaker, enclosed within quotation marks.
 - Example: He said, "I am busy."
2. **Indirect Narration:** We report the substance of what the speaker said without using their exact words. Quotation marks are not used.
 - Example: He said that **he was busy**.
- **Reporting Speech:** The part outside the quotation marks (e.g., He said).
- **Reported Speech:** The part inside the quotation marks (e.g., "I am busy.").

Essential Pronoun Changes

Pronouns in the reported speech change to maintain the perspective of the reporter. The following table is crucial for understanding these changes:

Subject (Nominative)	Object (Accusative)	Possessive	Reflexive
I	Me	My / Mine	Myself
We	Us	Our / Ours	Ourselves
You	You	Your / Yours	Yourself / Yourselves
He	Him	His	Himself
She	Her	Her / Hers	Herself
It	It	Its	Itself
They	Them	Their / Theirs	Themselves

Rules:

1. **First Person (I, we)** changes according to the **subject** of the reporting verb.
2. **Second Person (you)** changes according to the **object** of the reporting verb.
3. **Third Person (he, she, it, they)** generally remains **unchanged**.

Changes in Tenses

The tense of the reported speech often changes when the reporting verb is in the past tense.

Rule 1: Reporting Verb in Past Tense

If the reporting verb (e.g., said, told) is in the past tense, the verb in the reported speech changes as follows:

Direct Speech (Tense)	Indirect Speech (Tense)
Present Indefinite	Past Indefinite
Present Continuous	Past Continuous

He said, "Congratulations!"	He congratulated me.
She said, "Good morning."	She wished me good morning.
He said, "Curse this rain!"	He cursed the rain.
My friend said, "Goodbye."	My friend bade me goodbye.

Practice MCQs – Direct and Indirect Narration

1. "By God," he exclaimed, "I have never seen such a magnificent sight in my life."

- a) He exclaimed by God that he had never seen such a magnificent sight in his life.
- b) He swore by God that he has never seen such a magnificent sight in his life.
- c) He exclaimed and swore that he had never seen such a magnificent sight in his life.
- d) He swore by God that he had never seen such a magnificent sight in his life.

Answer: d) He swore by God that he had never seen such a magnificent sight in his life.

2. "If you had told me about your predicament, I would have helped you," she said to him.

- a) She told him that if he had told her about his predicament, she would have helped him.
- b) She told him that if he told her about his predicament, she would have helped him.
- c) She told him that if he had told her about his predicament, she would help him.
- d) She said to him that if he told her about his predicament, she would have helped him.

Answer: a) She told him that if he had told her about his predicament, she would have helped him.

3. The philosopher said, "Man is mortal, but his ideas can be immortal."

- a) The philosopher said that man is mortal, but his ideas can be immortal.
- b) The philosopher said that man was mortal, but his ideas could be immortal.
- c) The philosopher said that man is mortal, but his ideas could be immortal.
- d) The philosopher said that man was mortal, but his ideas can be immortal.

Answer: a) The philosopher said that man is mortal, but his ideas can be immortal.

4. "Please, please don't leave me alone here," the child cried to his mother.

- a) The child pleaded to his mother not to leave him alone there.
- b) The child cried and pleaded his mother not to leave him alone there.
- c) The child earnestly pleaded with his mother not to leave him alone there.
- d) The child told his mother to not leave him alone there.

Answer: c) The child earnestly pleaded with his mother not to leave him alone there.

5. "Fool!" she shouted at the man, "You have ruined everything."

- a) She shouted at the man that he was a fool and had ruined everything.
- b) She called the man a fool and shouted that he had ruined everything.
- c) She exclaimed that he was a fool and had ruined everything.
- d) She called him a fool and said that he has ruined everything.

Answer: b) She called the man a fool and shouted that he had ruined everything.

6. He said, "Let's wait here till the rain stops."

- a) He said that we should wait here till the rain stopped.
- b) He suggested that they should wait there till the rain stopped.
- c) He proposed that they should wait there till the rain stops.
- d) He suggested that we wait here until the rain stopped.

Answer: b) He suggested that they should wait there till the rain stopped.

7. "I must go to the bank tomorrow," she said, "as I have no cash left."

- a) She said that she must go to the bank the

Chapter 12

Idioms and Phrasal Verbs

Introduction to Idioms and Phrasal Verbs

- **Idiom:** A group of words established by usage as having a meaning not deducible from the individual words (e.g., *rain cats and dogs*). They add color and depth to the language.
- **Phrasal Verb:** A verb combined with a preposition or an adverb (or both) to create a new verbal phrase with a meaning different from the original verb (e.g., *give up*, *look into*). They are fundamental to fluent and natural English.

Idioms:

Idiom	English Meaning	Urdu Meaning	Example
Above board	Honest and open.	دیانتداری، صاف بازی	Don't worry, the deal was completely above board.
To smell a rat	To suspect foul dealings.	شک کرنا، کھوتا محسوس کرنا	When he offered to double my investment, I began to smell a rat.
To throw dust in someone's eyes	To deceive or mislead someone.	کسی کی آنکھوں میں دھول جھونکنا، دھوکہ دینا	The report threw dust in the public's eyes about the true environmental impact.
To give a false coloring	To misrepresent something.	غلط رنگ چڑھانا، مسخ کرنا	He gave a false coloring to the events to make himself look like a hero.
To play fast and loose	To behave in an unreliable and insincere way.	عہد بھگنی کرنا، بے وفائی کرنا	You can't trust him; he plays fast and loose with the truth.
Sharp practices	Dishonest business dealings.	عیاری، بددیانتی	The company was accused of sharp practices to eliminate competition.
Crocodile tears	Pretended or insincere sorrow.	مگر مچھ کے آنسو، دکھاوے کے آنسو	She shed crocodile tears at his dismissal, though she had advocated for it.
A wolf in sheep's clothing	A person who appears harmless but is actually dangerous.	بھڑپے جیسا شخص، منافق	Be careful of him; he's a wolf in sheep's clothing.
To fight tooth and nail	To fight with all one's might.	دانت کھٹے کرنا، خوب جدوجہد کرنا	The community fought tooth and nail to save the local park.

Phrasal Verb	English Meaning	Urdu Meaning	Example
Account for	To explain the reason for.	وضاحت پیش کرنا	Can you account for the missing funds?
Add up	To make sense; seem consistent.	معنی خیز ہونا	His story just doesn't add up.
Ask after	To inquire about someone's health or well-being.	کسی کے بارے میں دریافت کرنا	She asked after you when I saw her.
Back down	To withdraw a claim or demand.	اپنی بات سے پیچھے ہٹنا	He refused to back down from the argument.
Back up	To support; to make a copy of data.	سپورٹ کرنا، بیک اپ بنانا	I will back you up in the meeting. Always back up your files.
Bail out	To rescue from a difficult situation; to leave abruptly.	مصیبت سے نکالنا؛ اچانک چلے جانا	The government had to bail out the bank. I'm going to bail out of this party early.
Break down	To stop functioning; to lose emotional control; to analyze in detail.	خراب ہو جانا؛ رونے لگنا؛ تجزیہ کرنا	My car broke down. She broke down crying. Let's break down the costs.
Break into	To enter a place forcibly.	زبردستی گھسنا	Thieves broke into the house last night.
Break off	To end a relationship or stop suddenly.	تعلق ختم کرنا؛ اچانک روک دینا	They broke off their engagement.
Break out	To escape; for something (like war, fire) to start suddenly.	فرار ہونا؛ پھوٹ پڑنا	A fire broke out in the kitchen.
Break up	To end a relationship; to disperse.	تعلق ختم کرنا؛ منتشر کرنا	The couple broke up last month. The police broke up the fight.
Bring about	To cause to happen.	سبب بننا	The new policy brought about significant changes.
Bring forward	To move an event to an earlier time.	تاریخ آگے لانا	The meeting has been brought forward to Tuesday.
Bring up	To raise a child; to mention a topic.	پرورش کرنا؛ بات چھیڑنا	She was brought up in London. He brought up an interesting point.

Work out	To exercise; to be successful; to calculate.	ورزش کرنا؛ کامیاب ہونا؛ حل کرنا	I work out at the gym. I hope everything works out for you. Can you work out the total cost?
-----------------	--	---------------------------------	--

Practice MCQs – Idioms and Phrasal Verbs

1. He decided to *bite the bullet* and finally confront his boss about the promotion.

- A. Avoid the issue
- B. Prepare carefully
- C. Face a painful situation bravely
- D. Resign from the job

Answer: C

2. Her extravagant plans to build a castle *went up in smoke* when the investors backed out.

- A. Were highly praised
- B. Were partially successful
- C. Ended in complete failure
- D. Were postponed indefinitely

Answer: C

3. The detective *smelled a rat* when the witness changed his story for the third time.

- A. Became angry
- B. Suspected deception
- C. Found evidence
- D. Felt nauseous

Answer: B

4. After the scandal, the company had to *face the music* from regulatory authorities.

- A. Enjoy success
- B. Accept consequences
- C. Avoid punishment
- D. Celebrate victory

Answer: B

5. The new manager *brought about* significant changes in the organizational structure.

- A. Prevented
- B. Delayed
- C. Caused to happen
- D. Criticized

Answer: C

6. His explanation for the missing funds *doesn't add up*.

- A. Make sense
- B. Seem honest
- C. Appear complete
- D. Sound convincing

Answer: A

7. She's always *blowing her own trumpet* about her academic achievements.

- A. Being modest
- B. Boasting
- C. Criticizing others

D. Working hard

Answer: B

8. The negotiations *broke down* when neither side would compromise.

- A. Succeeded
- B. Concluded
- C. Failed
- D. Accelerated

Answer: C

9. His sudden resignation came as *a bolt from the blue* for everyone in the office.

- A. Expected event
- B. Complete surprise
- C. Regular occurrence
- D. Minor incident

Answer: B

10. We need to *cut corners* to complete the project within the limited budget.

- A. Increase quality
- B. Reduce costs
- C. Extend deadlines
- D. Hire more staff

Answer: B

11. The CEO *called off* the merger at the last moment.

- A. Postponed
- B. Cancelled
- C. Accelerated
- D. Approved

Answer: B

12. Despite initial difficulties, their startup eventually *bore fruit*.

- A. Failed miserably
- B. Produced results
- C. Lost money
- D. Changed direction

Answer: B

13. The politician was accused of *throwing dust in the public's eyes* with false promises.

- A. Being transparent
- B. Deceiving people
- C. Helping citizens
- D. Speaking truth

Answer: B

14. After the argument, they decided to *bury the hatchet* and work together.

- A. To dig for treasure
- B. To forget their disagreement and make peace

Chapter 13

Synonyms and Antonyms

- Synonyms** are words or phrases that have the same or nearly the same meaning as another word or phrase in the same language. For example, "happy" and "joyful" are synonyms. Knowing synonyms helps in understanding nuanced meanings and improves writing style.
- Antonyms** are words that have the exact opposite meaning of another word. For example, "hot" is the antonym of "cold." A strong grasp of antonyms is crucial for understanding contrast and constructing balanced arguments.

Word	Urdu Meaning	Synonyms	Antonyms	Sentence
Abate	کم ہونا، گھٹنا	Subside, Diminish, Decrease, Lessen	Intensity, Increase, Augment, Escalate	The storm finally began to abate after raging for hours.
Aberration	غلل، انحراف	Anomaly, Deviation, Irregularity, Oddity	Normality, Regularity, Standard, Conformity	His poor performance was an aberration from his usual excellence.
Abhor	نفرت کرنا، کراہت کرنا	Despise, Detest, Loathe, Hate	Admire, Adore, Cherish, Love	She abhors any form of cruelty towards animals.
Abridge	مختصر کرنا، خلاصہ کرنا	Shorten, Condense, Abbreviate, Curtail	Elongate, Expand, Amplify, Extend	The publisher released an abridged version of the classic novel for students.
Acrimonious	تج، کڑواہٹ بھرا	Bitter, Caustic, Hostile, Sarcastic	Harmonious, Kind, Gentle, Amicable	The divorce proceedings were acrimonious and lengthy.
Admonish	ڈانٹنا، تنبیہ کرنا	Reprimand, Rebuke, Chide, Warn	Praise, Commend, Applaud, Encourage	The teacher had to admonish the student for talking in class.
Adversity	مصیبت، مشکل	Hardship, Misfortune, Distress, Difficulty	Prosperity, Fortune, Success, Affluence	She showed great resilience in the face of adversity .
Alleviate	کم کرنا، آرام پہنچانا	Mitigate, Relieve, Assuage, Ease	Aggravate, Worsen, Exacerbate, Intensity	This medicine will help alleviate the pain.
Ambiguous	مبہم، غیر واضح	Vague, Unclear, Equivocal, Cryptic	Clear, Unambiguous, Explicit, Definite	His ambiguous instructions led to a lot of confusion.
Amiable	خوش اخلاق، ملنسار	Friendly, Affable, Genial, Congenial	Hostile, Unfriendly, Antagonistic, Rude	The new manager was an amiable person, easy to talk to.
Animosity	عداوت، بیر	Hostility, Antagonism, Rancor, Enmity	Friendliness, Goodwill, Amity, Harmony	There is a deep-seated animosity between the two rival groups.

13. Synonyms and Antonyms

Whimsical	تلون مزاج، انوکھا	Fanciful, Capricious, Playful, Quirky	Serious, Practical, Rational, Pragmatic	The story is filled with whimsical characters and events.
Zealous	پرجوش، سرگرم	Passionate, Fervent, Ardent, Enthusiastic	Apathetic, Indifferent, Unenthusiastic, Lethargic	She was a zealous advocate for human rights.

13. Synonyms and Antonyms

M
K

P
R
E
P
A
R
A
T
I
O
N
S

Practice MCQs

1. What is the synonym of "NOVEL" (as an adjective)?

- A) Traditional
- B) Hazardous
- C) New
- D) Complicated

Answer: C) New

2. What is the synonym of "IMPERVIOUS"?

- A) Vulnerable
- B) Resistant
- C) Sensitive
- D) Susceptible

Answer: B) Resistant

3. What is the synonym of "SCRUTINIZE"?

- A) Ignore
- B) Skim
- C) Examine
- D) Overlook

Answer: C) Examine

4. What is the synonym of "INGENIOUS"?

- A) Uninspired
- B) Dull
- C) Clever
- D) Simple

Answer: C) Clever

5. What is the synonym of "SAGACIOUS"?

- A) Foolish
- B) Redundant
- C) Wise
- D) Obtuse

Answer: C) Wise

6. What is the synonym of "MAGNANIMOUS"?

- A) Petty
- B) Spiteful
- C) Vindictive
- D) Generous

Answer: D) Generous

7. What is the synonym of "INNATE"?

- A) Acquired
- B) Extrinsic
- C) Learned

D) Inborn

Answer: D) Inborn

8. What is the synonym of "OBFUSCATE"?

- A) Elucidate
- B) Clarify
- C) Confuse
- D) Explain

Answer: C) Confuse

9. What is the synonym of "FASTIDIOUS"?

- A) Negligent
- B) Sloppy
- C) Meticulous
- D) Careless

Answer: C) Meticulous

10. What is the synonym of "TRANSIENT"?

- A) Permanent
- B) Enduring
- C) Temporary
- D) Perpetual

Answer: C) Temporary

11. She was the victim of a MALICIOUS rumor.

- A) Benevolent
- B) Compassionate
- C) Spiteful
- D) Kind

Answer: C) Spiteful

12. The government implemented a policy of fiscal AUSTERITY.

- A) Luxury
- B) Frugality
- C) Indulgence
- D) Opulence

Answer: B) Frugality

13. A prolonged illness can DEBILITATE even a strong person.

- A) Strengthen
- B) Invigorate
- C) Weaken
- D) Fortify

Answer: C) Weaken

14. The divorce proceedings were ACRIMONIOUS and lengthy.



Chapter 14

Letter Writing

What is Letter Writing?

Letter writing is the art and practice of composing written messages addressed to a specific individual, group, or organization, with the intention of conveying information, expressing thoughts, or achieving a particular purpose.

- It is a **structured form of communication** that follows established conventions and formats.
- It can be **handwritten or typed**, though modern practice increasingly favors digital formats.
- It involves a **sender (writer)** and a **recipient (receiver)**.

"Letter writing is putting our thoughts, feelings, or requests into words on paper (or screen) and sending them to someone else in a meaningful and organized way."

Formal/Precise Definition:

Letter writing is the systematic process of composing and transmitting a written document—formatted according to recognized conventions—from one party to another, with the goal of facilitating communication, documentation, or transactional exchange in personal, professional, or official contexts.

Expanded Definition:

- It is a **deliberate act of communication** requiring clarity of thought, proper structure, and appropriate language.
- It is governed by **specific formats** (e.g., block format, indented format) depending on the type of letter.
- It serves as a **permanent record** of the communication that takes place.

Elements of a Letter:

Element	Description
Sender's Address	Where the letter originates
Date	When the letter was written
Recipient's Address	Who the letter is intended for
Salutation	Formal or informal greeting
Body	The main content/message
Closing	Formal or informal sign-off
Signature	Authentication by the sender

Objectives of Letter Writing

Objectives refer to the **primary goals** a writer aims to achieve through a letter. These are distinct from the broader "purpose."

Objective	Explanation	Example
To Inform	To convey facts, data, or updates to the recipient.	Sending a meeting agenda, sharing a policy change.
To Request	To ask for something—information, action, or permission.	Writing to request a leave of absence or asking for a catalog.

Sender's Address	Shows who is writing the letter.
Date	Indicates when the letter was written.
Receiver's Address	Shows to whom the letter is written.
Subject Line	Briefly states the purpose of the letter.
Salutation	Polite greeting to the recipient.
Opening Paragraph	Introduces the purpose of writing.
Body Paragraphs	Explain the main message in detail.
Closing Paragraph	Summarizes the letter and requests action.
Complimentary Close	Polite ending (e.g., <i>Yours sincerely</i>).
Signature	Confirms the authenticity of the letter.
Designation	Indicates the sender's official position.
Enclosures	Lists the attached supporting documents.
CC (Carbon Copy)	Indicates additional recipients.
Reference Number	Official tracking number used in offices.

Types of Letters

Types of letters are different categories of written communication based on their **purpose, audience, tone, and format**. Broadly, letters are classified into **Formal Letters** and **Informal Letters**.

Classification of Letters

Type	Written To	Language	Purpose
Formal Letter	Officials, Organizations, Institutions	Formal, Polite	Official communication
Informal Letter	Friends, Family, Relatives	Friendly, Personal	Personal communication

FORMAL LETTERS

Formal letters follow a fixed format and use polite, professional language.

1. Application Letter

Definition

A letter written to request admission, leave, scholarship, or any official approval.

Purpose

- Apply for something
- Request permission
- Seek approval

Language Style

- Polite
- Respectful
- Professional

Format

- Sender's Address
- Date
- Receiver's Address
- Subject
- Salutation
- Body
- Closing
- Signature

Example

Application for Leave.

2. Job Application Letter

Definition

A letter written to apply for a job vacancy.

Purpose

To convince the employer to hire you.

Language Style

Professional and persuasive.

Example

Application for Lecturer (Biology).

3. Complaint Letter

Definition

A letter written to complain about a problem.

Purpose

To seek correction or action.

Language Style

Polite but firm.

Example

Complaint about electricity shortage.

4. Inquiry Letter

Definition

A letter written to obtain information.

Purpose

To ask questions.

Language Style

Formal and clear.

Example

Inquiry about admission.

5. Request Letter

Definition

A letter requesting help or a service.

Purpose

To request something officially.

Language Style

Courteous.

Example

Request for experience certificate.



M K P R E P A R A T I O N S

6. Permission Letter

Definition

A letter seeking permission.

Purpose

To obtain approval.

Language Style

Respectful.

Example

Permission for educational tour.

7. Recommendation Letter

Definition

A letter recommending a person.

Purpose

Support someone's application.

Language Style

Professional and positive.

Example

Recommendation for scholarship.

8. Official Letter

Definition

Communication between government offices or institutions.

Purpose

Official correspondence.

Language Style

Highly formal.

Example

Letter issued by an Education Department.

9. Circular Letter

Definition

One letter sent to many recipients.

Purpose

Announce information.

Language Style

Formal.

Example

Holiday notification.

10. Business Letter

Definition

A letter used in business communication.

Purpose

Commercial correspondence.

Language Style

Professional.

Example

Order placement.

11. Cover Letter

Definition

A letter attached with a CV.

Purpose

Introduce yourself to an employer.

Language Style

Professional.

Example

Cover letter for teaching job.

12. Appreciation Letter

Definition

A letter expressing appreciation.

Purpose

Recognize good work.

Language Style

Warm yet professional.

Example

Appreciation for excellent performance.

13. Acknowledgement Letter

Definition

A letter confirming receipt.

Purpose

Acknowledge documents or payments.

Language Style

Formal.

Example

Receipt acknowledgement.

14. Resignation Letter

Definition

A letter announcing resignation.

Purpose

Leave a job professionally.

Language Style

Respectful.

Example

Resignation from lecturer post.

15. Acceptance Letter

Definition

A letter accepting an offer.

Purpose

Confirm acceptance.

Language Style

Positive and formal.

Example

Acceptance of job offer.

16. Rejection Letter

Definition

A letter declining an offer.

Purpose

Politely refuse.

Language Style

Respectful.

Example

Rejecting job offer.

17. Appointment Letter

Definition

An official letter offering employment.

Purpose

Confirm appointment.

Language Style

Official.

Example



Language Style

Gentle and caring.

Example

Sympathy after illness.

5. Informal Invitation Letter

Definition

A personal invitation.

Purpose

Invite relatives or friends.

Language Style

Friendly.

Example

Birthday invitation.

6. Holiday Letter

Definition

A letter describing a vacation.

Purpose

Share holiday experiences.

Language Style

Personal.

Example

Trip to Murree.

7. Personal Advice Letter

Definition

A letter giving advice.

Purpose

Help solve a personal problem.

Language Style

Friendly and encouraging.

Example

Advice on exam preparation.

Differences Between Formal and Informal Letters

Feature	Formal Letter	Informal Letter
Purpose	Official communication	Personal communication
Recipient	Office, Organization, Authority	Friends, Family, Relatives
Language	Formal, polite	Friendly, conversational
Format	Fixed and structured	Flexible
Tone	Professional	Personal
Contractions	Avoided	Acceptable
Examples	Job application, complaint	Friend, parents, invitation

1. Letter for Request for Urgent Appointment of New Teachers Due to Staff Shortage

[Sender's Address]

[Date]

[Receiver's Address]

Subject: Request for Urgent Appointment of New Teachers Due to Staff Shortage

Dear Sir/Madam,

I am writing to bring to your kind attention the critical shortage of teaching staff at our institution and to formally request the urgent appointment of new teachers. This situation is severely impeding our ability to deliver quality education and maintain academic standards, necessitating immediate intervention.

Currently, our school is operating with a significantly reduced number of teachers, leading to an unsustainable student-teacher ratio and an excessive workload for existing staff. This shortage spans multiple key subjects, resulting in inadequate curriculum coverage, limited individual student attention, and an inability to conduct essential co-curricular activities. The prolonged absence of sufficient teaching personnel has already begun to adversely affect students' academic performance and overall development, undermining the educational objectives we strive to achieve. Given these circumstances, I earnestly request the appointment of additional qualified teachers to address these gaps and restore effective teaching-learning processes.

I kindly urge you to prioritize this matter and take necessary actions to expedite the recruitment process. Your prompt support in this regard will be instrumental in safeguarding the interests of our students and upholding the quality of education. I look forward to your positive response and assurance at the earliest.

Yours faithfully,



PEDAGOGY



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>



Introduction to Pedagogy

Q1. The term "Pedagogy" is derived from which language?

- A. Latin
- B. Greek
- C. Arabic
- D. French

Answer: B. Greek

Q2. The word "Pedagogy" is derived from the Greek words "paidos" and "agogos" which respectively mean:

- A. Child and Leader
- B. Student and Teacher
- C. Knowledge and Wisdom
- D. Learning and Teaching

Answer: A. Child and Leader

Q3. In ancient Greece, a "pedagogue" was specifically a:

- A. School teacher
- B. Slave who accompanied children to school
- C. Philosopher of education
- D. Government education official

Answer: B. Slave who accompanied children to school

Q4. The literal meaning of the word "Pedagogy" is:

- A. Art of teaching
- B. Science of learning
- C. Art of leading children
- D. Science of education

Answer: C. Art of leading children

Q5. Pedagogy is best defined as the:

- A. Study of educational administration
- B. Science and art of teaching
- C. Study of child psychology
- D. Art of curriculum development

Answer: B. Science and art of teaching

Q6. Who is considered the "Father of Pedagogy"?

- A. John Dewey
- B. Jean-Jacques Rousseau
- C. Johann Heinrich Pestalozzi
- D. Jan Amos Comenius

Answer: D. Jan Amos Comenius

Q7. Jan Amos Comenius is famous for writing which landmark educational book?

- A. Emile

B. The Great Didactic

C. The Republic

D. Democracy and Education

Answer: B. The Great Didactic

Q8. Which educational thinker is known as the "Father of Modern Education"?

- A. John Dewey
- B. Jean-Jacques Rousseau
- C. Jan Amos Comenius
- D. Johann Friedrich Herbart

Answer: C. Jan Amos Comenius

Q9. The book "Emile" was written by:

- A. John Dewey
- B. Jean-Jacques Rousseau
- C. Jan Amos Comenius
- D. Maria Montessori

Answer: B. Jean-Jacques Rousseau

Q10. Rousseau's philosophy emphasized education based on:

- A. Rigid discipline
- B. Natural development of the child
- C. Religious instruction
- D. Rote memorization

Answer: B. Natural development of the child

Q11. Who is considered the "Father of Kindergarten"?

- A. John Dewey
- B. Jean-Jacques Rousseau
- C. Friedrich Froebel
- D. Maria Montessori

Answer: C. Friedrich Froebel

Q12. Friedrich Froebel introduced the concept of:

- A. Project Method
- B. Kindergarten
- C. Montessori Method
- D. Dalton Plan

Answer: B. Kindergarten

Q13. The term "Kindergarten" means:

- A. Children's school
- B. Children's garden
- C. Learning place
- D. Play school

Answer: B. Children's garden

Q14. Who developed the "Project Method" of teaching?



Teaching Techniques and Methodologies

1. What is the primary focus of the modern, student-centered role of a teacher?

- A) Disseminating information through lectures
- B) Acting as the fountainhead of knowledge
- C) Facilitating knowledge discovery and collaboration
- D) Ensuring passive reception of knowledge

Answer: Facilitating knowledge discovery and collaboration

2. Which of the following is NOT a key role of a teacher?

- A) Subject Matter Expert
- B) Financial Advisor
- C) Pedagogical Expert
- D) Systematic Assessor

Answer: Financial Advisor

3. Vygotsky's Zone of Proximal Development (ZPD) is defined as the difference between what a learner can do:

- A) With and without technology
- B) In a group and individually
- C) Without help and with guidance from a skilled partner
- D) At home and at school

Answer: Without help and with guidance from a skilled partner

4. Which teaching technique involves learning through observation, retention, and replication of demonstrated behavior?

- A) Brainstorming
- B) Modeling
- C) Lecturing
- D) Collaborating

Answer: Modeling

5. The constructivist approach to learning emphasizes that knowledge is:

- A) Passively received from the teacher
- B) Actively constructed by the learner
- C) Only acquired through memorization
- D) Solely dependent on textbook content

Answer: Actively constructed by the learner

6. Which of the following is a personal quality of an effective teacher?

- A) Collaboration with colleagues

- B) High expectations for students
- C) Commitment to lifelong learning
- D) Emotional maturity

Answer: High expectations for students

7. What is the most critical factor in time management that is directly linked to student achievement?

- A) Allocated Time
- B) Engaged Time
- C) Academic Learning Time
- D) Break Time

Answer: Academic Learning Time

8. The 'Inquiry' approach to teaching effectiveness is determined by:

- A) The teacher's display of warmth and enthusiasm
- B) Student results on standardized tests
- C) The quality of the teacher's reflection on their style and student outcomes
- D) The number of research-based techniques used

Answer: The quality of the teacher's reflection on their style and student outcomes

9. Which co-teaching strategy involves two teachers teaching the same content to two equal groups of students simultaneously?

- A) One Teach/One Assist
- B) Station Teaching
- C) Parallel Teaching
- D) Alternative Teaching

Answer: Parallel Teaching

10. A key element of Cooperative Learning that ensures no one "hitches a free ride" is:

- A) Positive Interdependence
- B) Face-to-Face Interaction
- C) Individual Accountability
- D) Group Processing

Answer: Individual Accountability

11. What is the main purpose of using the brainstorming technique in the classroom?

- A) To critically evaluate every idea as it is presented
- B) To generate a large number of ideas for creative problem-solving
- C) To teach formal debate skills
- D) To assess individual student knowledge



ICT in Education

1. What is the primary function of a computer?

- A) To connect to the internet
- B) To execute arithmetic and logical operations automatically
- C) To display information on a screen
- D) To store data permanently

Answer: To execute arithmetic and logical operations automatically

2. The term 'computer' is derived from which Latin word?

- A) Computare
- B) Communis
- C) Componere
- D) Computus

Answer: Computare

3. What is raw, unorganized, and unprocessed facts and figures known as?

- A) Information
- B) Data
- C) Input
- D) Output

Answer: Data

4. Which of the following is an example of information?

- A) 51, 77, 58, 82, 64, 70
- B) The average of six test scores is 67%
- C) A list of student names
- D) A series of random numbers

Answer: The average of six test scores is 67%

5. The speed of a computer is measured in:

- A) Bytes
- B) Hertz (Hz)
- C) Bits per second
- D) Volts

Answer: Hertz (Hz)

6. The principle "Garbage In, Garbage Out" (GIGO) highlights the importance of:

- A) Processing speed
- B) Input accuracy
- C) Storage capacity
- D) Output devices

Answer: Input accuracy

7. Which characteristic makes computers immune to boredom and fatigue?

- A) Speed
- B) Accuracy
- C) Diligence
- D) Versatility

Answer: Diligence

8. Which type of computer is the most powerful and expensive?

- A) Personal Computer
- B) Mainframe Computer
- C) Supercomputer
- D) Minicomputer

Answer: Supercomputer

9. Mainframe computers are primarily used for:

- A) Personal gaming
- B) Supporting thousands of users simultaneously
- C) Single-user graphic design
- D) Portable note-taking

Answer: Supporting thousands of users simultaneously

10. Which computer is a powerful single-user machine used for engineering design?

- A) Workstation
- B) Minicomputer
- C) Supercomputer
- D) Personal Computer

Answer: Workstation

11. The two main components of a computer system are:

- A) Input and Output
- B) Hardware and Software
- C) CPU and Memory
- D) Data and Information

Answer: Hardware and Software

12. Which unit acts as a bridge between the external environment and the computer?

- A) Output Unit
- B) Central Processing Unit
- C) Storage Unit
- D) Input Unit

Answer: Input Unit

13. A touch screen is an example of which type of device?

- A) Output Device
- B) Processing Device



Teaching of Mathematics

Q1. The word "Mathematics" is derived from which Greek word?

- A. Mathema
- B. Mathesis
- C. Mathematikos
- D. Mathanein

Answer: A. Mathema

Q2. The Greek word "Mathema" means:

- A. Number
- B. Science
- C. That which is learned
- D. Logic

Answer: C. That which is learned

Q3. Mathematics is best defined as:

- A. The study of numbers only
- B. The science of quantity, structure, space, and change
- C. The art of calculation
- D. The study of patterns in nature

Answer: B. The science of quantity, structure, space, and change

Q4. The primary aim of teaching mathematics at the school level is to:

- A. Prepare students for engineering careers
- B. Develop logical and critical thinking
- C. Enable students to pass examinations
- D. Teach calculation skills only

Answer: B. Develop logical and critical thinking

Q5. Which of the following is an objective of teaching mathematics?

- A. Developing problem-solving skills
- B. Memorizing formulas
- C. Learning calculation tricks
- D. Preparing for competitive exams only

Answer: A. Developing problem-solving skills

Q6. According to Bloom's Taxonomy, which cognitive level involves recalling mathematical facts and formulas?

- A. Understand
- B. Apply
- C. Remember
- D. Analyze

Answer: C. Remember

Q7. The "Concrete Operational Stage" according to Piaget is the most suitable stage for teaching:

- A. Abstract algebra
- B. Geometry proofs
- C. Concrete mathematical operations with objects
- D. Calculus

Answer: C. Concrete mathematical operations with objects

Q8. According to Vygotsky, the Zone of Proximal Development (ZPD) in mathematics teaching refers to:

- A. What students can do independently
- B. What students can achieve with guidance
- C. The gap between independent and guided performance
- D. The assessment of learning outcomes

Answer: C. The gap between independent and guided performance

Q9. The concept of "Scaffolding" in mathematics teaching was introduced by:

- A. Jean Piaget
- B. Lev Vygotsky
- C. Jerome Bruner
- D. John Dewey

Answer: C. Jerome Bruner

Q10. Which teaching method in mathematics emphasizes "Learning by Doing"?

- A. Lecture method
- B. Demonstration method
- C. Project method
- D. Drill method

Answer: C. Project method

Q11. The "Lecture Method" in mathematics teaching is most effective for:

- A. Developing problem-solving skills
- B. Introducing new concepts to large groups
- C. Individualized instruction
- D. Hands-on learning

Answer: B. Introducing new concepts to large groups

Q12. The "Inductive Method" in mathematics teaching involves:

- A. Moving from general to specific
- B. Moving from specific examples to general principles
- C. Memorizing formulas
- D. Teacher-centered instruction



School Administration and Supervision

1. The term "administration" is derived from the Latin word meaning?

- A) To lead
- B) To command
- C) Management or direction
- D) To organize

Answer: Management or direction

2. The root word "administrare" combines 'ad-' and 'ministrare', which means?

- A) To command and lead
- B) To see and oversee
- C) To manage and control
- D) To serve and to

Answer: To serve and to

3. Modern educational supervision is best described as?

- A) An inspectional service
- B) A cooperative, developmental service
- C) A punitive, directive service
- D) A financial audit service

Answer: A cooperative, developmental service

4. Which of the following is NOT a key operational area in the scope of school administration?

- A) Curriculum and Instruction
- B) Staff Personnel
- C) Stock Market Analysis
- D) School-Community Relations

Answer: Stock Market Analysis

5. A key need for school administration is to manage the?

- A) Political affiliations of staff
- B) Growing complexity of education systems
- C) Personal lives of students
- D) International trade policies

Answer: Growing complexity of education systems

6. The role of the school principal emerged primarily in which century?

- A) 18th Century
- B) 19th Century
- C) 20th Century
- D) 21st Century

Answer: 19th Century

7. Who introduced the concept of Clinical Supervision?

- A) Carl Glickman
- B) Frederick Taylor
- C) Morris Cogan
- D) Elton Mayo

Answer: Morris Cogan

8. Developmental Supervision, which tailors support to a teacher's stage of development, was pioneered by?

- A) Arthur Costa
- B) Max Weber
- C) Carl Glickman
- D) James MacGregor Burns

Answer: Carl Glickman

9. Which type of administration is characterized by shared decision-making and consultation?

- A) Autocratic
- B) Laissez-Faire
- C) Democratic
- D) Bureaucratic

Answer: Democratic

10. A major disadvantage of autocratic administration is that it?

- A) Is time-consuming
- B) Suppresses creativity and initiative
- C) Leads to disorganization
- D) Lacks clear goals

Answer: Suppresses creativity and initiative

11. Frederick Taylor's Scientific Management theory emphasizes?

- A) Human relations
- B) Efficiency and standardization
- C) Shared leadership
- D) Personal charisma

Answer: Efficiency and standardization

12. The Human Relations Theory in administration was significantly influenced by the work of?

- A) Max Weber
- B) Elton Mayo
- C) Ludwig von Bertalanffy
- D) Frederick Taylor

Answer: Elton Mayo

13. Which theory views a school as a complex, interrelated system?

- A) Bureaucratic Theory



Classroom Management and Discipline

1. According to Harry Wong (2004), classroom management is defined as:

- A) The process of controlling student behavior through rules and consequences.
- B) The practices and processes a teacher uses to uphold an environment where instruction and learning can occur smoothly.
- C) A system for fostering student creativity and independent thought.
- D) The administrative duties a teacher performs to maintain classroom order.

Answer: The practices and processes a teacher uses to uphold an environment where instruction and learning can occur smoothly.

2. Which of the following is NOT cited as a key importance of effective classroom management?

- A) Maximizes learning time
- B) Creates a positive and safe atmosphere
- C) Guarantees all students will achieve high grades
- D) Reduces teacher stress

Answer: Guarantees all students will achieve high grades

3. According to Froyen and Iverson (1999), which component involves managing the instructional process?

- A) Conduct Management
- B) Content Management
- C) Covenant Management
- D) Curriculum Management

Answer: Content Management

4. The A-C-T-S model of classroom management dimensions includes all EXCEPT:

- A) Activity
- B) Climate
- C) Time
- D) Strategy

Answer: Strategy

5. What is the standard space requirement per student in an Elementary school classroom?

- A) 0.6 m²
- B) 1.0 m²
- C) 1.2 m²
- D) 1.5 m²

Answer: 0.6 m²

6. A seating arrangement that is ideal for whole-group discussions but may lead to disturbances due to students being close together is the:

- A) Rows
- B) Clusters
- C) U-Shape
- D) Pair Pods

Answer: U-Shape

7. A student who withdraws from new persons or events is displaying which type of temperament?

- A) Active
- B) Passive
- C) Irritable
- D) Reflective

Answer: Passive

8. Which of the following is a characteristic of Attention-Deficit/Hyperactivity Disorder (ADHD)?

- A) Exceptional musical ability
- B) Difficulties in social interaction with a restricted range of interests
- C) Inattention, hyperactivity, and impulsivity
- D) A pattern of angry/irritable mood and argumentative behavior

Answer: Inattention, hyperactivity, and impulsivity

9. Differentiating instruction to cater to individual differences primarily involves:

- A) Using the same teaching method for all students for consistency.
- B) Varying teaching methods like lectures, discussions, and projects.
- C) Focusing only on students with special educational needs.
- D) Allowing students to choose whether to complete assignments.

Answer: Varying teaching methods like lectures, discussions, and projects.

10. Which strategy is recommended for building a positive emotional climate in the classroom?

- A) Addressing all misbehavior publicly to serve as a lesson
- B) Building strong teacher-student relationships
- C) Minimizing student interaction to reduce conflict



Curriculum Development

1. The word "Curriculum" is derived from the Latin word meaning what?

- A) Chariot
- B) Runway
- C) Book
- D) Teacher

Answer: Runway

2. According to the modern concept, curriculum is the sum total of what?

- A) Textbooks and syllabi
- B) All planned learning experiences
- C) Only academic subjects
- D) Examination papers

Answer: All planned learning experiences

3. Which of the following is an example of a co-curricular activity?

- A) Classroom lecture
- B) Laboratory experiment
- C) Debate club
- D) Final examination

Answer: Debate club

4. Who defined curriculum as "All the organized courses, activities, and experiences which students have under the direction of the school"?

- A) Ralph Tyler
- B) J.F. Kerr
- C) Hilda Taba
- D) Doll

Answer: Hilda Taba

5. The Arabic term for curriculum is:

- A) Nizam
- B) Dars
- C) Minhaj
- D) Ilm

Answer: Minhaj

6. A detailed outline of the topics and sub-topics of a subject to be covered in a specific time is called a:

- A) Course
- B) Syllabus
- C) Curriculum
- D) Lesson Plan

Answer: Syllabus

7. Knowledge that is related to the methods of inquiry and thinking processes in a discipline is known as:

- A) Substantive Knowledge
- B) Procedural Knowledge
- C) Syntactical Knowledge
- D) Factual Knowledge

Answer: Syntactical Knowledge

8. According to Mead, which of the following is NOT a fundamental element of curriculum?

- A) Objectives
- B) Content
- C) School Building
- D) Evaluation

Answer: School Building

9. Bloom's Taxonomy classifies educational objectives into how many domains?

- A) Two
- B) Three
- C) Four
- D) Five

Answer: Three

10. The domain of Bloom's Taxonomy that involves feelings, attitudes, and values is the:

- A) Cognitive Domain
- B) Affective Domain
- C) Psychomotor Domain
- D) Social Domain

Answer: Affective Domain

11. Objectives that are written as observable and measurable statements of intended learning outcomes are called:

- A) General Objectives
- B) Specific Objectives
- C) Behavioral Objectives
- D) Unit Objectives

Answer: Behavioral Objectives

12. The ABCD model for writing behavioral objectives stands for:

- A) Action, Behavior, Condition, Degree
- B) Audience, Behavior, Condition, Degree
- C) Audience, Belief, Content, Degree
- D) Action, Belief, Condition, Data

Answer: Audience, Behavior, Condition, Degree



Educational Guidance and Counselling

1. The term "Guidance" is etymologically derived from which language?

A) Latin
B) Greek
C) French
D) German

Answer: French

2. According to Crow and Crow, what is the primary purpose of guidance?

A) To treat mental illness
B) To help individuals manage life activities and make decisions
C) To provide financial assistance
D) To enforce discipline

Answer: To help individuals manage life activities and make decisions

3. Which perspective views guidance as a philosophy emphasizing the inherent worth of an individual?

A) As a Service
B) As an Educational Construct
C) As a Concept
D) As a Process

Answer: As a Concept

4. Counselling is best described as a:

A) Broad and general process
B) Group-oriented activity only
C) Specialized and in-depth component of guidance
D) Method for academic teaching

Answer: Specialized and in-depth component of guidance

5. According to Carl Rogers, counselling is a service to assist individuals in:

A) Finding a job
B) Changing attitudes and behaviour
C) Selecting university courses
D) Improving physical health

Answer: Changing attitudes and behaviour

6. What is the key focus of counselling?

A) External facts and events
B) The personal meaning of events and experiences
C) Historical data
D) Financial planning

C) Historical data

D) Financial planning

Answer: The personal meaning of events and experiences

7. What is the primary nature of Guidance compared to Counselling?

A) More internal
B) More therapeutic
C) More external and informational
D) More emotional

Answer: More external and informational

8. Counselling is considered to be:

A) Only remedial
B) Only preventive
C) Remedial, preventive, therapeutic, and developmental
D) Only developmental

Answer: Remedial, preventive, therapeutic, and developmental

9. The guidance process is often _____, while counselling is primarily _____.

A) Individual-centered; group-oriented
B) Long-term; short-term
C) Group-oriented; individual-centered
D) Informal; formal

Answer: Group-oriented; individual-centered

10. Who can typically provide guidance services?

A) Only psychiatrists
B) Only trained counsellors
C) Teachers, parents, and counsellors
D) Only social workers

Answer: Teachers, parents, and counsellors

11. The main aim of guidance is to:

A) Bring about deep emotional healing
B) Identify potential and assist in decision-making
C) Treat psychological disorders
D) Provide medical advice

Answer: Identify potential and assist in decision-making



Answer: Unpredictability and chance events

64. **Identifying the content and requirements of a job is called:**

A) Job Enrichment
B) Job Analysis
C) Job Rotation
D) Departmentalization

Answer: Job Analysis

65. **Adding more responsibility to a job is known as:**

A) Job Enlargement
B) Job Rotation
C) Job Enrichment
D) Job Specialization

Answer: Job Enrichment

66. **Adding more tasks at the same level is called:**

A) Job Enrichment
B) Job Enlargement
C) Job Rotation
D) Division of Labor

Answer: Job Enlargement

67. **Why is professional training for counsellors essential?**

A) It is a legal formality.
B) Untrained counsellors can cause harm.
C) To learn administrative tasks.
D) To become a teacher.

Answer: Untrained counsellors can cause harm.

68. **According to Jones, a counsellor must have at least a:**

A) High school diploma
B) Bachelor's degree
C) Graduate or equivalent degree
D) PhD

Answer: Graduate or equivalent degree

69. **A guidance service model where all school personnel perform guidance functions is:**

A) Centralized Specialism
B) Decentralized Generalism
C) Curricular Integration
D) Eclectic Approach

Answer: Decentralized Generalism

70. **The primary role of a school counsellor is to:**

A) Teach subjects
B) Counsel students
C) Manage school finances
D) Discipline students

Answer: Counsel students

71. **What is the status of guidance and counselling in Pakistan's public education system?**

A) Highly developed and universal
B) Largely absent
C) Only for gifted students
D) Mandatory by law

Answer: Largely absent

72. **A major challenge for guidance in Pakistan is:**

A) Too many trained counsellors
B) Lack of policy implementation
C) Excessive funding
D) Absence of students

Answer: Lack of policy implementation

73. **What social factor hinders the acceptance of guidance in Pakistan?**

A) Overpopulation
B) Social stigma
C) High literacy rate
D) Technological advancement

Answer: Social stigma

74. **What is needed to set standards and enforce ethics for counsellors in Pakistan?**

A) More universities
B) A professional regulatory body
C) International funding
D) School principals

Answer: A professional regulatory body

75. **Integrating guidance into teacher training programmes is part of:**

A) The problem
B) The historical background
C) The way forward
D) A non-test technique

Answer: The way forward

76. **Guidance as a service includes organized procedures like:**

A) Only teaching



Human Development and Presentation Skills

Q1. Human development is best defined as:

- A. The physical changes that occur from birth to adulthood
- B. The systematic changes and continuities in the individual that occur between conception and death
- C. The process of learning new skills and knowledge
- D. The biological maturation of the human body

Answer: B. The systematic changes and continuities in the individual that occur between conception and death

Q2. The domains of human development include:

- A. Physical, cognitive, and social-emotional
- B. Physical, spiritual, and moral
- C. Cognitive, linguistic, and artistic
- D. Social, economic, and political

Answer: A. Physical, cognitive, and social-emotional

Q3. The principle that development proceeds from the head downward is called:

- A. Proximal-distal principle
- B. Cephalo-caudal principle
- C. General-to-specific principle
- D. Sequential principle

Answer: B. Cephalo-caudal principle

Q4. The principle that development proceeds from the center of the body outward is called:

- A. Cephalo-caudal principle
- B. Proximal-distal principle
- C. Differentiation principle
- D. Integration principle

Answer: B. Proximal-distal principle

Q5. Development is a product of the interaction between:

- A. Heredity and environment
- B. Nature and nurture
- C. Both A and B
- D. Maturation only

Answer: C. Both A and B

Q6. Which of the following is a principle of human development?

- A. Development is haphazard and unpredictable
- B. Development follows an orderly sequence
- C. Development stops at adolescence
- D. Development is solely determined by heredity

Answer: B. Development follows an orderly sequence

Q7. The relative effects of heredity and environment:

- A. Are fixed throughout development
- B. Vary in different areas of development
- C. Are equal in all aspects
- D. Cannot be measured

Answer: B. Vary in different areas of development

Q8. Which of the following stages of development is characterized by the fastest physical growth?

- A. Prenatal period
- B. Infancy (0-2 years)
- C. Childhood (2-12 years)
- D. Adolescence (12-18 years)

Answer: B. Infancy (0-2 years)

Q9. The prenatal period of development extends from:

- A. Birth to 2 years
- B. Conception to birth
- C. 2 to 6 years
- D. 6 to 12 years

Answer: B. Conception to birth

Q10. The developmental stage from birth to approximately 2 years is called:

- A. Infancy
- B. Toddlerhood
- C. Early childhood
- D. Pre-school age

Answer: A. Infancy

Q11. The stage from 2 to 6 years is commonly referred to as:

- A. Infancy
- B. Early childhood or pre-school age
- C. Middle childhood
- D. Adolescence

Answer: B. Early childhood or pre-school age

Q12. The developmental stage from 6 to 12 years is called:

- A. Early childhood
- B. Middle childhood or school age
- C. Adolescence
- D. Young adulthood

Answer: B. Middle childhood or school age

Q13. Adolescence is the period between:

- A. 2 to 6 years



Planning and Management in Education

1. According to the classical distinction, what is the essence of Administration?

- A) Doing and Implementing
- B) Thinking and Deciding
- C) Leading and Motivating
- D) Organizing and Staffing

Answer: Thinking and Deciding

2. Management is primarily concerned with:

- A) Formulating broad policies
- B) Getting work done through others
- C) Shaping public opinion
- D) Serving the board of directors

Answer: Getting work done through others

3. Which function is considered a top-level activity?

- A) Management
- B) Supervision
- C) Administration
- D) Operational planning

Answer: Administration

4. The heart of management is identified as:

- A) Directing
- B) Decision-making
- C) Planning
- D) Coordinating

Answer: Planning

5. Who distinguished administration as a decision-making function and management as an execution function?

- A) Henry Mintzberg
- B) Frederick Taylor
- C) Oliver Sheldon
- D) Henri Fayol

Answer: Oliver Sheldon

6. A government school is an example of a:

- A) Informal organization
- B) Formal organization
- C) Social organization
- D) Virtual organization

Answer: Formal organization

7. Which of the following is a key significance of organization?

- A) Reduces specialization
- B) Increases role ambiguity

C) Ensures optimum utilization of resources

D) Promotes individual interests

Answer: Ensures optimum utilization of resources

8. The acronym POSDCORB was coined by:

- A) Koontz and O'Donnell
- B) George and Jerry
- C) Gulick and Urwick
- D) Henri Fayol

Answer: Gulick and Urwick

9. The process of hiring and developing required personnel is known as:

- A) Planning
- B) Organizing
- C) Staffing
- D) Directing

Answer: Staffing

10. The function of checking for errors and taking corrective action is:

- A) Coordination
- B) Reporting
- C) Controlling
- D) Budgeting

Answer: Controlling

11. The 5 Ms of Management do NOT include:

- A) Money
- B) Manpower
- C) Marketing
- D) Methods

Answer: Marketing

12. According to Henry Mintzberg, a manager acting as a symbolic head performs which role?

- A) Leader
- B) Liaison
- C) Figurehead
- D) Spokesperson

Answer: Figurehead

13. A manager who seeks and receives internal and external information is performing the role of a:

- A) Disseminator
- B) Monitor
- C) Entrepreneur
- D) Negotiator

Answer: Monitor



Early Child Hood Education (ECE)

1. What is the age range typically covered by Early Childhood Education (ECE)?

- A) 3 to 6 years
- B) 4 to 8 years
- C) Birth to 8 years
- D) 5 to 10 years

Answer: Birth to 8 years

2. Which of the following is considered the core philosophy of Early Childhood Education?

- A) Rote memorization
- B) Play-based, hands-on experiences
- C) Teacher-centered instruction
- D) Strict academic discipline

Answer: Play-based, hands-on experiences

3. Which pioneer wrote the first picture book for children, *Orbis Pictus*?

- A) John Locke
- B) Friedrich Froebel
- C) John Amos Comenius
- D) Johann Pestalozzi

Answer: John Amos Comenius

4. The concept of Tabula Rasa, suggesting a child is a "clean slate," was proposed by:

- A) Jean-Jacques Rousseau
- B) John Dewey
- C) John Locke
- D) Maria Montessori

Answer: John Locke

5. Who believed that children were naturally good and emphasized a flexible school atmosphere?

- A) John Locke
- B) Jean-Jacques Rousseau
- C) John Dewey
- D) Lev Vygotsky

Answer: Jean-Jacques Rousseau

6. Which educator stressed the idea of an integrated curriculum to develop the "whole child"?

- A) Friedrich Froebel
- B) Johann Heinrich Pestalozzi
- C) Maria Montessori
- D) John Dewey

Answer: Johann Heinrich Pestalozzi

7. Who is known as the "Father of the Kindergarten"?

- A) John Dewey
- B) Friedrich Froebel
- C) Johann Pestalozzi
- D) Jean Piaget

Answer: Friedrich Froebel

8. Friedrich Froebel designed the first educational toys, which he called:

- A) Manipulatives
- B) Gifts and Occupations
- C) Sensory tools
- D) Learning blocks

Answer: Gifts and Occupations

9. Italy's first female physician who developed the Montessori Method was:

- A) Margaret McMillan
- B) Maria Montessori
- C) Rachel McMillan
- D) Jean Piaget

Answer: Maria Montessori

10. The core principle of the Montessori Method is best summarized by the phrase:

- A) Education is life itself
- B) Play is the highest phase of child development
- C) Help me do it myself
- D) Learning by listening

Answer: Help me do it myself

11. Who founded the Progressive Education movement and believed "education is life itself"?

- A) John Dewey
- B) Friedrich Froebel
- C) Jean Piaget
- D) Lev Vygotsky

Answer: John Dewey

12. The McMillan sisters are credited with inventing the name for what type of school?

- A) Kindergarten
- B) Nursery School
- C) Preschool
- D) Daycare

Answer: Nursery School

13. Which of the following is NOT a major area of development in early childhood?



Educational Policies of Pakistan

1. What is the primary purpose of an educational policy as defined in the document?

- A) To generate revenue for the government
- B) To manage, direct, and improve the entire education system
- C) To replace teachers with technology
- D) To focus solely on higher education

Answer: To manage, direct, and improve the entire education system

2. Which of the following is NOT listed as a purpose of educational policy?

- A) Achieving National Goals
- B) Controlling the Quality of Education
- C) Privatizing all educational institutions
- D) Solving Critical Problems

Answer: Privatizing all educational institutions

3. The First Educational Conference of 1947 was held under the supervision of:

- A) Liaquat Ali Khan
- B) Fazal Ur Rehman
- C) Allama Iqbal
- D) Quaid-e-Azam Muhammad Ali Jinnah

Answer: Quaid-e-Azam Muhammad Ali Jinnah

4. The First Educational Conference (1947) proposed free and compulsory education at which level?

- A) Secondary
- B) University
- C) Primary
- D) Technical

Answer: Primary

5. The Adult Education Committee in 1947 estimated it would take how many years to eliminate illiteracy?

- A) 50 years
- B) 86 years
- C) 140 years
- D) 25 years

Answer: 140 years

6. The 1947 Conference recommended the use of which tools for teaching?

- A) Smartboards and Tablets
- B) Radio and Films
- C) Only textbooks

D) Social media platforms

Answer: Radio and Films

7. The Sharif Commission (1959) was formed during the government of:

- A) Zulfikar Ali Bhutto
- B) General Yahya Khan
- C) President Ayub Khan
- D) General Zia-ul-Haq

Answer: President Ayub Khan

8. What was the key focus of the Sharif Commission (1959)?

- A) Islamization and Vocational Training
- B) Character building, Science, and Technical Education
- C) Literacy and Equality
- D) Life Skills and Quality

Answer: Character building, Science, and Technical Education

9. The Sharif Commission recommended which language as the medium of instruction?

- A) English
- B) Punjabi
- C) Urdu
- D) Arabic

Answer: Urdu

10. Which regulatory body was established as a result of the Sharif Commission?

- A) Higher Education Commission (HEC)
- B) Academy of Educational Planning and Management (AEPAM)
- C) University Grants Commission (UGC)
- D) National Testing Service (NTS)

Answer: University Grants Commission (UGC)

11. The Sharif Commission proposed an examination system with what ratio of internal to external assessment?

- A) 50% internal, 50% external
- B) 75% internal, 25% external
- C) 25% internal, 75% external
- D) 100% internal assessment

Answer: 25% internal, 75% external

12. The New Education Policy of 1970 was presented by:

- A) Zulfikar Ali Bhutto



Inclusive Education

Q1. Inclusive education is best defined as:

- A. Education provided only to students with disabilities in special schools
- B. An educational approach that provides equitable learning opportunities for all students, regardless of their backgrounds or abilities
- C. Education that separates students based on their academic performance
- D. A system where gifted students are given special privileges

Answer: B. An educational approach that provides equitable learning opportunities for all students, regardless of their backgrounds or abilities

Q2. According to UNESCO, inclusive education aims to:

- A. Provide education only to children with disabilities
- B. Identify and remove all barriers to education
- C. Create separate classrooms for different ability levels
- D. Focus only on academic achievement

Answer: B. Identify and remove all barriers to education

Q3. Inclusive education means:

- A. All children in separate classrooms based on their abilities
- B. All children in the same classrooms, in the same schools
- C. Only children with disabilities in mainstream schools
- D. Gifted children in special programs

Answer: B. All children in the same classrooms, in the same schools

Q4. The core philosophy of inclusive education is based on:

- A. Segregation of students with special needs
- B. Zero rejection philosophy
- C. Competition among students
- D. Standardized testing for all

Answer: B. Zero rejection philosophy

Q5. The Salamanca Statement on inclusive education was adopted in:

- A. 1989
- B. 1994
- C. 2000

D. 2006

Answer: B. 1994

Q6. The Salamanca Conference was held in which country?

- A. France
- B. Spain
- C. Italy
- D. United Kingdom

Answer: B. Spain

Q7. The Salamanca Statement was adopted by representatives from how many governments?

- A. 50
- B. 72
- C. 92
- D. 120

Answer: C. 92

Q8. The Salamanca Statement affirms the right to education of:

- A. Only children with disabilities
- B. Every individual regardless of individual differences
- C. Only gifted children
- D. Only children from minority groups

Answer: B. Every individual regardless of individual differences

Q9. Inclusive education is a response to:

- A. The need for more competitive education
- B. The systemic exclusion of students who are viewed as different
- C. The demand for higher academic standards
- D. The need for more technology in classrooms

Answer: B. The systemic exclusion of students who are viewed as different

Q10. Inclusive education covers everything from:

- A. Curricula to pedagogy and teaching
- B. School buildings only
- C. Teacher salaries only
- D. Student uniforms only

Answer: A. Curricula to pedagogy and teaching

Q11. According to UNESCO, which of the following is a reason for exclusion from education?

- A. Gender and sexual orientation
- B. Ethnic or social origin
- C. Language and religion
- D. All of the above



Answer: C. Maintaining eye contact with the audience

Q38. The use of pauses in a presentation is effective because it:

- A. Shows nervousness
- B. Allows the audience to process information
- C. Wastes time
- D. Indicates lack of preparation

Answer: B. Allows the audience to process information

Q39. Which of the following is an effective way to close a presentation?

- A. Saying "That's all"
- B. Summarizing key points and providing a call to action
- C. Ending abruptly
- D. Asking if there are questions

Answer: B. Summarizing key points and providing a call to action

Q40. The "Rule of Three" in presentations suggests that:

- A. Three presenters are better than one
- B. People remember information presented in threes
- C. Presentations should be three minutes long
- D. Three visual aids are sufficient

Answer: B. People remember information presented in threes

Q41. Which of the following is an example of a nonverbal communication skill in presentations?

- A. Pronunciation
- B. Vocabulary
- C. Eye contact
- D. Grammar

Answer: C. Eye contact

Q42. A speaker who uses appropriate gestures during a presentation is likely to:

- A. Distract the audience
- B. Enhance the message and engage the audience
- C. Appear unprofessional
- D. Lose credibility

Answer: B. Enhance the message and engage the audience

Q43. Which of the following is a barrier to effective presentation?

- A. Clear structure
- B. Audience engagement

C. Speaking too fast

D. Appropriate visual aids

Answer: C. Speaking too fast

Q44. The purpose of an informative presentation is to:

- A. Persuade the audience to take action
- B. Entertain the audience
- C. Educate or inform the audience about a topic
- D. Motivate the audience

Answer: C. Educate or inform the audience about a topic

Q45. The purpose of a persuasive presentation is to:

- A. Inform the audience
- B. Convince the audience to adopt a particular viewpoint or take action
- C. Entertain the audience
- D. Validate the audience

Answer: B. Convince the audience to adopt a particular viewpoint or take action

Q46. Which of the following is a characteristic of effective visual aids?

- A. They contain complete sentences
- B. They are simple and visually appealing
- C. They are text-heavy
- D. They include multiple colors and fonts

Answer: B. They are simple and visually appealing

Q47. The "KISS" principle in presentation design stands for:

- A. Keep It Simple, Stupid
- B. Keep It Smart, Stupid
- C. Keep It Short, Sweet
- D. Keep It Standard, Simple

Answer: A. Keep It Simple, Stupid

Q48. A good presenter should be aware of:

- A. Their own comfort only
- B. The audience's needs and expectations
- C. The room temperature
- D. The time of day

Answer: B. The audience's needs and expectations



BIOLOGY



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>



Introduction to Biology

Introduction to Biology

1. **Biology** is the scientific study of life.
2. The word Biology is derived from the Greek words '*bios*' (life) and '*logos*' (study or reasoning).
3. **Carl Linnaeus** first used the term "Biology" in 1736.
4. **Lamarck and Treviranus** made the term "Biology" common in 1800.
5. The Holy Quran instructs humanity to reveal the study of life and its origins.
6. The Quranic verse "We made every living thing from water" (Sura: Al-Ambia) hints at the common aquatic origin of life.
7. Theophrastus is known as the **Father of Botany**.
8. **Aristotle** is known as the **Father of Zoology**.
9. **Jabir Bin Hayan** introduced experimental investigation in chemistry and wrote books on plants and animals.
10. **Abdul Malik Asmai** was the first Muslim scientist to study animals in detail; his famous book is "Al-Abil".
11. **Bu Ali Sina (Avicenna)** is known as the founder of medicine; his famous book "Al-Qanun-fi-al-Tib" is known as the canon of medicine in the West.

Major Divisions/Branches of Biology

12. The three major divisions of biology are **Zoology**, **Botany**, and **Microbiology**.
13. **Zoology** is the study of animals.
14. **Botany** is the study of plants.
15. **Microbiology** is the study of microorganisms like bacteria and viruses.
16. **Morphology** is the study of the form and structure of organisms.
17. **Anatomy** is the study of the internal structure of organisms.
18. **Physiology** is the study of the functions of different parts of living organisms.
19. **Histology** is the microscopic study of tissues.
20. **Cytology** is the study of cells and their organelles.
21. **Molecular Biology** deals with the study of biological molecules like proteins and nucleic acids.
22. **Embryology** is the study of the development of an organism from a fertilized egg (zygote).
23. **Genetics** is the study of genes and the transmission of characters from parents to offspring (heredity and variation).
24. **Paleontology** is the study of fossils.
25. The oldest known fossil is of **Cyanobacterium**, estimated to be 3.5 billion years old.
26. **Taxonomy** is the study of the naming and classification of organisms.
27. **Ecology** is the study of the relationships between organisms and their environment.
28. **Marine Biology** is the study of life in oceans and seas.
29. **Pathology** is the study of diseases, their causes, and effects.
30. **Immunology** is the study of the immune system and its role in defending against diseases.

Practice MCQs

1. The word 'Biology' is derived from which language?

- A) Latin
- B) Arabic
- C) Greek
- D) English

Answer: Greek

2. The study of internal structure of organisms is called:

- A) Morphology
- B) Physiology
- C) Anatomy
- D) Histology

Answer: Anatomy

3. Which branch of biology deals with the study of fossils?

- A) Paleontology
- B) Entomology
- C) Taxonomy
- D) Embryology

Answer: Paleontology

4. The most abundant bioelement in the human body by mass is:

- A) Carbon
- B) Hydrogen
- C) Oxygen
- D) Nitrogen

Answer: Oxygen

5. A group of organisms of the same species living in a specific area at the same time is called a:

- A) Community
- B) Population
- C) Biome
- D) Ecosystem

Answer: Population

6. Which of the following is a colonial organism?

- A) Amoeba
- B) Paramecium
- C) Volvox
- D) Euglena

Answer: Volvox

7. The scientific name of the frog is:

- A) Rana tagrina
- B) Rana tigrina
- C) Rosa indica

D) Brassica campestris

Answer: Rana tigrina

8. The branch of biology that studies the relationships between organisms and their environment is:

- A) Genetics
- B) Ecology
- C) Physiology
- D) Morphology

Answer: Ecology

9. Which mosquito is the primary vector for the transmission of malaria in humans?

- A) Culex
- B) Aedes
- C) Anopheles
- D) Tabanus

Answer: Anopheles

10. Who is known as the Father of Medicine?

- A) Theophrastus
- B) Aristotle
- C) Jabir Bin Hayan
- D) Bu Ali Sina

Answer: Bu Ali Sina

11. The first step in the scientific method is:

- A) Hypothesis
- B) Observation
- C) Experimentation
- D) Recognition of a problem

Answer: Recognition of a problem

12. Which of the following is a macromolecule?

- A) Water
- B) Glucose
- C) Starch
- D) Carbon dioxide

Answer: Starch

13. The microscopic study of tissues is called:

- A) Cytology
- B) Histology
- C) Anatomy
- D) Parasitology

Answer: Histology

14. The number of bioelements that make up 99% of the human body mass is:

- A) 16
- B) 10



Biodiversity & Classification

1. Introduction to Biodiversity

1. **Biodiversity** means the variety of organisms in a particular area or on Earth.
2. It is measured by the number of different kinds of organisms and the variation within each kind.
3. Biologists have discovered, classified, and catalogued almost **two million** kinds of organisms.
4. The total number of species on Earth is estimated to be much higher than the number currently known.
5. Biodiversity is **not evenly distributed** across the globe.
6. **Tropical regions** have the highest biodiversity, while **polar regions** have the lowest.
7. The biodiversity of an area depends on factors like **climate, altitude, and soil type**.
8. Biodiversity is the result of **billions of years of evolution**.
9. **International Biodiversity Day** is celebrated on **May 22** to promote the protection of biodiversity.
10. Biodiversity provides essential **ecosystem services** like climate regulation and nutrient cycling.
11. It is a source of **food, medicine, building materials, fibres, and fuel**.
12. Biodiversity has significant **economic benefits**, supporting agriculture, tourism, and the pharmaceutical industry.

2. Aims, Principles, and Basis of Classification

13. **Classification** is the process of dividing organisms into groups and subgroups based on their similarities and differences.
14. The main aims of classification are to determine similarities/differences and to find **evolutionary relationships**.
15. Classification makes it easier to study, identify, and understand the characteristics of organisms.
16. It provides a **framework** for studying and comparing different species.
17. Classification explains the **inter-relationship** among various organisms.
18. It helps in the **identification of new species** and understanding their evolutionary history.
19. Classification provides a **common language** for biologists worldwide.
20. The branch of biology dealing with classification is called **Taxonomy**.
21. **Systematics** is the branch that deals with classification and traces the evolutionary history of organisms.
22. Classification is based on similarities in **external and internal structures, developmental stages, and genetic makeup**.
23. Modern classification uses **genetic similarities and differences** (DNA analysis) to determine relationships.

3. Taxonomic Hierarchy (Linnaean System)

24. The groups into which organisms are classified are known as **taxonomic ranks** or **taxa**.
25. The Swedish botanist **Carl Linnaeus** devised the Linnaean system of taxonomic ranks in 1735.
26. The **seven** main taxonomic ranks, from broadest to most specific, are: **Kingdom, Phylum, Class, Order, Family, Genus, Species**.
27. A later addition, **Domain**, is now the highest taxonomic rank.
28. **Kingdom** is a group of related phyla (or divisions in plants and fungi).
29. **Phylum** (or **Division** for plants and fungi) is a group of related classes.
30. **Class** is a group of related orders.
31. **Order** is a group of related families.
32. **Family** is a group of related genera.
33. **Genus** is a group of related species.
34. **Species** is the basic unit of classification, consisting of similar organisms that can interbreed and produce fertile offspring.
35. Members of a lower taxon resemble one another more than members of a higher taxon.

2. Biodiversity and Classification

Practice MCQs

1. What does the term "biodiversity" refer to?

- A) The number of animals in a forest
- B) The variety of life in a particular ecosystem
- C) The study of biological classification
- D) The process of species evolution

Answer: The variety of life in a particular ecosystem

2. Approximately how many species have biologists identified and classified?

- A) 1 million
- B) 2 million
- C) 5 million
- D) 10 million

Answer: 2 million

3. Which region of the world typically has the highest biodiversity?

- A) Polar regions
- B) Deserts
- C) Temperate grasslands
- D) Tropical regions

Answer: Tropical regions

4. International Biodiversity Day is celebrated on which date?

- A) April 22
- B) May 22
- C) June 5
- D) December 10

Answer: May 22

5. What is the primary goal of biological classification?

- A) To give common names to organisms
- B) To understand evolutionary relationships and group organisms systematically
- C) To increase the number of known species
- D) To focus only on plant and animal differences

Answer: To understand evolutionary relationships and group organisms systematically

6. The branch of biology that deals with classification is called?

- A) Ecology
- B) Physiology
- C) Taxonomy
- D) Genetics

Answer: Taxonomy

7. Who is credited with devising the Linnaean system of classification?

- A) Aristotle
- B) Charles Darwin
- C) Robert Whittaker
- D) Carolus Linnaeus

Answer: Carolus Linnaeus

8. Which of the following is the highest taxonomic rank in modern classification?

- A) Kingdom
- B) Domain
- C) Phylum
- D) Class

Answer: Domain

9. The correct order of taxonomic categories from most broad to most specific is:

- A) Kingdom, Order, Class, Phylum, Family, Genus, Species
- B) Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species
- C) Species, Genus, Family, Order, Class, Phylum, Kingdom
- D) Phylum, Kingdom, Class, Order, Family, Genus, Species

Answer: Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species

10. What is the basic unit of classification?

- A) Genus
- B) Family
- C) Species
- D) Order

Answer: Species

11. A species is defined as a group of organisms that can:

- A) Look similar
- B) Live in the same habitat
- C) Interbreed and produce fertile offspring
- D) Have the same number of chromosomes

Answer: Interbreed and produce fertile offspring

12. Who proposed the earliest two-kingdom classification system?

- A) Carolus Linnaeus
- B) Ernst Haeckel
- C) Robert Whittaker
- D) Aristotle

2. Biodiversity and Classification

M
K

P
R
E
P
A
R
A
T
I
O
N
S



Biological Molecules

Introduction to Biochemistry

1. **Biochemistry** is the study of the chemical components and chemical processes in living organisms.
2. All structures of living organisms have a specific **biochemical organization**.
3. Life processes like photosynthesis, respiration, and digestion can be described in **biochemical terms**.
4. **Molecular Biology** is a specialized branch of biochemistry.
5. The sum of all chemical reactions taking place within a cell is called **metabolism**.
6. **Anabolism** involves reactions where simpler substances combine to form complex substances, requiring energy.
7. **Catabolism** involves the breakdown of complex molecules into simpler ones, releasing energy.
8. All living things are made of **organic** and **inorganic** compounds.
9. The most important organic compounds are **carbohydrates, proteins, lipids, and nucleic acids**.
10. Major inorganic substances include **water, carbon dioxide, acids, bases, and salts**.

Chemical Bonds in Biological Molecules

11. A **covalent bond** is formed by the mutual sharing of electrons between two atoms.
12. **Carbon** is tetravalent and can form stable covalent bonds with many elements.
13. Examples of covalent bonds in biomolecules include **peptide bonds, glycosidic bonds, and phosphodiester bonds**.
14. An **ionic bond** is formed when one atom donates an electron to another, creating positively and negatively charged ions.
15. A **hydrogen bond** is a weak attraction between a hydrogen atom and an electronegative atom like oxygen or nitrogen.
16. Hydrogen bonds are crucial for maintaining the structure of **DNA, proteins, and water's properties**.
17. **Hydrophobic interactions** occur between nonpolar molecules in an aqueous environment to minimize contact with water.
18. **Hydrophilic interactions** occur between polar molecules and water molecules.
19. The **C-H bond** is a potential source of chemical energy for cellular activities.
20. In cell membranes, **phospholipids** arrange with hydrophilic heads outward and hydrophobic tails inward.

Importance of Water

21. **Water** is the most abundant compound in all organisms, acting as the **medium of life**.
22. The concentration of water varies from **65% to 89%** in different organisms.
23. Human brain cells contain about **85%** water.
24. Due to its **polarity**, water is an excellent solvent for polar and ionic substances.
25. Water's polarity allows it to form **hydrogen bonds** with other molecules.
26. **Hydrophobic exclusion** is the tendency of non-polar molecules to separate from water.
27. **Specific heat capacity** is the amount of heat required to raise the temperature of 1g of a substance by 1°C.



Practice MCQs

1. What is the study of chemical components and processes in living organisms called?

- A) Physiology
- B) Anatomy
- C) Biochemistry
- D) Genetics

Answer: Biochemistry

2. The sum of all chemical reactions in a cell is collectively known as:

- A) Anabolism
- B) Catabolism
- C) Metabolism
- D) Homeostasis

Answer: Metabolism

3. Which of the following is a key element of all organic compounds?

- A) Nitrogen
- B) Carbon
- C) Oxygen
- D) Sulfur

Answer: Carbon

4. A bond formed by the mutual sharing of electrons between two atoms is a/an:

- A) Ionic bond
- B) Covalent bond
- C) Hydrogen bond
- D) Hydrophobic bond

Answer: Covalent bond

5. Which property of water is due to its polar nature and hydrogen bonding?

- A) High heat capacity
- B) Universal solvent
- C) Cohesion
- D) All of the above

Answer: All of the above

6. The amount of heat required to raise the temperature of 1g of water by 1°C is called its:

- A) Heat of vaporization
- B) Specific heat capacity
- C) Cohesion
- D) Ionization constant

Answer: Specific heat capacity

7. Ice floats on water because:

- A) It has a higher density
- B) It has a lower density

C) It is colder

D) Of hydrophobic exclusion

Answer: It has a lower density

8. Carbohydrates are chemically defined as:

- A) Esters of fatty acids
- B) Polymers of amino acids
- C) Polyhydroxy aldehydes or ketones
- D) Hydrocarbons

Answer: Polyhydroxy aldehydes or ketones

9. Which of the following is a triose sugar?

- A) Glucose
- B) Ribose
- C) Glyceraldehyde
- D) Fructose

Answer: Glyceraldehyde

10. The sugar found in RNA is:

- A) Deoxyribose
- B) Fructose
- C) Ribose
- D) Glucose

Answer: Ribose

11. Glucose and fructose are examples of:

- A) Stereoisomers
- B) Structural isomers
- C) Epimers
- D) Anomers

Answer: Structural isomers

12. The covalent bond linking two monosaccharides is called a:

- A) Peptide bond
- B) Glycosidic bond
- C) Ester bond
- D) Phosphodiester bond

Answer: Glycosidic bond

13. Which disaccharide is known as milk sugar?

- A) Sucrose
- B) Maltose
- C) Lactose
- D) Fructose

Answer: Lactose

14. The plant storage polysaccharide is:

- A) Glycogen
- B) Cellulose
- C) Chitin
- D) Starch

Enzymes

Introduction & Metabolism

1. The sum of all chemical reactions within a living organism is called **metabolism**.
2. The concept of metabolism was first given by **Ibn-e-Nafees**.
3. **Anabolism** involves the synthesis of complex molecules from simpler ones, consuming energy (e.g., photosynthesis, protein synthesis).
4. **Catabolism** involves the breakdown of complex molecules into simpler ones, releasing energy (e.g., cellular respiration, lipolysis).
5. **Enzymes** are biological catalysts that speed up biochemical reactions without being consumed.
6. Enzymes regulate **metabolic pathways**, where the product of one reaction becomes the substrate for the next.

Characteristics of Enzymes

7. Enzymes are primarily **globular proteins** in nature.
 8. The only non-protein enzymes are **ribozymes**, which are made of RNA.
 9. Enzymes **lower the activation energy** of a reaction, speeding it up.
 10. Enzymes are highly **specific** for their substrates and the type of reaction they catalyze.
 11. Enzymes are not used up in the reactions they catalyze and can be **reused**.
 12. Enzymes work efficiently in **small amounts**.
 13. Enzyme activity is sensitive to factors like **temperature, pH, and substrate concentration**.
 14. The catalytic activity of an enzyme is confined to a small region called the **active site**.
 15. Many enzymes require non-protein components called **cofactors** for their activity.
- 1. Cofactors, Coenzymes, and Prosthetic Groups**
16. **Cofactors** are non-protein components required for the proper functioning of many enzymes.
 17. **Inorganic cofactors** include metal ions like Zn^{2+} , Mg^{2+} , Fe^{2+} , Cu^{2+} , and Mn^{2+} , which are also called **activators**.
 18. **Organic cofactors** are of two types: **coenzymes** and **prosthetic groups**.
 19. **Coenzymes** are loosely attached organic cofactors, often derived from **vitamins** (e.g., NAD, FAD, ATP).
 20. **Prosthetic groups** are organic cofactors that are **covalently and permanently** bound to the enzyme (e.g., heme group in cytochromes).
 21. An enzyme without its cofactor is called an **apoenzyme** and is inactive.
 22. The functional enzyme, consisting of the apoenzyme and its cofactor, is called a **holoenzyme**.

Mechanism of Enzyme Action

23. The minimum energy required to start a reaction is called **activation energy**.
24. The reactant molecule that binds to an enzyme's active site is called the **substrate**.
25. The molecule produced as a result of the enzyme's action is called the **product**.

Practice MCQs

1. What is the primary chemical nature of most enzymes?

- A) Carbohydrates
- B) Lipids
- C) Proteins
- D) Nucleic acids

Answer: Proteins

2. The region of an enzyme where the substrate binds is called the:

- A) Allosteric site
- B) Cofactor site
- C) Active site
- D) Binding groove

Answer: Active site

3. Which model proposes that the enzyme's active site is flexible and molds itself around the substrate?

- A) Fluid Mosaic Model
- B) Lock and Key Model
- C) Induced Fit Model
- D) Enzyme-Substrate Model

Answer: Induced Fit Model

4. What is the optimum temperature for most human enzymes?

- A) 25°C
- B) 30°C
- C) 37°C
- D) 42°C

Answer: 37°C

5. A non-protein component that is permanently and covalently bound to an enzyme is called a:

- A) Coenzyme
- B) Activator
- C) Prosthetic group
- D) Apoenzyme

Answer: Prosthetic group

6. Which of the following is an example of a competitive inhibitor?

- A) Cyanide
- B) Heavy metal ions
- C) Malonate
- D) Penicillin

Answer: Malonate

7. The energy required to initiate a chemical reaction is known as:

- A) Kinetic energy
- B) Free energy
- C) Activation energy
- D) Potential energy

Answer: Activation energy

8. Enzymes that function outside the cell where they are produced are known as:

- A) Intracellular enzymes
- B) Ribozymes
- C) Extracellular enzymes
- D) Coenzymes

Answer: Extracellular enzymes

9. In feedback inhibition, the molecule that inhibits the enzyme is usually the:

- A) Substrate
- B) Cofactor
- C) First intermediate
- D) Final product

Answer: Final product

10. Which class of enzymes catalyzes the joining of two molecules using energy from ATP?

- A) Hydrolases
- B) Lyases
- C) Isomerases
- D) Ligases

Answer: Ligases

11. The enzyme pepsin is most active in which pH range?

- A) 1.5 - 2.0
- B) 4.0 - 5.0
- C) 6.5 - 7.5
- D) 8.0 - 9.0

Answer: 1.5 - 2.0

12. What happens to an enzyme when it is denatured?

- A) Its primary structure is destroyed
- B) It works faster
- C) It loses its shape and function
- D) It becomes more specific

Answer: It loses its shape and function

13. Which of the following is NOT a characteristic of enzymes?

- A) They are used up in the reaction
- B) They are specific in their action
- C) They lower the activation energy



Cell Structure and Function

Cell Theory

1. **Robert Hooke** in 1665 first discovered and named "cells" while examining cork.
2. **Anton van Leeuwenhoek** was the first to observe living cells ("animalcules") in pond water.
3. **Robert Brown** discovered the nucleus in the cell in 1831.
4. **Schleiden (1838) and Schwann (1839)** formulated the cell theory.
5. **Rudolf Virchow** proposed that all cells arise from pre-existing cells ("omnis cellula e cellula").
6. **Louis Pasteur** provided experimental proof for Virchow's hypothesis.
7. The three tenets of the **Cell Theory** are: all organisms are composed of cells, the cell is the basic unit of life, and all cells come from pre-existing cells.
8. **Exceptions to Cell Theory** include viruses, viroids, prions, coenocytic hyphae, and striated muscle fibers.
9. Viruses are considered **acellular** and are an exception to the cell theory.
10. The cell is the structural, functional, and fundamental unit of all living organisms.

Microscopy

11. The **resolution** is the ability of a microscope to distinguish two close points as separate.
12. The resolution of the naked human eye is approximately **0.1 mm**.
13. A **compound light microscope** uses visible light as an illuminating source.
14. The maximum magnification of a light microscope is about **1500X**.
15. The resolving power of a light microscope is about **0.2 μm** .
16. The source of illumination in an electron microscope is a **beam of electrons**.
17. An **Electron Microscope** has a much higher resolution (up to 0.2 nm) than a light microscope.
18. **Transmission Electron Microscope (TEM)** is used to view internal cell structures.
19. **Scanning Electron Microscope (SEM)** is used to study the surface details of cells.
20. Only **dead and dried** specimens can be viewed under an electron microscope.
21. Total magnification is calculated by multiplying the magnification of the **ocular lens** by the **objective lens**.

Prokaryotic vs. Eukaryotic Cells

22. **Prokaryotic cells** lack a true, membrane-bound nucleus.
23. In prokaryotes, the nuclear material is directly submerged in the cytoplasm in a region called the **nucleoid**.
24. **Eukaryotic cells** have a true, membrane-bound nucleus.
25. Prokaryotic cells represent a **more primitive stage of evolution**.
26. Prokaryotic cells generally lack membrane-bound organelles like mitochondria, ER, and Golgi apparatus.
27. The strengthening material in the prokaryotic cell wall is **peptidoglycan** or **murein**.
28. The entire prokaryotic cell wall is often regarded as a single huge molecule called the **sacculus**.
29. Prokaryotic ribosomes are **70S**, composed of 50S and 30S subunits.
30. Eukaryotic ribosomes are **80S**, composed of 60S and 40S subunits.

Practice MCQs

1. Most plants differ from animals in lacking:

- A) SER
- B) Cell wall
- C) Centriole
- D) Plastids

Answer: Centriole

2. Prokaryotic cells represent:

- A) A less primitive stage of evolution
- B) A more primitive stage of evolution
- C) A more advancing stage of evolution
- D) A moderate stage of evolution

Answer: A more primitive stage of evolution

3. Prokaryotic cells differ from eukaryotic ones in lacking:

- A) Chromosomes
- B) 80s ribosomes
- C) Nucleoid
- D) Plasmid

Answer: 80s ribosomes

4. Plant cells never suffer from:

- A) Lysosomal disorder
- B) Viral disorders
- C) Fungal disorders
- D) Bacterial disorders

Answer: Lysosomal disorder

5. A plant cell differs from animal cells in having:

- A) Vacuoles
- B) Microtubules
- C) Microfilaments
- D) Plastids

Answer: Plastids

6. Contrary to the animal cell, plant cells lack:

- A) Thylakoids
- B) Asters
- C) Cell wall
- D) Central vacuole

Answer: Asters

7. Nuclear material is directly submerged in the cytoplasm in:

- A) Plant cell
- B) Animal cell
- C) Prokaryotic cell
- D) Viral cell

Answer: Prokaryotic cell

8. For DNA replication, energy comes from:

- A) System or cell
- B) Breaking of the phosphate group of nucleotides
- C) Enzymes provide energy
- D) Only ATP can provide energy

Answer: Only ATP can provide energy

9. Most eukaryotic cells are:

- A) Macroscopic
- B) Microscopic
- C) Huge
- D) Moderate in size

Answer: Microscopic

10. The part of the eukaryotic cell where the formation and action of primes takes place respectively is:

- A) Nucleoplasm and cytoplasm
- B) Cytoplasm and nucleoplasm
- C) Cytoplasm only
- D) Nucleoplasm only

Answer: Cytoplasm and nucleoplasm

11. The entire cell wall of prokaryotes is often regarded as a single huge molecular complex called:

- A) Murine
- B) Capsule
- C) Peptidoglycan
- D) Sacculus

Answer: Sacculus

12. Prokaryotic cells differ from eukaryotic ones in having:

- A) Ribosomes
- B) Flagella
- C) Extra chromosomal DNA
- D) Pili

Answer: Pili

13. Plasma membrane carbohydrates are conjugated with:

- A) Protein
- B) Lipids
- C) Proteins and lipids both
- D) Glycoprotein and glycolipid

Answer: Proteins and lipids both

14. The outer surface of the plasma membrane contains:

- A) Intermediate filaments
- B) Microfilament

Cell Cycle

Introduction to Cell Cycle

1. The **cell cycle** is the series of events from the formation of a cell until it divides into two daughter cells.
2. Rudolf Virchow proposed the principle that **all cells come from pre-existing cells**.
3. The two main phases of the cell cycle are **Interphase** and the **M phase (Mitotic phase)**.

Interphase

4. **Interphase** is the period between two consecutive cell divisions and is a phase of high metabolic activity, not a resting phase.
5. Interphase lasts for about **90%** of the total cell cycle time.
6. Interphase is divided into three sub-phases: **G1, S, and G2**.
7. During the **G1 phase (First Gap Phase)**, the cell grows in size, synthesizes proteins and organelles, and produces enzymes required for DNA replication.
8. The **S phase (Synthesis Phase)** is when **DNA replication** occurs, resulting in each chromosome consisting of two identical **sister chromatids**.
9. During the **G2 phase (Second Gap Phase)**, the cell continues to grow, produces proteins essential for division (like tubulin for spindle fibres), and checks for DNA damage.
10. Cells that temporarily or permanently stop dividing enter a state called the **G0 phase** (quiescence).
11. Examples of cells that enter **G0** permanently include **neurons** and cells of the **eye lens**.

Mitosis

12. **Mitosis** is a type of cell division where a parent cell divides to produce two daughter cells with the **same number of chromosomes** as the parent cell.
13. Mitosis occurs in the **somatic cells** (body cells) of eukaryotes.
14. The process similar to mitosis in prokaryotes is called **binary fission**.
15. Mitosis is divided into two main stages: **Karyokinesis** (division of the nucleus) and **Cytokinesis** (division of the cytoplasm).
16. **Karyokinesis** is further divided into four phases: **Prophase, Metaphase, Anaphase, and Telophase**.
17. During **Prophase**, **chromatin** condenses into visible **chromosomes**, the nucleolus disappears, and the nuclear envelope breaks down.
18. In animal cells, the **centrosome** duplicates, and the two centrosomes move to opposite poles, forming the **mitotic spindle** made of **spindle fibres**.
19. Plant cells lack **centrioles**; their spindle fibres are formed by the aggregation of tubulin proteins in the cytoplasm.
20. During **Metaphase**, chromosomes, attached to spindle fibres at their **kinetochores**, align at the cell's equator, forming the **metaphase plate**.

Practice MCQs

1. What is the series of events from a cell's formation until it divides into daughter cells called?

- A) Interphase
- B) Mitotic Phase
- C) Cell Cycle
- D) Cytokinesis

Answer: Cell Cycle

2. Which phase of the cell cycle is characterized by high metabolic activity and preparation for division?

- A) M Phase
- B) Cytokinesis
- C) Interphase
- D) G0 Phase

Answer: Interphase

3. During which phase of interphase is DNA replicated?

- A) G1 Phase
- B) G2 Phase
- C) S Phase
- D) M Phase

Answer: S Phase

4. A cell that has temporarily or permanently stopped dividing is said to be in which phase?

- A) G1 Phase
- B) S Phase
- C) G2 Phase
- D) G0 Phase

Answer: G0 Phase

5. Which type of cell division ensures the same number of chromosomes in the daughter cells as in the parent cell?

- A) Meiosis
- B) Mitosis
- C) Binary Fission
- D) Apoptosis

Answer: Mitosis

6. The division of the nucleus during cell division is known as:

- A) Cytokinesis
- B) Karyokinesis
- C) Synapsis
- D) Phragmoplast

Answer: Karyokinesis

7. During which phase of mitosis do chromosomes condense and become visible?

- A) Metaphase
- B) Anaphase
- C) Telophase
- D) Prophase

Answer: Prophase

8. In animal cells, which organelle is responsible for organizing the mitotic spindle?

- A) Nucleolus
- B) Centrosome
- C) Golgi Apparatus
- D) Lysosome

Answer: Centrosome

9. The structure where spindle fibers attach to a chromosome is called the:

- A) Centromere
- B) Kinetochore
- C) Chromatid
- D) Aster

Answer: Kinetochore

10. At which stage of mitosis do chromosomes align at the equator of the cell?

- A) Prophase
- B) Metaphase
- C) Anaphase
- D) Telophase

Answer: Metaphase

11. The separation of sister chromatids occurs during which phase of mitosis?

- A) Prophase
- B) Metaphase
- C) Anaphase
- D) Telophase

Answer: Anaphase

12. What is the reverse of prophase, where nuclear envelopes reform?

- A) Metaphase
- B) Anaphase
- C) Telophase
- D) Interphase

Answer: Telophase

13. How does cytokinesis in plant cells differ from that in animal cells?

- A) Formation of a cleavage furrow

Chromosomes and DNA

Discovery and Basic Concepts of Chromosomes

1. **Chromosomes** are thread-like structures that appear inside the nucleus at the time of **cell division**.
2. They were first observed in 1882 by the German embryologist **Walther Fleming** in the rapidly dividing cells of **salamander larvae**.
3. The term "chromosome" was proposed by **Waldeyer**, which literally means coloured bodies.
4. The number of chromosomes varies from species to species and is a characteristic feature.
5. **Penicillium**, a fungus, has only **one pair** of chromosomes, while some ferns have more than **500 pairs**.
6. A mosquito has **6**, honeybee **32**, corn **20**, sugarcane **80**, frog **26**, and a mouse has **40** chromosomes.
7. Human cells have **46** chromosomes, consisting of **23 pairs**.
8. The particular array of chromosomes that an individual possesses is called its **karyotype**.
9. The possession of all chromosomes is essential for survival, and missing a part or whole chromosome leads to serious consequences or death.
10. In an interphase cell, chromosomes become uncondensed and form a fine network called the **chromatin network**.

Morphology and Types of Chromosomes

11. A typical chromosome is made of two **chromatids**, a **centromere (primary constriction)**, and sometimes a **secondary constriction**.
12. Chromatids are attached to each other at the **centromere**, which divides the chromosome into two arms.
13. The **secondary constriction** is also called the **nucleolar organizer** and gives rise to nucleoli during interphase.
14. The knob-like structure at the end of a chromosome, beyond the secondary constriction, is called a **satellite**.
15. The terminal ends of chromosomes are called **telomeres**, which prevent chromosomes from attaching to each other.
16. Chromosomes are classified based on centromere position: **metacentric** (center), **submetacentric** (slightly off-center), **acrocentric** (near the end), and **telocentric** (at the end).
17. At anaphase, chromosomes acquire shapes like **i, j, and V** depending on the centromere location.

Composition and Organization of Chromosomes

18. Chromosomes are composed of about **40% DNA** and **60% protein**, with a significant amount of RNA associated with them.
19. A typical human chromosome contains about **140 million nucleotides** in its DNA.
20. The DNA of a single human chromosome, if stretched out, would be about **5 centimeters** long.
21. DNA is a **negatively charged** molecule due to its phosphate groups.
22. **Histones** are positively charged proteins due to an abundance of the basic amino acids **arginine and lysine**.
23. In the nucleus, DNA is coiled around histone proteins to form a complex known as a **nucleosome**.
24. A nucleosome consists of a DNA duplex coiled around a core of **eight histone proteins** every **200 nucleotides**.
25. The chain of nucleosomes is called a **nucleosome string** (10 nm thick), which coils to form the **chromatin fibre** (30 nm thick).
26. The chromatin fibre undergoes higher-order coiling to form a **supercoil** (300 nm), which further condenses into a **chromatid** (700 nm).
27. **Heterochromatin** is the highly condensed, transcriptionally inactive region of chromatin.
28. **Euchromatin** is the less condensed, genetically active region of chromatin that is expressed.

Chromosomal Theory of Inheritance

Practice MCQs

1. Who first observed chromosomes in the dividing cells of salamander larvae in 1882?

- A) Walter Sutton
- B) T.H. Morgan
- C) Walther Fleming
- D) Karl Correns

Answer: Walther Fleming

2. The term "chromosome," meaning coloured body, was proposed by:

- A) Fleming
- B) Waldeyer
- C) Sutton
- D) Mendel

Answer: Waldeyer

3. What is the diploid chromosome number in a human cell?

- A) 46
- B) 23
- C) 32
- D) 20

Answer: 46

4. Which organism has only one pair of chromosomes?

- A) Frog
- B) Penicillium
- C) Mosquito
- D) Mouse

Answer: Penicillium

5. The particular array of chromosomes an individual possesses is called its:

- A) Phenotype
- B) Genotype
- C) Karyotype
- D) Allele

Answer: Karyotype

6. A chromosome with a centromere located at its terminal end is classified as:

- A) Metacentric
- B) Submetacentric
- C) Acrocentric
- D) Telocentric

Answer: Telocentric

7. The terminal ends of chromosomes that prevent fusion are called:

- A) Satellites

B) Centromeres

C) Telomeres

D) Kinetochore

Answer: Telomeres

8. What is the approximate percentage composition of DNA in a chromosome?

- A) 20%
- B) 40%
- C) 60%
- D) 80%

Answer: 40%

9. A typical human chromosome contains approximately how many nucleotides?

- A) 140 million
- B) 14 million
- C) 1.4 billion
- D) 140 billion

Answer: 140 million

10. The positively charged proteins that DNA wraps around to form nucleosomes are:

- A) Enzymes
- B) Histones
- C) Collagens
- D) Keratins

Answer: Histones

11. The basic repeating structural unit of eukaryotic chromatin is the:

- A) Chromosome
- B) Nucleosome
- C) Ribosome
- D) Lysosome

Answer: Nucleosome

12. The highly condensed, transcriptionally inactive form of chromatin is called:

- A) Euchromatin
- B) Heterochromatin
- C) Nucleochromatin
- D) Asterochromatin

Answer: Heterochromatin

13. Who first suggested a central role for chromosomes in heredity in 1900?

- A) Walter Sutton
- B) Gregor Mendel
- C) T.H. Morgan
- D) Karl Correns



Variation and Genetics

Fundamental Concepts

1. A **gene** is the basic unit of biological information and a segment of DNA that codes for a polypeptide.
2. The position of a gene on a chromosome is called its **locus**.
3. Partners of a gene pair occupying the same locus on homologous chromosomes are called **alleles**.
4. The genetic complement of an individual is called its **genotype**.
5. The measurable or observable trait or characteristic of an individual is called its **phenotype**.
6. When both alleles of a gene pair are identical, the individual is said to be **homozygous**.
7. When the two alleles of a gene pair are different, the individual is said to be **heterozygous**.
8. A **gene pool** is the sum total of all genes and their alleles in a breeding population at a given time.
9. A sudden, permanent change in the cell's DNA is called a **mutation**.
10. **Jumping genes** are genes that do not settle at one locus and keep hopping on the same or different chromosomes.

Mendel's Laws of Inheritance

11. **Gregor Johann Mendel** is known as the father of genetics for his work on pea plants.
12. Mendel established **true-breeding** lines for his experiments, which always produced offspring identical to parents upon self-fertilization.
13. A cross between two individuals differing in a single trait is called a **monohybrid cross**.
14. In a monohybrid cross, the F1 generation exhibits only the **dominant** phenotype.
15. The phenotypic ratio in the F2 generation of a monohybrid cross is **3:1**.
16. The genotypic ratio in the F2 generation of a monohybrid cross is **1:2:1** (Homozygous Dominant: Heterozygous: Homozygous Recessive).
17. Mendel's **Law of Segregation** states that the two alleles for each trait separate (segregate) from each other during gamete formation so that each gamete gets only one allele.
18. A cross used to determine the genotype of an individual with a dominant phenotype is called a **test cross**.
19. A cross between two individuals differing in two traits is called a **dihybrid cross**.
20. In a dihybrid cross, the F1 generation is heterozygous for both traits and exhibits the dominant phenotype for both.
21. The phenotypic ratio in the F2 generation of a dihybrid cross, with independent assortment, is **9:3:3:1**.
22. Mendel's **Law of Independent Assortment** states that alleles for different traits assort independently of one another during gamete formation.
23. Independent assortment occurs because chromosomes orient independently during **metaphase I** of meiosis.
24. The inheritance of genes is based on **mathematical probabilities**.
25. The **product rule** states that the probability of two independent events occurring together is the product of their individual probabilities.

Practice MCQs

1. Genes that keep hopping on different loci on the same or different chromosomes are called:

- A) Polygene
- B) Multiple gene
- C) Jumping gene
- D) Allele

Answer: Jumping gene

2. The partner of a gene pair occupying the same gene locus is called:

- A) Nucleosome
- B) Genome
- C) Allele
- D) Gene

Answer: Allele

3. When a gene at one locus interacts with and suppresses the effect of a gene at another locus, the interaction is known as:

- A) Multiple alleles
- B) Pleiotropy
- C) Dominance
- D) Epistasis

Answer: Epistasis

4. In which dominance relation are the genotype and phenotype ratios the same in the F₂ generation?

- A) Over dominance
- B) Co-dominance
- C) Complete dominance
- D) Incomplete dominance

Answer: Incomplete dominance

5. The ABO blood group system is an example of:

- A) Polygene
- B) Multiple genes
- C) Multiple alleles
- D) Multiple mutation

Answer: Multiple alleles

6. The physiological effect of an allele over its partner allele at the same gene locus is called:

- A) Epistasis
- B) Pleiotropy
- C) Dominance
- D) Mutation

Answer: Dominance

7. The position of a gene on a chromosome is called:

- A) Location
- B) Place
- C) Locus
- D) Habitat

Answer: Locus

8. A permanent change in the cell's DNA is called:

- A) Amplification
- B) Transposition
- C) Inheritance
- D) Mutation

Answer: Mutation

9. During a monohybrid cross, what proportion of the F₂ generation are true-breeding for the dominant trait?

- A) 2/4
- B) 1/4
- C) 3/4
- D) 4/4

Answer: 1/4

10. Alleles of two or more gene pairs at different loci influencing the same trait in an additive way define:

- A) Epistasis
- B) Pleiotropy
- C) Polygene
- D) Mutation

Answer: Polygene

11. A character determined by three alleles is:

- A) Human skin color
- B) Human eye color
- C) Human blood group
- D) Human Rh factor

Answer: Human blood group

12. A measurable or observable trait is called:

- A) Phenotype
- B) Genotype
- C) Single nucleotide Polymorphism
- D) Genome

Answer: Phenotype

13. X-linked dominant traits are more common in:

- A) Males
- B) Females
- C) Insects
- D) Males and females equally

Answer: Females



Evolution

Introduction to Evolutionary Concepts

1. **Evolution** refers to the processes that have transformed life on Earth from its earliest forms to the vast diversity observed today.
2. The idea that organisms evolve was first suggested by ancient philosophers like **Aristotle**.
3. **Creationism** is the concept that each species was specially created by God in its present form and is incapable of change.
4. **Evolutionists** believe that life is the result of much stable change from lower to higher forms over time.
5. **Charles Darwin** was the first to argue from evidence that species evolved from ancestral species and proposed **Natural Selection** as the mechanism.

Historical Background of Evolutionary Thought

1. **Carolus Linnaeus** introduced binomial nomenclature and sought order in the diversity of life, though he believed in the permanence of species.
2. **Jean-Baptiste Lamarck** was the first to propose a comprehensive theory of evolution in his 1809 book *Philosophie Zoologique*.
3. **George Cuvier**, a proponent of **Catastrophism**, explained Earth's history by a series of sudden, catastrophic events.
4. **James Hutton** and **Charles Lyell** proposed **Uniformitarianism**, which states that geological changes are slow and continuous, indicating a very old Earth.
5. **Thomas Malthus**, in his *Essay on the Principle of Population*, noted that populations can grow exponentially while food supply grows only arithmetically, leading to a struggle for existence.
6. **Alfred Russel Wallace** independently developed a theory of natural selection nearly identical to Darwin's, which prompted Darwin to publish his work.
7. The joint papers of Darwin and Wallace were presented to the **Linnaean Society of London** on July 1, 1858.

Lamarckism

8. **Lamarckism** is based on two main ideas: the **use and disuse of organs** and the **inheritance of acquired characteristics**.
9. Lamarck argued that organs used extensively become larger and stronger, while disused organs deteriorate and disappear over generations.
10. The classic example of Lamarckism is the evolution of the **giraffe's long neck** due to constant stretching to reach higher leaves.
11. The **drawbacks of Lamarckism** include a lack of experimental proof and the fact that acquired characteristics are **non-genetic** and cannot be inherited.
12. **August Weismann** disproved the inheritance of acquired characteristics by cutting off the tails of mice for many generations with no effect.

Darwinism and Natural Selection

13. **Charles Darwin** developed his theory after observations made during his five-year voyage on the **HMS Beagle**, particularly in the **Galapagos Islands**.

Practice MCQs

1. Who proposed the theory of inheritance of acquired characteristics?

- A) Charles Darwin
- B) Thomas Malthus
- C) Alfred Wallace
- D) Jean-Baptiste Lamarck

Answer: Jean-Baptiste Lamarck

2. The concept that geological processes are slow and continuous, and that the Earth is very old, is known as:

- A) Catastrophism
- B) Creationism
- C) Uniformitarianism
- D) Lamarckism

Answer: Uniformitarianism

3. Which scientist's work on population growth inspired Darwin's concept of the struggle for existence?

- A) Charles Lyell
- B) Thomas Malthus
- C) James Hutton
- D) Gregor Mendel

Answer: Thomas Malthus

4. The wings of a bird and the wings of an insect are an example of:

- A) Homologous structures
- B) Vestigial structures
- C) Analogous structures
- D) Divergent evolution

Answer: Analogous structures

5. What is the total aggregate of genes in a population at any one time called?

- A) Genotype
- B) Allele frequency
- C) Gene pool
- D) Genetic drift

Answer: Gene pool

6. According to the Hardy-Weinberg principle, the frequency of the heterozygous genotype is represented by:

- A) p^2
- B) q^2
- C) p
- D) $2pq$

Answer: $2pq$

7. The oldest known fossils on Earth are of:

- A) Fungi
- B) Eukaryotes
- C) Prokaryotes
- D) Multicellular animals

Answer: Prokaryotes

8. The evolution of the modern horse, showing a reduction in the number of toes, is evidence from:

- A) Biogeography
- B) The fossil record
- C) Comparative embryology
- D) Molecular biology

Answer: The fossil record

9. Which of the following is a condition for a population to be in Hardy-Weinberg equilibrium?

- A) Non-random mating
- B) Gene flow
- C) Natural selection
- D) Large population size

Answer: Large population size

10. The theory that mitochondria and chloroplasts evolved from free-living prokaryotes is known as the:

- A) Membrane invagination theory
- B) Theory of special creation
- C) Endosymbiont theory
- D) Fluid mosaic model

Answer: Endosymbiont theory

11. The human appendix, tailbone (coccyx), and wisdom teeth are examples of:

- A) Homologous structures
- B) Analogous structures
- C) Vestigial organs
- D) Adaptive structures

Answer: Vestigial organs

12. A change in the frequency of alleles in a small population due to a random event is called:

- A) Gene flow
- B) Natural selection
- C) Genetic drift
- D) Mutation

Answer: Genetic drift

13. The book "Philosophie Zoologique," which presented an early theory of evolution, was written by:



Ecology & Environment

Introduction to Ecology & Ecosystem

1. **Ecology** is the study of the interrelationship between organisms and their environment.
2. The term ecology was originally coined by the German zoologist **Ernst Haeckel** in 1866.
3. The environment includes both **physical (abiotic)** and **biological (biotic)** conditions.
4. The major unit of ecology is the **ecosystem**.
5. An **ecosystem** is a self-sufficient unit formed by interactions between a biotic community and abiotic components.
6. **Biotic components** consist of all living organisms like plants, animals, fungi, and microorganisms.
7. **Abiotic components** include non-living factors like air, water, soil, light, and temperature.
8. A **population** is a group of interbreeding individuals of the same species occurring together in space and time.
9. A **community** is formed by all the populations that live in a habitat and interact with one another.
10. Major types of ecosystems that occupy broad geographical regions are called **biomes**.
11. The **biosphere** is a thin layer of Earth where all life exists, extending from the ocean depths to the upper atmosphere.
12. The **habitat** is the actual location or place where an organism lives.
13. The **niche** is the role a species plays in a community, including its behavior and influence.
14. **Autecology** is the study of a single population's relationship to its environment.
15. **Synecology** is the study of the relationship of different communities to their environment.

Components and Processes in an Ecosystem

16. The three main functional components of an ecosystem concerned with feeding are **producers, consumers, and decomposers**.
17. **Producers** are autotrophs, primarily green plants, that manufacture organic food from inorganic substances.
18. In aquatic ecosystems, the main producers are **phytoplankton** and shallow water rooted plants.
19. **Consumers** are heterotrophs that obtain energy directly or indirectly from producers.
20. **Herbivores** are primary consumers that feed directly on producers.
21. **Carnivores** are consumers that feed on other animals; they can be primary, secondary, or tertiary consumers.
22. **Decomposers**, mainly fungi and bacteria, obtain energy from dead and decaying matter and release chemical elements back into the environment.
23. The main processes in an ecosystem include **feeding, circulation of chemical elements, and energy flow**.
24. A **food chain** is a series of organisms where each feeds on the one before it and is fed upon by the one after it.
25. All food chains begin with a **producer (green plant)**.
26. The combination of many interconnected food chains is called a **food web**.
27. Each step in a food chain is known as a **trophic level**.
28. **Trophic level 1 (T1)** consists of producers.
29. **Trophic level 2 (T2)** consists of primary consumers (herbivores).
30. **Trophic level 3 (T3)** consists of secondary consumers.
31. **Trophic level 4 (T4)** consists of tertiary consumers.
32. Decomposers occupy the **fifth trophic level (T5)**.
33. A short food chain is more efficient at supporting a community than a long one.

Energy Flow and Ecological Pyramids

34. The **Sun** is the primary source of energy for almost all ecosystems.
35. Only about **1%** of the total solar energy is trapped by producers in an ecosystem.
36. The total amount of energy fixed by plants is the **Gross Primary Production (GPP)**.

Practice MCQs

1. What is the study of the interrelationship between organisms and their environment called?

- A) Biology
- B) Physiology
- C) Ecology
- D) Geology

Answer: Ecology

2. Who originally coined the term 'ecology'?

- A) Charles Darwin
- B) Ernst Haeckel
- C) Charles Elton
- D) Joseph Grinnell

Answer: Ernst Haeckel

3. The major unit of ecological study is the:

- A) Population
- B) Community
- C) Ecosystem
- D) Biome

Answer: Ecosystem

4. Which of the following is an abiotic component of an ecosystem?

- A) Plant
- B) Fungus
- C) Water
- D) Animal

Answer: Water

5. A group of interbreeding individuals of the same species in a given area is a:

- A) Community
- B) Population
- C) Family
- D) Biome

Answer: Population

6. All the populations inhabiting a common area and interacting is called a:

- A) Species
- B) Community
- C) Ecosystem
- D) Biosphere

Answer: Community

7. The actual location where an organism lives is its:

- A) Niche
- B) Habitat
- C) Ecosystem

D) Community

Answer: Habitat

8. The functional role of a species in a community is its:

- A) Habitat
- B) Niche
- C) Territory
- D) Domain

Answer: Niche

9. The study of a single population's relationship to its environment is:

- A) Synecology
- B) Autecology
- C) Genetics
- D) Physiology

Answer: Autecology

10. Organisms that can synthesize their own food are called:

- A) Consumers
- B) Decomposers
- C) Producers
- D) Herbivores

Answer: Producers

11. In an aquatic ecosystem, the main producers are:

- A) Sea grasses
- B) Phytoplankton
- C) Zooplankton
- D) Fish

Answer: Phytoplankton

12. Animals that feed directly on producers are called:

- A) Primary Consumers
- B) Secondary Consumers
- C) Tertiary Consumers
- D) Decomposers

Answer: Primary Consumers

13. Fungi and bacteria in an ecosystem act as:

- A) Producers
- B) Consumers
- C) Decomposers
- D) Herbivores

Answer: Decomposers

14. The sequence of organisms through which energy and nutrients move is a:

M
K

P
R
E
P
A
R
A
T
I
O
N
S

10. Ecology & Environment

Plant Systems, Reproduction, and Physiology

Plant Root System

1. The **root system** is primarily responsible for **anchoring** the plant and **absorbing water and minerals**.
2. The root system originates from the **radicle** of the embryo.
3. The **taproot system** has a single dominant primary root and is found in **dicots** like mustard and mango.
4. The **fibrous root system** has numerous thin, thread-like roots and is found in **monocots** like grasses and wheat.
5. The **root cap** is a protective covering at the root tip that shields the meristem.
6. The **region of meristematic activity** contains cells that are constantly dividing.
7. The **region of elongation** is where cells elongate, leading to root growth.
8. The **region of maturation** contains **root hairs** for absorption.
9. **Root hairs** are unicellular extensions of epidermal cells that increase surface area for absorption.
10. The internal structure of a root consists of the **epidermis, cortex, endodermis, and vascular system**.
11. The **endodermis** contains the **Casparian strip**, a waxy band that regulates water and solute entry into the vascular cylinder.
12. **Xylem** conducts water and minerals **upwards** from roots to shoots.
13. **Phloem** transports food via **translocation** in **all directions**.

Plant Shoot System & Leaf Structure

14. The **shoot system** comprises the aerial parts: stem, branches, leaves, flowers, and fruits.
15. The **stem** provides support, bears leaves and flowers, and contains vascular bundles.
16. The **leaf** is the primary site for **photosynthesis** and **transpiration**.
17. The **petiole** is the stalk that attaches the leaf to the stem.
18. The **lamina** is the flat, green, expanded part of the leaf.
19. The internal structure of a leaf includes the **epidermis, mesophyll, and stomata**.
20. The **epidermis** is covered by a waxy **cuticle** to reduce water loss.
21. The **mesophyll** is divided into **palisade** and **spongy** layers.
22. **Palisade mesophyll** consists of tightly packed cells rich in **chloroplasts** for maximum light absorption.
23. **Spongy mesophyll** has irregular cells with large **air spaces** to facilitate gas exchange.
24. **Stomata** are minute pores surrounded by **guard cells** that regulate gaseous exchange and transpiration.

Transport in Plants

25. **Xylem** is composed of dead cells (vessels and tracheids).
26. **Phloem** is composed of living cells (sieve tubes and companion cells).
27. Water movement in xylem is driven by **root pressure, capillary action, and transpiration pull**.
28. Food movement in phloem occurs via **translocation**, an active process requiring energy.
29. The **TACT mechanism** explains water ascent: **Transpiration, Adhesion, Cohesion, and Tension**.
30. **Transpiration pull** is the main driving force for the ascent of sap.

86. **Geotropism** is growth in response to gravity (roots are positive, shoots are negative).
87. **Thigmotropism** is growth in response to touch (e.g., climbing vines).
88. **Chemotropism** is growth in response to chemicals (e.g., pollen tube growth).
89. **Photoperiodism** is the plant's response to the relative lengths of day and night, influencing flowering.
90. Plants are classified as **short-day plants**, **long-day plants**, or **day-neutral plants** based on photoperiodism.
91. The photoreceptor for photoperiodism is **phytochrome**, which exists in two interconvertible forms: **P₆₆₀** (**Pr**) and **P₇₃₀** (**Pfr**).
92. **Vernalization** is the promotion of flowering by exposure to **low temperatures**.
93. **Osmoregulation** involves maintaining water and solute balance.
94. **Hydrophytes** are plants adapted to aquatic environments.
95. **Xerophytes** are plants adapted to dry conditions with features like sunken stomata and succulent tissues.
96. **Mesophytes** are plants adapted to moderate environments.
97. **Halophytes** are plants adapted to saline soils.
98. **Turgor pressure** provides support to herbaceous plants.
99. Supporting tissues in plants include **parenchyma**, **collenchyma**, and **sclerenchyma**.
100. **Sclerenchyma** cells have thick, lignified walls and are dead at maturity, providing structural support.

Practice MCQs

1. What is the primary function of the root system in plants?

- A) Photosynthesis
- B) Reproduction
- C) Anchoring and absorption of water and minerals
- D) Gas exchange

Answer: Anchoring and absorption of water and minerals

2. Which type of root system is characterized by a single dominant primary root?

- A) Fibrous root system
- B) Taproot system
- C) Adventitious root system
- D) Aerial root system

Answer: Taproot system

3. What are the unicellular extensions of epidermal cells in the root that increase surface area for absorption?

- A) Root cap
- B) Root hairs
- C) Casparian strip
- D) Endodermis

Answer: Root hairs

4. The protective cap covering the tip of the root is called the?

- A) Region of maturation
- B) Root hair
- C) Root cap
- D) Meristem

Answer: Root cap

5. Which layer of the root contains the Casparian strip and regulates the entry of substances into the vascular cylinder?

- A) Epidermis
- B) Cortex
- C) Endodermis
- D) Pericycle

Answer: Endodermis

6. Which vascular tissue is responsible for the upward conduction of water and minerals?

- A) Phloem
- B) Xylem
- C) Cambium
- D) Cortex

Answer: Xylem

7. The movement of food in all directions through the plant is called?



Human Digestive System

Introduction to the Digestive System

1. The **digestive system** breaks down food into absorbable forms to deliver nutrients to body cells.
2. It consists of the **gastrointestinal tract (GIT)** and **accessory digestive organs**.
3. The GIT is a continuous tube from the **mouth** to the **anus**.
4. The four major layers of the GIT wall, from innermost to outermost, are: **mucosa, submucosa, muscularis, and serosa**.
5. **Viscera** is a general term for abdominal organs, including those of digestion.
6. The term **gut** generally refers to the developing stomach and intestine.

The Oral Cavity

7. The **oral cavity** is bounded by lips anteriorly, cheeks laterally, palate superiorly, and a muscular floor inferiorly.
8. It is lined with **stratified squamous epithelium** for protection against abrasion.
9. The **palate** consists of the anterior **hard palate** and the posterior **soft palate**.
10. The **uvula** is a projection from the soft palate that helps prevent food from entering the nasal cavity during swallowing.
11. **Palatine tonsils** are located in the lateral walls of the fauces.
12. **Mechanical digestion** in the mouth is called **mastication** (chewing), performed by the teeth.
13. **Chemical digestion** in the mouth is initiated by **salivary amylase** on starch.
14. Three pairs of major salivary glands are: **parotid, submandibular, and sublingual**.
15. **Saliva** contains water, mucus, salivary amylase, bicarbonate ions, lysozyme, and immune globulins.
16. Saliva has a pH of 6.0-7.0, which is favorable for salivary amylase activity.
17. **Lingual lipase**, secreted by Ebner's glands, begins fat digestion in the mouth.
18. Chewing increases the **surface area** of food for enzymatic action.
19. The mass of chewed and moistened food is called a **bolus**.

The Pharynx and Swallowing (Deglutition)

20. The **pharynx** is a common passage for food and air, divided into nasopharynx, oropharynx, and laryngopharynx.
21. **Swallowing** has three phases: **voluntary oral phase, involuntary pharyngeal phase, and involuntary esophageal phase**.
22. During the pharyngeal phase, the **soft palate** rises to close the nasopharynx.
23. The **epiglottis** covers the glottis (opening to the larynx) to prevent food from entering the trachea.
24. The **upper esophageal sphincter** relaxes to allow the bolus to enter the esophagus.

The Esophagus

25. The **esophagus** is a muscular tube about 25 cm long connecting the pharynx to the stomach.
26. It lies posterior to the trachea and passes through the diaphragm via the **esophageal hiatus**.

Practice MCQs

1. Which enzyme in saliva initiates the chemical digestion of carbohydrates in the oral cavity?

- A) Pepsin
- B) Lingual lipase
- C) Gastric lipase
- D) Salivary amylase

Answer: Salivary amylase

2. What is the primary function of the soft palate and uvula during swallowing?

- A) Prevent food from entering the trachea
- B) Prevent food from entering the nasal cavity
- C) Produce saliva for lubrication
- D) Push the bolus into the pharynx

Answer: Prevent food from entering the nasal cavity

3. The wave-like muscular contractions that propel food through the esophagus are known as:

- A) Segmentation
- B) Emulsification
- C) Mastication
- D) Peristalsis

Answer: Peristalsis

4. Which cells in the gastric glands are responsible for the secretion of hydrochloric acid (HCl)?

- A) Chief cells
- B) Mucous cells
- C) Parietal cells
- D) G cells

Answer: Parietal cells

5. The semi-liquid, acidic mass of partially digested food that leaves the stomach is called:

- A) Bolus
- B) Chyle
- C) Chyme
- D) Feces

Answer: Chyme

6. Which vitamin requires intrinsic factor, produced by the parietal cells, for its absorption in the ileum?

- A) Vitamin A
- B) Vitamin C
- C) Vitamin D
- D) Vitamin B₁₂

Answer: Vitamin B₁₂

7. The first and shortest part of the small intestine that receives chyme from the stomach is the:

- A) Jejunum
- B) Ileum
- C) Duodenum
- D) Cecum

Answer: Duodenum

8. Bile salts play a crucial role in the digestion of fats by which of the following processes?

- A) Enzymatic hydrolysis
- B) Active transport
- C) Emulsification
- D) Denaturation

Answer: Emulsification

9. Which of the following pancreatic enzymes is secreted in an inactive form (zymogen) to prevent self-digestion?

- A) Pancreatic amylase
- B) Pancreatic lipase
- C) Trypsinogen
- D) Ribonuclease

Answer: Trypsinogen

10. The tiny, finger-like projections in the small intestine that greatly increase its surface area for absorption are called:

- A) Rugae
- B) Villi
- C) Microvilli
- D) Haustra

Answer: Villi

11. The absorption of digested fats into the lymphatic system of the villi occurs in the form of:

- A) Micelles
- B) Free fatty acids
- C) Chylomicrons
- D) Glycerol

Answer: Chylomicrons

12. What is the primary function of the large intestine?

- A) Digestion of proteins
- B) Absorption of water and electrolytes
- C) Emulsification of fats
- D) Production of bile

Answer: Absorption of water and electrolytes



Human Respiratory System

Introduction to Respiration

1. **External respiration** involves the exchange of gases between the environment and the blood at the body system level.
2. **Internal respiration** refers to cellular catabolic processes that use oxygen and produce carbon dioxide.
3. The main organs providing the **respiratory surface** for gaseous exchange are the **lungs**.

Properties of the Respiratory Surface

4. The **respiratory surface** must be **moist and permeable** for gases to diffuse.
5. It must be **thin** to minimize the diffusion distance for gases.
6. A **large surface area** is essential for sufficient gas exchange.
7. A **good blood supply** is required for efficient transport of gases.
8. A **good ventilation mechanism** maintains a steep diffusion gradient.
9. It is **located internally** to prevent water loss from its moist surface.
10. **Structural support** prevents it from collapsing.
11. Air reaches it via a **branched tubular way**, becoming saturated with water vapor.

Components of the Human Respiratory System

12. The respiratory system is divided into the **upper and lower respiratory tract**.
13. The **upper respiratory tract** includes the **nasal cavity, pharynx, and larynx**.
14. The **lower respiratory tract** includes the **trachea, bronchi, bronchioles, and lungs**.

Upper Respiratory Tract

15. The **nasal cavity** warms, humidifies, and filters inhaled air.
16. **Hairs, mucus, and cilia** in the nose trap foreign particles.
17. The **pharynx** is a common passage for both air and food.
18. The **larynx**, or voice box, contains the **vocal cords**.
19. The **epiglottis** is a cartilaginous flap that prevents food from entering the larynx during swallowing.
20. The opening of the larynx is called the **glottis**.

Lower Respiratory Tract

21. The **trachea** (windpipe) is supported by **C-shaped cartilaginous rings**.
22. The trachea divides into two **primary bronchi**.
23. The **right primary bronchus** is shorter, wider, and more vertical than the left.
24. **Bronchi** branch into **secondary and tertiary bronchi**.
25. **Bronchioles** are less than 1 mm in diameter and **lack cartilage**.
26. **Terminal bronchioles** end in **alveolar ducts**.
27. **Alveolar ducts** open into clusters of **alveoli**.
28. **Alveoli** are the **functional units** for gas exchange in the lungs.



89. Smoking is the main cause of **lung cancer**, responsible for about **87%** of cases.

90. Smoking also causes **chronic bronchitis** and **emphysema**.

91. It damages **cilia**, increasing the risk of infections like **pneumonia**.

92. Smoking can worsen **asthma and allergies**.

Other Key Concepts

93. The **total lung capacity** in humans is about **6000 ml**.

94. The **tidal volume** for a normal adult at rest is about **500 ml**.

95. The **residual volume** is the air that remains in the lungs after forced expiration (**~1.5 Liters**).

96. **Carbon monoxide (CO) poisoning** occurs because CO binds to haemoglobin with an affinity **249 times greater** than oxygen.

97. Symptoms of CO poisoning include **headache, dizziness, nausea, and cherry-red lips**.

98. Birds have a highly efficient respiratory system with **one-way air flow** and **air sacs**, allowing better oxygen extraction at high altitudes.

99. **CPR (Cardiopulmonary Resuscitation)** is a life-saving technique involving **mouth-to-mouth resuscitation**.

100. The **hilum** is the depression on the lung where blood vessels and airways enter.

Practice MCQs

1. What is the approximate residual volume of air that always remains in the human lungs?

- A) 0.5 Liters
- B) 1.0 Liter
- C) 1.5 Liters
- D) 3.0 Liters

Answer: 1.5 Liters

2. Through which process does gaseous exchange primarily occur in animals?

- A) Active Transport
- B) Osmosis
- C) Diffusion
- D) Facilitated Diffusion

Answer: Diffusion

3. Which part of the human respiratory system is the actual site of gas exchange?

- A) Trachea
- B) Bronchi
- C) Bronchioles
- D) Alveoli

Answer: Alveoli

4. During inhalation, what is the state of the diaphragm?

- A) Relaxed and dome-shaped
- B) Relaxed and flattened

- C) Contracted and dome-shaped
- D) Contracted and flattened

Answer: Contracted and flattened

5. What is the primary form in which carbon dioxide is transported in the blood?

- A) Dissolved in plasma
- B) Bound to haemoglobin as carbamino haemoglobin
- C) As bicarbonate ions
- D) Bound to plasma proteins

Answer: As bicarbonate ions

6. The right bronchus differs from the left bronchus in that it is:

- A) Longer and narrower
- B) Shorter and wider
- C) Identical in structure
- D) Lacks cartilage

Answer: Shorter and wider

7. Which respiratory pigment is primarily responsible for oxygen storage in muscles?

- A) Haemoglobin
- B) Myoglobin
- C) Haemocyanin
- D) Cytochrome

Answer: Myoglobin



Skeletal & Muscular System

Bones and Cartilage

1. The **skeleton** is an internal framework of bones and cartilage that provides support, protects organs, and enables movement.
2. The broad ends of a long bone are called the **epiphysis**.
3. The middle shaft of a long bone is called the **diaphysis**.
4. The outer connective tissue membrane covering the bone is the **periosteum**.
5. The dense, hard layer of bone found under the periosteum is the **compact bone**.
6. The basic structural unit of compact bone is the **Haversian system (Osteon)**.
7. A Haversian system consists of concentric layers of mineralized matrix called **lamellae**.
8. Small spaces within the lamellae that house mature bone cells are called **lacunae**.
9. Mature bone cells that maintain bone tissue are called **osteocytes**.
10. The central canal in a Haversian system that contains blood vessels and nerves is the **Haversian canal**.
11. Small channels connecting lacunae to each other and to the Haversian canal are **canaliculi**.
12. The lattice-like, light, and strong bone found beneath the compact bone is **spongy (cancellous) bone**.
13. **Red bone marrow**, found in spongy bone, is responsible for the production of blood cells.
14. **Yellow bone marrow**, found in the shafts of long bones, consists mostly of fat cells and serves as an energy reserve.
15. **Osteoblasts** are bone-forming cells that synthesize and secrete the unmineralized bone matrix.
16. **Osteoclasts** are bone-destroying cells that break down bone tissue and release calcium into the blood.
17. The process of bone formation is called **osteogenesis** or **ossification**.
18. Most long bones develop from a cartilage model through a process called **endochondral ossification**.
19. The layer of connective tissue that surrounds cartilage is called the **perichondrium**.
20. Cartilage cells are called **chondrocytes** and are located within spaces in the matrix called **lacunae**.
21. Unlike bone, cartilage is **avascular** (lacks blood vessels), which slows its healing process.
22. **Hyaline cartilage** is found at the ends of long bones, in the nose, larynx, and trachea.
23. **Fibrocartilage** is found in areas of high stress, such as the intervertebral discs and the knee meniscus.
24. **Elastic cartilage** is found in the external ear and the epiglottis.

Human Skeleton (Axial & Appendicular)

25. The adult human skeleton consists of **206** bones.
26. The **axial skeleton** forms the central axis of the body and includes the skull, vertebral column, and rib cage.
27. The **appendicular skeleton** includes the bones of the limbs, pectoral girdle, and pelvic girdle.
28. The skull is composed of **22** bones.
29. The cranium (brain box) is made of **8** bones.
30. The two paired cranial bones are the **parietal** and **temporal** bones.
31. The unpaired cranial bones are the **frontal, occipital, ethmoid, and sphenoid** bones.
32. There are **14** facial bones.
33. The only movable bone in the skull is the **mandible** (jawbone).
34. The middle ear contains three pairs of ossicles: **malleus, incus, and stapes**.
35. The **hyoid bone** is a U-shaped bone in the neck that does not articulate with any other bone.
36. The vertebral column consists of **33** vertebrae in total.
37. The five groups of vertebrae are: **7 cervical, 12 thoracic, 5 lumbar, 5 sacral (fused), and 4 coccygeal (fused)**.
38. The first cervical vertebra is the **atlas**, which supports the skull.
39. The second cervical vertebra is the **axis**, which allows the head to rotate.

Practice MCQs

1. Which structure is the basic functional and structural unit of compact bone?

- A) Lacunae
- B) Canaliculi
- C) Haversian system
- D) Lamellae

Answer: Haversian system

2. The bone cells responsible for breaking down bone tissue to release calcium are called:

- A) Osteoblasts
- B) Osteocytes
- C) Osteoclasts
- D) Chondrocytes

Answer: Osteoclasts

3. Which type of cartilage is found in the intervertebral discs and the pubic symphysis?

- A) Hyaline cartilage
- B) Elastic cartilage
- C) Fibrocartilage
- D) Calcified cartilage

Answer: Fibrocartilage

4. The total number of bones in the adult human skeleton is:

- A) 106
- B) 206
- C) 306
- D) 406

Answer: 206

5. The first cervical vertebra, which articulates with the skull, is known as the:

- A) Axis
- B) Atlas
- C) Sacrum
- D) Coccyx

Answer: Atlas

6. How many pairs of true ribs are there in the human rib cage?

- A) 5
- B) 7
- C) 10
- D) 12

Answer: 7

7. The socket in the pelvic bone that articulates with the head of the femur is called the:

- A) Glenoid cavity

B) Acetabulum

C) Obturator foramen

D) Pubic symphysis

Answer: Acetabulum

8. Which of the following is an example of a fibrous joint?

- A) Shoulder joint
- B) Knee joint
- C) Skull suture
- D) Intervertebral disc

Answer: Skull suture

9. In a synovial joint, the fluid that reduces friction and lubricates the joint is:

- A) Lymph
- B) Synovial fluid
- C) Cerebrospinal fluid
- D) Serous fluid

Answer: Synovial fluid

10. A joint that allows movement in all planes, including rotation, is a:

- A) Hinge joint
- B) Pivot joint
- C) Ball-and-socket joint
- D) Gliding joint

Answer: Ball-and-socket joint

11. The medical condition 'Slipped Disc' is more accurately described as:

- A) Spondylosis
- B) Sciatica
- C) Herniation of the nucleus pulposus
- D) Osteoporosis

Answer: Herniation of the nucleus pulposus

12. Which type of arthritis is an autoimmune disorder affecting the synovial membrane?

- A) Osteoarthritis
- B) Rheumatoid arthritis
- C) Gouty arthritis
- D) Septic arthritis

Answer: Rheumatoid arthritis

13. Osteoporosis is characterized by:

- A) Inflammation of joints
- B) Weakened bones with reduced mass
- C) Slipping of intervertebral discs
- D) Curvature of the spine

Answer: Weakened bones with reduced mass



Nervous Coordination & Chemical Coordination

Introduction to Coordination

1. The system that provides coordination through electric signals among body parts is the **nervous system**.
2. The study of the structure and functions of the nervous system is called **neurology**.
3. **Nervous coordination** involves three basic steps: reception of stimulus, processing of information, and response to stimulus.
4. **Chemical coordination** is managed by the endocrine system through hormones.
5. A **receptor** acts as a **transducer**, converting energy from one form (e.g., light, sound) into an electrical impulse.

Neurons: Structure and Types

6. The basic structural and functional unit of the nervous system is the **neuron**.
7. The three main parts of a neuron are the **cell body**, **dendrites**, and **axon**.
8. The cell body contains **Nissl's granules**, which are groups of ribosomes and rough ER for protein synthesis.
9. **Dendrites** are short, branched extensions that receive stimuli and conduct impulses toward the cell body.
10. The **axon** is a long nerve fiber that conducts signals away from the cell body to the **presynaptic terminals**.
11. **Schwann cells** are neuroglial cells in the PNS that wrap around axons to form the **myelin sheath**.
12. The gaps between Schwann cells are called **Nodes of Ranvier**.
13. Based on function, the three types of neurons are **sensory neurons**, **motor neurons**, and **interneurons**.
14. **Sensory neurons** (afferent) transmit impulses from receptors to the CNS and are typically unipolar.
15. **Motor neurons** (efferent) transmit impulses from the CNS to effectors and are multipolar.
16. **Interneurons** are located entirely within the CNS and connect sensory and motor neurons.
17. Structurally, neurons can be **unipolar**, **bipolar**, or **multipolar**.

Nerve Impulse & Transmission

18. A **nerve impulse** is a wave of electrochemical changes that travels along a neuron.
19. The **resting membrane potential** is about **-70 mV**, with the inside of the neuron being negative relative to the outside.
20. The resting potential is maintained by the **sodium-potassium pump**, which actively transports **3 Na⁺ out** and **2 K⁺ in**.
21. The high concentration of **K⁺ inside** the cell and **Na⁺ outside** the cell contributes to the resting potential.
22. **Negative organic ions** (proteins, RNA) inside the neuron contribute to the negative internal charge.
23. An **action potential** is generated when a stimulus reaches the **threshold** level.
24. **Depolarization** is caused by the rapid influx of **Na⁺ ions** into the axon.
25. **Repolarization** occurs due to the efflux of **K⁺ ions** out of the axon.
26. **Hyperpolarization** is a brief overshoot where the membrane potential becomes more negative than the resting potential.
27. The period after an action potential when the neuron cannot be stimulated is the **refractory period**.

111. Insulin deficiency leads to **diabetes mellitus**.
112. The **adrenal medulla** secretes **epinephrine** and **norepinephrine** (fight-or-flight hormones).
113. The **adrenal cortex** secretes **glucocorticoids** (e.g., cortisol for glucose regulation) and **mineralocorticoids** (e.g., aldosterone for salt/water balance).
114. Adrenal cortex under secretion causes **Addison's disease**; over secretion causes **Cushing's disease**.
115. The **gonads** (testes and ovaries) produce sex hormones: **testosterone** in males and **estrogen/progesterone** in females.

Hypothalamus and Feedback Mechanisms

116. The **hypothalamus** is the master control center of the endocrine system, producing releasing and inhibiting hormones for the pituitary.
117. In **positive feedback**, the end product enhances the process (e.g., oxytocin in childbirth).
118. In **negative feedback**, the end product inhibits the process, maintaining homeostasis (e.g., insulin/glucagon regulating blood sugar).

Practice MCQs

1. Which part of a neuron is primarily responsible for receiving stimuli from other neurons?

- A) Axon
- B) Myelin sheath
- C) Dendrite
- D) Node of Ranvier

Answer: Dendrite

2. The rapid influx of which ion is responsible for the depolarization phase of an action potential?

- A) Potassium (K⁺)
- B) Chloride (Cl⁻)
- C) Calcium (Ca²⁺)
- D) Sodium (Na⁺)

Answer: Sodium (Na⁺)

3. Which division of the autonomic nervous system is responsible for the "fight or flight" response?

- A) Somatic
- B) Parasympathetic
- C) Sympathetic
- D) Enteric

Answer: Sympathetic

4. The junction between two neurons where communication occurs is known as the:

- A) Ganglion
- B) Synapse
- C) Node of Ranvier

D) Effector

Answer: Synapse

5. Which part of the brain is primarily responsible for maintaining balance and coordination?

- A) Cerebrum
- B) Thalamus
- C) Cerebellum
- D) Hypothalamus

Answer: Cerebellum

6. Which of the following is an inhibitory neurotransmitter?

- A) Acetylcholine
- B) Epinephrine
- C) GABA (Gamma-aminobutyric acid)
- D) Dopamine

Answer: GABA (Gamma-aminobutyric acid)

7. The myelin sheath around axons in the peripheral nervous system is produced by:

- A) Astrocytes
- B) Microglia
- C) Schwann cells
- D) Oligodendrocytes

Answer: Schwann cells

8. What is the resting membrane potential of a typical neuron?

- A) +40 mV
- B) 0 mV

Homeostasis & Thermoregulation

Introduction to Homeostasis

1. **Homeostasis** is the tendency of an organism to regulate its internal conditions to maintain health and functioning.
2. The **internal environment** consists of interstitial fluid, lymph, and plasma.
3. The **external environment** is the atmosphere or water in which the organism lives.
4. A homeostatic system consists of three components: **receptors, control center (integrator), and effectors**.
5. The primary feedback mechanism for maintaining homeostasis is **negative feedback**, which reverses a stimulus.
6. **Positive feedback** amplifies a stimulus and can be harmful; examples include childbirth and blood clotting.
7. The **hypothalamus** in the brain acts as the body's thermostat for temperature regulation.

Thermoregulation

8. **Thermoregulation** is the maintenance of internal temperature within a range that allows cells to function efficiently.
9. The main purpose of thermoregulation is to keep the **enzyme systems** of the body working properly.
10. Animals classified on the basis of their ability to thermoregulate are **poikilotherms** (variable temperature) and **homeotherms** (constant temperature).
11. Animals classified on the basis of their source of body heat are **ectotherms** (external heat source) and **endotherms** (internal heat production).
12. Birds and mammals are **endothermic homeotherms**.
13. Physiological responses to heat, controlled by the hypothalamus, include **vasodilation** and **sweating**.
14. **Vasodilation** increases blood flow to the skin surface, promoting heat loss via radiation.
15. **Sweating** cools the body through the evaporation of sweat from the skin's surface.
16. Physiological responses to cold include **vasoconstriction, shivering, piloerection, and increased metabolic rate**.
17. **Vasoconstriction** reduces blood flow to the skin, minimizing heat loss.
18. **Shivering** is the spasmodic contraction of muscles that produces heat.
19. **Piloerection** (erection of hairs) traps an insulating layer of air to reduce heat loss.
20. The normal core temperature of the human body is approximately **37°C**.

Osmoregulation

21. **Osmoregulation** is the maintenance of constant water and solute concentrations in the body.
22. **Osmoregulators** are animals that maintain an internal osmotic concentration different from their environment (e.g., freshwater animals, most marine vertebrates).
23. **Osmoconformers** are animals whose body fluid concentration changes with that of the external environment (e.g., marine invertebrates, sharks).
24. Freshwater animals are **hypertonic** to their environment, leading to a constant gain of water and loss of salts.
25. Marine bony fishes are **hypotonic** to seawater, leading to a constant loss of water and gain of salts.
26. To compensate for water loss, marine bony fishes **drink large amounts of seawater**.
27. **Ionocytes** are special salt cells in the gills of fishes and skin of amphibians that actively transport salts.

52. The **ascending limb** is impermeable to water but actively reabsorbs **NaCl**.
53. The **descending limb** is permeable to **water**.
54. **Antidiuretic Hormone (ADH)** makes the **collecting duct** permeable to water, promoting water reabsorption.
55. **Aldosterone** promotes the active reabsorption of **sodium ions (Na⁺)** in the distal tubule and collecting duct.

Disorders and Treatments

56. **Urinary Tract Infections (UTIs)** are more common in women due to a shorter urethra.
57. **Kidney stones (Nephrolithiasis)** are hard crystals formed in the kidney or urinary tract.
58. **Lithotripsy (ESWL)** is a non-surgical procedure that uses shock waves to break kidney stones.
59. **Dialysis** is an artificial method to filter blood when kidneys fail. The two main types are **hemodialysis** and **peritoneal dialysis**.
60. The only complete cure for end-stage renal failure (uremia) is a **kidney transplant**.

Practice MCQs

1. What is homeostasis?

- A) Movement of water across membranes
- B) Tendency to maintain internal stability
- C) Excretion of waste products
- D) Regulation of blood pressure

Answer: Tendency to maintain internal stability

2. Which part of the brain acts as the body's thermostat?

- A) Medulla
- B) Cerebellum
- C) Cerebrum
- D) Hypothalamus

Answer: Hypothalamus

3. What type of feedback mechanism is primarily responsible for maintaining homeostasis?

- A) Positive feedback
- B) Neutral feedback
- C) Negative feedback
- D) Reflex action

Answer: Negative feedback

4. Which of the following is an example of positive feedback?

- A) Regulation of blood sugar
- B) Maintenance of body temperature
- C) Childbirth
- D) ADH secretion

Answer: Childbirth

5. Thermoregulation is defined as the maintenance of:

- A) Constant blood glucose levels

- B) Stable internal temperature

- C) Constant water balance

- D) Stable blood pressure

Answer: Stable internal temperature

6. Which of these animals is an endotherm?

- A) Frog
- B) Lizard
- C) Great white shark
- D) Earthworm

Answer: Great white shark

7. The main physiological response to heat is:

- A) Vasoconstriction and shivering
- B) Vasodilation and sweating
- C) Piloerection and increased metabolic rate
- D) Vasoconstriction and piloerection

Answer: Vasodilation and sweating

8. Shivering is a physiological response to:

- A) Heat
- B) Cold
- C) Dehydration
- D) Low blood sugar

Answer: Cold

9. Osmoregulation involves the maintenance of constant:

- A) Body temperature
- B) Water and solute concentration
- C) Heart rate
- D) Blood glucose levels

Answer: Water and solute concentration

Reproduction

1. **Reproduction** is the ability of an organism to produce new offspring of its own kind.
2. It is essential for the **survival of the species**, not the individual.
3. Human reproduction involves **internal fertilization**.

Male Reproductive System

4. The **male reproductive system** functions to produce and maintain **sperms**.
5. It includes **gonads (testes)**, accessory ducts, glands, and the **copulatory organ (penis)**.
6. **Testes** are located outside the abdomen in a skin pouch called the **scrotum**.
7. The **scrotum** maintains a temperature **2–3°C lower** than body temperature for optimal spermatogenesis.
8. Each testis contains **250–300 lobules**, each with **1–4 seminiferous tubules**.
9. **Seminiferous tubules** are the site of **sperm production**.
10. **Sertoli cells** are found in the seminiferous tubules and nourish developing sperms.
11. **Leydig (interstitial) cells** are located between seminiferous tubules and produce **testosterone**.
12. **Epididymis** stores and transports sperms.
13. **Vas deferens** carries sperms from the epididymis to the **ejaculatory duct**.
14. **Ejaculatory duct** is formed by the union of the vas deferens and the duct of the **seminal vesicle**.
15. **Urethra** serves as a common passage for urine and semen.
16. **Seminal vesicles** produce a fluid rich in **fructose** that provides energy to sperms.
17. The **prostate gland** secretes an alkaline fluid that neutralizes vaginal acidity.
18. **Bulbourethral (Cowper's) glands** secrete a pre-ejaculate fluid that lubricates the urethra.
19. **Semen** is a mixture of sperm and secretions from accessory glands.
20. A normal ejaculate contains **20–150 million sperm per ml**.

Spermatogenesis

21. **Spermatogenesis** is the process of sperm formation in the **seminiferous tubules**.
22. **Spermatogonia** divide by **mitosis** to form **primary spermatocytes**.
23. **Primary spermatocytes** undergo **meiosis I** to form **secondary spermatocytes**.
24. **Secondary spermatocytes** undergo **meiosis II** to form **spermatids**.
25. **Spermatids** mature into **spermatozoa** through **spermiogenesis**.
26. A healthy adult male produces about **400 million sperms per day**.
27. Mature sperm consists of a **head** (contains nucleus), **midpiece** (mitochondria), and **tail** (flagellum).
28. The **acrosome** in the sperm head contains enzymes like **hyaluronidase** for egg penetration.

Hormonal Control in Males

29. **Gonadotropin-Releasing Hormone (GnRH)** from the hypothalamus stimulates the anterior pituitary.
30. **Follicle-Stimulating Hormone (FSH)** stimulates **Sertoli cells** to support spermatogenesis.
31. **Luteinizing Hormone (LH)** stimulates **Leydig cells** to produce **testosterone**.
32. **Testosterone** promotes **spermatogenesis** and development of **secondary sexual characteristics**.
33. **Inhibin**, produced by Sertoli cells, inhibits **FSH** secretion via negative feedback.

Female Reproductive System

34. The **female reproductive system** includes **ovaries, oviducts, uterus, and vagina**.
35. **Ovaries** produce **ova** and secrete **estrogen** and **progesterone**.
36. **Oviducts (Fallopian tubes)** are the site of **fertilization**.
37. The **uterus** has three parts: **fundus, body, and cervix**.
38. The uterine wall consists of **perimetrium, myometrium, and endometrium**.
39. The **endometrium** is the inner lining where **implantation** occurs.

- A) Uterus
- B) Cervix
- C) Ovary
- D) Oviduct

Answer: Ovary

4. Which hormone triggers ovulation?

- A) FSH
- B) Progesterone
- C) LH
- D) Estrogen

Answer: LH

5. Syphilis is caused by:

- A) Neisseria gonorrhoeae
- B) Treponema pallidum
- C) Herpes simplex virus
- D) HIV

Answer: Treponema pallidum

6. The discharge of a secondary oocyte from the ovary is called:

- A) Fertilization
- B) Ovulation
- C) Implantation
- D) Menstruation

Answer: Ovulation

7. The second meiotic division in the secondary oocyte proceeds up to:

- A) Prophase II
- B) Metaphase II
- C) Anaphase II
- D) Telophase II

Answer: Metaphase II

8. Which of the following differentiates directly into mature sperm?

- A) Primary spermatocyte
- B) Secondary spermatocyte
- C) Spermatid
- D) Spermatogonia

Answer: Spermatid

9. The uterus opens into the vagina through the:

- A) Cervix
- B) Oviduct
- C) Vulva
- D) Urethra

Answer: Cervix

10. Spermatogonia differentiate directly into:

- A) Primary spermatocytes
- B) Secondary spermatocytes

- C) Spermatids
- D) Spermatozoa

Answer: Primary spermatocytes

11. Where are interstitial cells located in the testes?

- A) Inside seminiferous tubules
- B) Between seminiferous tubules
- C) In the epididymis
- D) In the vas deferens

Answer: Between seminiferous tubules

12. The hormone produced by the corpus luteum is:

- A) Estrogen
- B) Progesterone
- C) FSH
- D) LH

Answer: Progesterone

13. The oocyte released during ovulation is in which stage?

- A) Prophase I
- B) Metaphase I
- C) Metaphase II
- D) Anaphase II

Answer: Metaphase II

14. Which structure is formed after ovulation from the ruptured follicle?

- A) Corpus callosum
- B) Corpus luteum
- C) Graafian follicle
- D) Follicle atresia

Answer: Corpus luteum

15. On puberty, the development of primary follicles is stimulated by:

- A) LH
- B) FSH
- C) Estrogen
- D) Progesterone

Answer: FSH

16. Which organism causes gonorrhea?

- A) Treponema pallidum
- B) Neisseria gonorrhoeae
- C) Herpes simplex
- D) HIV

Answer: Neisseria gonorrhoeae

17. In the human testis, which structure carries sperm from inside the testis?

- A) Seminiferous tubules



CHEMISTRY



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>



Fundamentals of Chemistry

Introduction to Chemistry

1. Chemistry is the branch of physical science that deals with the composition, structure, properties of matter, the changes it undergoes, and the laws governing those changes.
2. The modern world is a world of chemicals, and chemistry has wide applications serving humanity and nature.
3. The development of chemistry has provided facilities like petrochemicals, medicines, plastics, and detergents.
4. During the Muslim period (600-1600 AD), chemistry grew significantly and was known as "Al-Chemy."
5. The principal goals of Muslim chemists were to prolong life, transmute base metals into gold, and find physical evidence for religious beliefs.
6. Muslim scientists laid the foundation of modern laboratory methods like filtration, fermentation, and distillation.
7. Jabber Ibn Haiyan (721-803 AD), known as the father of chemistry, invented experimental methods like distillation and sublimation.
8. Al-Razi (864-930) classified chemical compounds into four types and prepared alcohol by fermentation.
9. Al-Beruni (973-1048) determined the densities of different substances.
10. Ibne-Sina (980-1037), known as the Aristotle of the Muslim world, rejected the idea of converting base metals into gold.

Branches of Chemistry

11. **Physical Chemistry** deals with the relationship between the physical properties of substances and their chemical changes.
12. **Organic Chemistry** is the study of hydrocarbons (compounds of carbon and hydrogen) and their derivatives.
13. **Inorganic Chemistry** deals with the study of all elements and their compounds, except hydrocarbons and their derivatives.
14. **Analytical Chemistry** involves the qualitative (type) and quantitative (amount) analysis of matter.
15. **Industrial Chemistry** deals with techniques and processes for preparing industrial products like cement, glass, and fertilizers.
16. **Nuclear Chemistry** is concerned with the study of the nucleus, nuclear changes, and radiation emission or absorption.
17. **Biochemistry** deals with the chemical processes and substances that occur within living organisms.
18. **Environmental Chemistry** involves the study of the interaction of chemical substances/processes with the environment.

Basic Definitions (Matter, Substance, Element, Compound, Mixture)



67. **Al-Ghazali's Burning Cotton** experiment initially proposed necessary causation (fire causes cotton to burn).
68. Al-Ghazali later departed from this, stating events are a succession by God's will, not direct causation.
69. **Inductive Reasoning** draws general conclusions from specific observations.
70. **Deductive Reasoning** draws specific conclusions from general statements or principles.

Practice MCQs

M
K

P
R
E
P
A
R
A
T
I
O
N
S

1. What is the definition of chemistry?

- A) Study of living organisms
- B) Study of celestial bodies
- C) Study of matter, its composition, properties, and changes
- D) Study of earth's crust

Answer: Study of matter, its composition, properties, and changes

2. Who is generally known as the father of chemistry?

- A) Al-Razi
- B) Jabber Ibn Haiyan
- C) Al-Beruni
- D) Ibne-Sina

Answer: Jabber Ibn Haiyan

3. Which branch of chemistry deals with the study of hydrocarbons and their derivatives?

- A) Inorganic Chemistry
- B) Physical Chemistry
- C) Organic Chemistry
- D) Analytical Chemistry

Answer: Organic Chemistry

4. A chemist determining the amount of an impurity in drinking water is most likely using which branch?

- A) Industrial Chemistry
- B) Biochemistry
- C) Analytical Chemistry
- D) Nuclear Chemistry

Answer: Analytical Chemistry

5. Anything that has mass and occupies space is defined as:

- A) Substance
- B) Element
- C) Matter
- D) Compound

Answer: Matter

6. A pure substance which cannot be split into simpler substances by ordinary means is a/an:

- A) Compound
- B) Mixture
- C) Element
- D) Solution

Answer: Element

7. A substance formed by the chemical combination of elements in a fixed ratio is a:

- A) Homogeneous Mixture
- B) Compound
- C) Heterogeneous Mixture
- D) Solution

Answer: Compound

8. Which of the following is a heterogeneous mixture?

- A) Sugar solution
- B) Salt solution
- C) Salad
- D) Alcohol in water

Answer: Salad

9. The number of protons in the nucleus of an atom is called its:

- A) Mass Number
- B) Atomic Mass
- C) Atomic Number
- D) Neutron Number

Answer: Atomic Number

10. The total number of protons and neutrons in an atom is its:

- A) Atomic Mass
- B) Atomic Number
- C) Mass Number
- D) Isotope Number

Answer: Mass Number

11. The standard atom to which the masses of other atoms are compared is:



Experimental Techniques, Chromatography & Materials

1. **Analytical chemistry** is the science of chemical characterization.
2. **Qualitative analysis** involves the identification of elements present in a compound.
3. **Quantitative analysis** involves determining the relative amounts of the elements in a compound.
4. A complete quantitative analysis involves obtaining a sample, separation, measurement, and drawing conclusions.

Filtration

5. Filtration is the process used to separate insoluble particles from liquids.
6. Filtration can be performed using a filter paper or a filter crucible.
7. For smooth filtration, the stem of the funnel should remain continuously full of liquid.
8. The funnel's tip should touch the side of the beaker to prevent splashing.
9. A fluted filter paper increases the rate of filtration.
10. A Gooch crucible is made of porcelain with a perforated bottom, often covered with asbestos mat or paper pulp.
11. A sintered glass crucible has a porous glass disc sealed into its bottom and requires no preparation.

Crystallization

12. Crystallization is the removal of a solid from a solution by increasing its concentration above the saturation point.
13. An ideal solvent should dissolve a large amount of the solute at its boiling point and only a small amount at room temperature.
14. An ideal solvent should not react chemically with the solute.
15. The hot saturated solution is filtered to remove insoluble impurities, often using a hot water funnel.
16. Slow cooling yields large crystals which may trap impurities.
17. Cooling at a moderate rate yields medium-sized crystals.
18. Crystals are collected by filtration, often using a Gooch crucible and a vacuum pump.
19. Crystals can be dried in an oven, between filter papers, or in a vacuum desiccator.
20. Colored impurities can be removed by boiling the substance with animal charcoal, which adsorbs the impurities.

Sublimation

21. Sublimation is the process where a solid vaporizes on heating and the vapors condense back to solid on cooling, without passing through the liquid phase.
22. It is used to purify solids like ammonium chloride, iodine, and naphthalene.

Solvent Extraction

23. Solvent extraction separates a solute by shaking the solution with an immiscible solvent in which the solute is more soluble.
24. It is performed using a separating funnel.
25. Repeated extractions with small portions of solvent are more efficient than a single extraction with a large volume.
26. Solvent extraction is an equilibrium process controlled by the distribution law or partition law.
27. The distribution coefficient (K) is the ratio of the concentration of solute in the two immiscible solvents at equilibrium.

Chromatography - Introduction

28. Chromatography is a separation technique based on the distribution of a solute between a stationary phase and a mobile phase.
29. The stationary phase can be a solid or a liquid supported on an inert solid.
30. The mobile phase can be a liquid or a gas.
31. Separation occurs due to differences in the relative affinities of components for the stationary and mobile phases.
32. The distribution coefficient (K) in chromatography is the concentration in the mobile phase divided by the concentration in the stationary phase.

Practice MCQs

1. What is the primary focus of qualitative analysis in chemistry?

- A) Determining the mass of elements
- B) Identifying the elements present
- C) Calculating the percentage composition
- D) Measuring the reaction rate

Answer: Identifying the elements present

2. Which factor is crucial for ensuring smooth filtration using a filter paper in a funnel?

- A) Using a fluted filter paper
- B) Keeping the stem of the funnel continuously full of liquid
- C) Using a large-sized beaker
- D) Cooling the solution first

Answer: Keeping the stem of the funnel continuously full of liquid

3. What is the main advantage of using a fluted filter paper?

- A) It is cheaper
- B) It increases the rate of filtration
- C) It absorbs impurities
- D) It fits any funnel size

Answer: It increases the rate of filtration

4. A Gooch crucible is typically used for which specific purpose?

- A) Slow evaporation
- B) Filtering precipitates that need high-temperature ignition
- C) Containing very acidic solutions
- D) Measuring liquid volume

Answer: Filtering precipitates that need high-temperature ignition

5. What is the fundamental principle behind the purification technique of crystallization?

- A) Difference in boiling points
- B) Magnetic properties
- C) Differential solubility in a solvent at different temperatures
- D) Vapor pressure

Answer: Differential solubility in a solvent at different temperatures

6. Why is slow cooling during crystallization generally avoided?

- A) It forms no crystals
- B) It produces crystals that may trap impurities
- C) It decomposes the solute
- D) It evaporates the solvent too quickly

Answer: It produces crystals that may trap impurities

7. Which drying method is considered safest for heat-sensitive crystallized substances?

- A) Oven drying at 110°C
- B) Pressing between filter papers
- C) Air drying at room temperature
- D) Vacuum desiccator

Answer: Vacuum desiccator

8. Animal charcoal is used during crystallization primarily for what purpose?

- A) To increase crystal size
- B) To act as a solvent
- C) To decolorize the solution by adsorption
- D) To cool the solution rapidly

Answer: To decolorize the solution by adsorption

9. The process where a solid directly converts to vapor upon heating is known as?

- A) Evaporation
- B) Distillation
- C) Sublimation
- D) Condensation

Answer: Sublimation

10. In solvent extraction, why are repeated extractions with small solvent portions more efficient?

- A) It saves solvent
- B) It is faster
- C) It maintains a higher concentration gradient for better solute transfer
- D) It requires less equipment

Answer: It maintains a higher concentration gradient for better solute transfer

11. The distribution law governs which separation technique?

- A) Filtration
- B) Crystallization
- C) Solvent extraction
- D) Sublimation

Answer: Solvent extraction

12. In chromatography, the phase that moves over the stationary phase is called the?

- A) Solid phase
- B) Mobile phase
- C) Dynamic phase
- D) Liquid phase

Answer: Mobile phase

13. What does the R_f value in paper chromatography represent?

- A) The ratio of solvent distance to solute distance
- B) The ratio of solute distance to solvent distance



Atomic Structure

Historical Development

1. Democritus, a Greek philosopher, first proposed that matter is composed of tiny, indivisible particles called atoms.
2. John Dalton presented his atomic theory in 1808, stating that matter is composed of indivisible atoms.
3. Dalton's theory postulated that atoms of a given element are identical in size, mass, and properties.
4. A key drawback of Dalton's theory was that it considered the atom to be the ultimate, indivisible particle.

Discovery of Fundamental Particles

5. Cathode rays were discovered in a gas discharge tube at low pressure and high voltage, producing fluorescence on the glass wall.
6. J.J. Thomson determined that cathode rays are streams of negatively charged particles (electrons).
7. The charge to mass ratio (e/m) for an electron was determined by J.J. Thomson to be 1.7588×10^{11} C/kg.
8. Eugen Goldstein discovered canal rays (positive rays) using a perforated cathode in a discharge tube.
9. The positive particle obtained from hydrogen gas in the discharge tube is the lightest and is called a proton.
10. James Chadwick discovered the neutron in 1932 by bombarding beryllium with alpha particles.
11. Millikan's oil drop experiment determined the charge on an electron to be 1.6022×10^{-19} Coulombs.
12. The mass of an electron, calculated from its charge and e/m ratio, is 9.1095×10^{-31} kg.

Rutherford's Atomic Model

13. Rutherford's gold foil experiment led to the discovery of the atomic nucleus.
14. Rutherford proposed a planetary model of the atom, where electrons revolve around a dense, positively charged nucleus.
15. Most of the volume of an atom is empty space, as most alpha particles passed through the gold foil undeflected.
16. A major defect of Rutherford's model was that it could not explain the stability of the atom, as a revolving electron should spiral into the nucleus by radiating energy.

Bohr's Atomic Model

17. Niels Bohr proposed a model for the hydrogen atom based on Planck's quantum theory.
18. Bohr's first postulate states that electrons revolve in stationary orbits of fixed energy without radiating energy.
19. The angular momentum of an electron in a permitted orbit is an integral multiple of $h/2\pi$ ($mvr = nh/2\pi$).
20. Energy is emitted or absorbed as a photon when an electron jumps from one energy level to another.
21. The energy of the photon emitted or absorbed is given by $\Delta E = E_2 - E_1 = h\nu$.
22. The radius of the n th orbit in a hydrogen atom is given by $r_n = 0.529 \times n^2 \text{ \AA}$.
23. The energy of an electron in the n th orbit of hydrogen is given by $E_n = -1312.36 / n^2 \text{ kJ/mol}$ or $E_n = -2.18 \times 10^{-18} / n^2 \text{ J}$.
24. The state with $n=1$ is called the ground state, and all higher states ($n=2,3,\dots$) are excited states.
25. Bohr's model successfully explained the line spectrum of hydrogen and hydrogen-like ions (He^+ , Li^{2+}).

26. 5. Atomic Spectra

27. A spectrum is the band of radiations obtained when light is resolved into its constituent wavelengths.
28. A continuous spectrum has no clear boundaries between colors, e.g., sunlight or a rainbow.
29. An atomic or line spectrum consists of distinct, separated lines characteristic of an element.
30. An emission spectrum has bright lines on a dark background, produced when atoms emit energy.
31. An absorption spectrum has dark lines on a bright background, produced when atoms absorb specific wavelengths.
32. Hydrogen spectrum consists of several series, including Lyman (UV), Balmer (Visible), Paschen (IR), Brackett (IR), and Pfund (IR).



60. The electronic configuration of Copper (^{29}Cu) is an exception: $[\text{Ar}] 4s^1 3d^{10}$, which provides extra stability with a fully filled d-subshell.

Dual Nature of Matter & Heisenberg's Principle

61. de Broglie proposed that all moving particles have a dual nature (both particle and wave character).
62. The de Broglie wavelength is given by $\lambda = h / p = h / (mv)$.
63. Davisson and Germer experimentally verified the wave nature of electrons by observing electron diffraction.
64. Heisenberg's Uncertainty Principle states that it is impossible to simultaneously determine the exact position and momentum of a microscopic particle ($\Delta x \cdot \Delta p \geq h/4\pi$).

M
K

P
R
E
P
A
R
A
T
I
O
N
S

Practice MCQs

1. According to Bohr's atomic model, the angular momentum of an electron in a given orbit is:

- A) Proportional to its principal quantum number
B) Inversely proportional to the square of its principal quantum number
C) An integral multiple of $h/2\pi$
D) A half-integral multiple of $h/2\pi$

Answer: An integral multiple of $h/2\pi$

2. The e/m ratio for cathode rays was determined by:

- A) Rutherford
B) Millikan
C) J.J. Thomson
D) Goldstein

Answer: J.J. Thomson

3. Which series in the hydrogen spectrum lies in the ultraviolet region?

- A) Balmer
B) Paschen
C) Lyman
D) Brackett

Answer: Lyman

4. According to the quantum theory of radiation, the energy of a photon is directly proportional to its:

- A) Wavelength
B) Amplitude
C) Frequency
D) Wave number

Answer: Frequency

5. The maximum number of electrons that can be accommodated in the M-shell ($n=3$) is:

- A) 8
B) 18
C) 32

D) 50

Answer: 18

6. The positive rays in the discharge tube experiment are also called:

- A) Anode rays
B) Cathode rays
C) Canal rays
D) Alpha rays

Answer: Canal rays

7. Rutherford's model of the atom failed to explain:

- A) The presence of a nucleus
B) The neutrality of the atom
C) The stability of the atom
D) The scattering of alpha particles

Answer: The stability of the atom

8. The shape of a p-orbital is best described as:

- A) Spherical
B) Dumbbell
C) Double Dumbbell
D) Complex

Answer: Dumbbell

9. The value of the azimuthal quantum number for f-subshell is:

- A) 1
B) 2
C) 3
D) 4

Answer: 3

10. Pauli's Exclusion Principle states that:

- A) Electrons fill the lowest energy orbitals first
B) No two electrons can have the same set of four quantum numbers
C) Electrons occupy degenerate orbitals singly before pairing



Physical States of Matter

Gaseous State

1. The **gaseous state** is characterized by molecules that are far apart with very weak intermolecular forces.
2. Gases have **no definite shape or volume** and occupy the entire volume of their container.
3. **Diffusion** is the spontaneous mixing of gas molecules from a region of higher concentration to a region of lower concentration.
4. **Effusion** is the escape of gas molecules one by one through a tiny hole without collision.
5. According to **Graham's Law of Diffusion**, the rate of diffusion of a gas is inversely proportional to the square root of its density or molar mass.
6. **Gas Pressure (P)** is defined as the force (F) exerted by the gas per unit area (A) of the container wall ($P = F/A$).
7. The SI unit of pressure is **Pascal (Pa)**, where $1 \text{ Pa} = 1 \text{ N/m}^2$.
8. **Standard Atmospheric Pressure** at sea level is 760 mm Hg, 760 torr, 1 atm, or 101.325 kPa.
9. Gases are **highly compressible** due to the large empty spaces between their molecules.
10. **Boyle's Law** states that the volume of a given mass of a gas is inversely proportional to its pressure at constant temperature ($P_1V_1 = P_2V_2$).
11. **Charles's Law** states that the volume of a given mass of a gas is directly proportional to its absolute temperature at constant pressure ($V_1/T_1 = V_2/T_2$).
12. The **Absolute Temperature (Kelvin) scale** is related to the Celsius scale by the formula: $K = ^\circ\text{C} + 273$.
13. **Absolute Zero (0 K or -273 °C)** is the temperature at which the volume of an ideal gas becomes zero.
14. **Avogadro's Law** states that equal volumes of all gases at the same temperature and pressure contain an equal number of molecules.
15. One mole of any gas at **Standard Temperature and Pressure (STP: 0°C, 1 atm)** occupies a volume of **22.4 liters or 22.414 dm³**.
16. The **Ideal Gas Equation** is a combination of Boyle's, Charles's, and Avogadro's laws: $PV = nRT$.
17. **R**, the Universal Gas Constant, has a value of $0.0821 \text{ dm}^3\cdot\text{atm}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$, $8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$, or $62.364 \text{ dm}^3\cdot\text{torr}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$.
18. **Real Gases** deviate from ideal behavior at high pressures and low temperatures due to the finite volume of molecules and intermolecular attractions.
19. The **Van der Waals equation** corrects the ideal gas equation for the volume of molecules (constant b) and intermolecular attractions (constant a).
20. **Dalton's Law of Partial Pressure** states that the total pressure of a mixture of non-reacting gases is equal to the sum of the partial pressures of the individual gases.
21. The **partial pressure** of a gas in a mixture is given by $P_a = X_a \times P_t$, where X_a is its mole fraction.
22. The **Kinetic Molecular Theory (KMT)** explains the behavior of gases based on the motion of their particles.
23. A key postulate of KMT is that the **average kinetic energy of gas molecules is directly proportional to the absolute temperature**.
24. The pressure of an ideal gas is given by the kinetic equation: $PV = (1/3)mNc^2$.
25. The **root mean square velocity (c_{rms})** of a gas is given by $\sqrt{(3RT/M)}$.
26. The **Liquefaction of Gases** is achieved by increasing pressure and decreasing temperature.
27. The **Critical Temperature (T_c)** is the temperature above which a gas cannot be liquefied, no matter how much pressure is applied.
28. The **Joule-Thomson Effect** is the cooling of a gas when it is allowed to expand adiabatically from a high pressure to a low pressure.



1. According to the Kinetic Molecular Theory, the average kinetic energy of gas molecules is directly proportional to:

- A) The pressure of the gas
- B) The volume of the gas
- C) The absolute temperature of the gas
- D) The molar mass of the gas

Answer: The absolute temperature of the gas

2. Which law states that the volume of a given mass of gas is inversely proportional to its pressure at constant temperature?

- A) Charles's Law
- B) Avogadro's Law
- C) Graham's Law
- D) Boyle's Law

Answer: Boyle's Law

3. The escape of gas molecules one by one through a tiny hole without collision is called:

- A) Diffusion
- B) Effusion
- C) Compression
- D) Expansion

Answer: Effusion

4. At Standard Temperature and Pressure (STP), one mole of any ideal gas occupies a volume of:

- A) 22.4 dm³
- B) 24.4 dm³
- C) 20.4 dm³
- D) 25.0 dm³

Answer: 22.4 dm³

5. The value of the Universal Gas Constant (R) in units of dm³.atm.mol⁻¹.K⁻¹ is:

- A) 8.314
- B) 1.987
- C) 0.0821
- D) 62.364

Answer: 0.0821

6. Which of the following is NOT a unit of pressure?

- A) Pascal
- B) Joule
- C) Torr
- D) Atmosphere

Answer: Joule

7. Graham's Law of Diffusion relates the rate of diffusion of a gas to its:

- A) Density
- B) Pressure
- C) Temperature
- D) Volume

Answer: Density

8. The temperature at which the volume of an ideal gas becomes zero is known as:

- A) Freezing point
- B) Boiling point
- C) Absolute zero
- D) Critical temperature

Answer: Absolute zero

9. The ideal gas equation is a combination of Boyle's Law, Charles's Law, and:

- A) Dalton's Law
- B) Graham's Law
- C) Avogadro's Law
- D) Henry's Law

Answer: Avogadro's Law

10. Real gases deviate from ideal behavior significantly at:

- A) High temperature and low pressure
- B) Low temperature and high pressure
- C) High temperature and high pressure
- D) Low temperature and low pressure

Answer: Low temperature and high pressure

11. Dalton's Law of Partial Pressure is applicable to a mixture of:

- A) Reacting gases
- B) Non-reacting gases
- C) Only noble gases
- D) Only diatomic gases

Answer: Non-reacting gases

12. The cooling of a gas when it expands adiabatically from a high pressure to a low pressure is known as:

- A) Boyle's effect
- B) Charles's effect
- C) Joule-Thomson effect
- D) Graham's effect

Answer: Joule-Thomson effect

13. The strongest type of intermolecular force present in liquid water is:

- A) Dipole-dipole forces
- B) London dispersion forces
- C) Hydrogen bonding



Acids, Bases & Salts

Introduction to Acids and Bases

1. **Acids** were originally identified by their sour taste.
2. **Bases** were originally identified by their slippery, soapy feel.
3. Acids change the colour of blue litmus to red.
4. Bases change the colour of red litmus to blue.
5. Acids react with active metals to produce hydrogen gas.
6. Acids react with carbonates and bicarbonates to produce carbon dioxide gas.
7. The reaction between an acid and a base produces a salt and water, a process called **neutralization**.
8. A substance that can behave as both an acid and a base is called an **amphoteric** substance.
9. **Water** is the most common amphoteric substance.
10. The **autoionization** of water involves the transfer of a proton between two water molecules to produce a hydronium ion and a hydroxide ion.

Acid-Base Theories

11. According to the **Arrhenius theory**, an acid is a substance that produces H^+ ions in aqueous solution.
12. According to the **Arrhenius theory**, a base is a substance that produces OH^- ions in aqueous solution.
13. According to the **Bronsted-Lowry theory**, an acid is a proton (H^+) donor.
14. According to the **Bronsted-Lowry theory**, a base is a proton (H^+) acceptor.
15. The Bronsted-Lowry theory is not restricted to aqueous solutions.
16. A **Lewis acid** is an electron-pair acceptor.
17. A **Lewis base** is an electron-pair donor.
18. The Lewis concept is more general than the Arrhenius and Bronsted-Lowry concepts.
19. A hydrogen ion (H^+) in water exists as a hydrated **hydronium ion** (H_3O^+).
20. A **strong acid** is one that ionizes completely in aqueous solution.
21. A **weak acid** is one that ionizes only partially in aqueous solution.
22. A **strong base** is one that dissociates completely in water to yield OH^- ions.
23. A **weak base** is one that ionizes only to a limited extent in water.
24. The strength of an acid is measured by its tendency to donate a proton.
25. The strength of a base is measured by its tendency to accept a proton.

Conjugate Acid-Base Pairs

26. A **conjugate base** is the species formed when an acid loses a proton.
27. A **conjugate acid** is the species formed when a base gains a proton.
28. Every acid has a conjugate base, and every base has a conjugate acid.
29. Two species that differ by a proton are called a **conjugate acid-base pair**.
30. A strong acid has a weak conjugate base.
31. A weak acid has a strong conjugate base.
32. A strong base has a weak conjugate acid.
33. A weak base has a strong conjugate acid.



4. In the reaction $\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$, the conjugate acid of NH_3 is:

- A) H_2O
- B) OH^-
- C) NH_4^+
- D) H_3O^+

Answer: NH_4^+

5. A solution with a pH of 5 is how many times more acidic than a solution with a pH of 8?

- A) 3 times
- B) 10 times
- C) 100 times
- D) 1000 times

Answer: 1000 times

6. The pH of a 0.001 M HCl solution is:

- A) 1
- B) 2
- C) 3
- D) 11

Answer: 3

7. The pOH of a 0.01 M NaOH solution is:

- A) 2
- B) 12
- C) 7
- D) 10

Answer: 2

8. Which of the following salts will produce a basic solution when dissolved in water?

- A) NaCl
- B) NH_4Cl
- C) CH_3COONa
- D) CuSO_4

Answer: CH_3COONa

9. The ionic product of water (K_w) at 25°C is:

- A) 1×10^{-7}
- B) 1×10^{-14}
- C) 14
- D) 7

Answer: 1×10^{-14}

10. A weak acid has a:

- A) Small K_a value and a large $\text{p}K_a$
- B) Large K_a value and a small $\text{p}K_a$
- C) Small K_a value and a small $\text{p}K_a$
- D) Large K_a value and a large $\text{p}K_a$

Answer: Small K_a value and a large $\text{p}K_a$

11. Which of the following is NOT a characteristic property of acids?

- A) Sour taste
- B) Turns red litmus blue
- C) Reacts with carbonates to produce CO_2
- D) Reacts with active metals to produce H_2

Answer: Turns red litmus blue

12. The phenomenon where water makes all strong acids appear equally strong is called:

- A) Neutralization
- B) Hydrolysis
- C) Leveling effect
- D) Autoionization

Answer: Leveling effect

13. According to the Lewis concept, a base is defined as a substance that can:

- A) Donate a proton
- B) Accept a proton
- C) Donate an electron pair
- D) Accept an electron pair

Answer: Donate an electron pair

14. Which of the following is a strong acid?

- A) CH_3COOH
- B) H_2CO_3
- C) H_3PO_4
- D) HCl

Answer: HCl

15. The pH of a neutral solution at 25°C is:

- A) 0
- B) 7
- C) 14
- D) 1

Answer: 7

16. If the pH of a solution is 10, the $[\text{H}^+]$ is:

- A) 10^{-10} M
- B) 10^{-4} M
- C) 10^{-10} M
- D) 10^{-7} M

Answer: 10^{-10} M

17. A buffer solution can be prepared by mixing:

- A) Strong acid and its salt
- B) Weak acid and its salt with a strong base
- C) Strong base and its salt
- D) Strong acid and strong base

Answer: Weak acid and its salt with a strong base

18. The salt NH_4Cl dissolves in water to give a solution that is:

- A) Basic
- B) Acidic



Chemical Bonding

Introduction to Chemical Bonds

1. A **chemical bond** is the attractive force that holds atoms together in a substance.
2. Atoms form bonds to **decrease their energy** and attain stability.
3. Except for noble gases, most elements exist in a combined state through chemical bonds.
4. The **Lewis and Kossel electronic theory of valence** states atoms bond by losing, gaining, or sharing electrons to achieve a noble gas configuration.
5. The tendency of atoms to have **eight electrons** in their valence shell is called the **octet rule**.
6. The tendency of atoms to have **two electrons** in their valence shell is called the **duplet rule**.
7. Noble gases are stable due to their **completely filled** outermost electron shells.
8. The **orbital concept** of bonding is based on the combination of atomic orbitals to form molecular orbitals.

Types of Chemical Bonds

9. The four main types of bonds are **Ionic, Covalent, Coordinate Covalent, and Metallic bonds**.
10. An **ionic bond** is formed by the complete transfer of electron(s) from a metal to a non-metal.
11. A **cation** is a positively charged ion formed when an atom loses electron(s).
12. An **anion** is a negatively charged ion formed when an atom gains electron(s).
13. Ionic bonds are held together by strong **electrostatic forces** of attraction between oppositely charged ions.
14. A **covalent bond** is formed by the mutual sharing of electron pairs between two non-metal atoms.
15. A **single covalent bond** involves the sharing of one pair of electrons.
16. A **double covalent bond** involves the sharing of two pairs of electrons.
17. A **triple covalent bond** involves the sharing of three pairs of electrons.
18. A **coordinate covalent bond** or **dative bond** is formed when the shared pair of electrons is donated by a single atom.
19. The atom that donates the electron pair is called the **donor**.
20. The atom that accepts the electron pair is called the **acceptor**.
21. A **metallic bond** is the attraction between positive metal ions and a 'sea' of delocalized electrons.

Valence Shell Electron Pair Repulsion (VSEPR) Theory

22. **VSEPR theory** states that electron pairs around a central atom arrange themselves to be as far apart as possible to minimize repulsion.
23. The order of repulsion between electron pairs is **Lone pair-Lone pair > Lone pair-Bond pair > Bond pair-Bond pair**.
24. A molecule with **two bond pairs** and no lone pairs has a **linear** shape (e.g., BeCl_2).
25. A molecule with **three bond pairs** and no lone pairs has a **trigonal planar** shape (e.g., BF_3).
26. A molecule with **two bond pairs and one lone pair** has a **bent or angular** shape (e.g., SnCl_2 , SO_2).
27. A molecule with **four bond pairs** and no lone pairs has a **tetrahedral** shape (e.g., CH_4).
28. A molecule with **three bond pairs and one lone pair** has a **trigonal pyramidal** shape (e.g., NH_3).
29. A molecule with **two bond pairs and two lone pairs** has a **bent or angular** shape (e.g., H_2O).
30. Multiple bonds (double, triple) are treated as a single electron pair region in VSEPR theory.

Valence Bond Theory (VBT) and Hybridization



62. **Dipole-dipole interactions** occur between the positive end of one polar molecule and the negative end of another.
63. **Hydrogen bonding** is a special type of dipole-dipole interaction between a hydrogen atom bonded to F, O, or N and a lone pair on another F, O, or N atom.
64. Hydrogen bonding is **stronger** than dipole-dipole forces but **weaker** than a covalent bond.
65. Hydrogen bonding explains the **anomalously high boiling point** of water.
- 9. Properties and Bonding**
66. **Ionic compounds** are generally solids at room temperature, have high melting/boiling points, and are good conductors in molten or aqueous state.
67. **Covalent compounds** generally have low melting/boiling points and are poor conductors of electricity.
68. **Ionic bonds are non-directional**, while **covalent bonds are directional**.
69. The principle "**Like dissolves like**" states that polar solutes dissolve in polar solvents, and non-polar solutes dissolve in non-polar solvents.
70. Reactions of ionic compounds are generally **fast**, while reactions of covalent compounds are generally **slow**.

Practice MCQs

1. What is the primary reason atoms form chemical bonds?

- A) To increase their energy
- B) To attain a noble gas configuration and decrease energy
- C) To become radioactive
- D) To lose their identity

Answer: To attain a noble gas configuration and decrease energy

2. The force which holds atoms together in a molecule is called:

- A) Nuclear force
- B) Gravitational force
- C) Chemical bond
- D) Centripetal force

Answer: Chemical bond

3. According to the Lewis concept, a chemical bond is formed by:

- A) Magnetic attraction
- B) Overlap of nuclei
- C) Losing, gaining, or sharing of electrons
- D) Gravitational pull

Answer: Losing, gaining, or sharing of electrons

4. The tendency of atoms to acquire eight electrons in their valence shell is known as:

- A) Duplet rule
- B) Octet rule
- C) Triplet rule
- D) Hund's rule

Answer: Octet rule

5. A bond formed by the complete transfer of electrons from one atom to another is called:

- A) Covalent bond
- B) Ionic bond
- C) Coordinate bond
- D) Metallic bond

Answer: Ionic bond

6. In the formation of NaCl, the sodium atom becomes a:

- A) Anion
- B) Cation
- C) Free radical
- D) Neutral atom

Answer: Cation

7. A covalent bond is most likely to be formed between:

- A) A metal and a non-metal
- B) Two metals
- C) Two non-metals
- D) A noble gas and a metal

Answer: Two non-metals

8. A bond formed by the mutual sharing of two pairs of electrons is called a:

- A) Single bond
- B) Double bond
- C) Triple bond
- D) Coordinate bond

Answer: Double bond

9. In a coordinate covalent bond, the shared pair of electrons is provided by:

- A) Both bonding atoms

Chemical Equilibrium

Reversible and Irreversible Reactions

1. A **reversible reaction** can proceed in both the forward and reverse directions.
2. An **irreversible reaction** proceeds predominantly in one direction and goes to completion.
3. In a reversible reaction, the reactants are not completely converted into products.
4. Examples of irreversible reactions include the reaction of sodium with water and the combustion of hydrogen.
5. The Haber process ($\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$) is a classic example of a reversible reaction.

State of Chemical Equilibrium

6. **Chemical equilibrium** is achieved when the rate of the forward reaction equals the rate of the reverse reaction.
7. At equilibrium, the **concentrations of reactants and products remain constant** over time.
8. Equilibrium is a **dynamic state** where molecular activity continues, but with no net change.
9. The same equilibrium state can be reached starting from either the reactants or the products.
10. The point of equilibrium is recognized when properties like concentration, pressure, or color become constant.

Law of Mass Action and Equilibrium Constant (K_c)

11. The **Law of Mass Action** states that the rate of a reaction is proportional to the product of the active masses of the reactants.
12. **Active mass** is represented by the molar concentration in mol dm^{-3} .
13. For a general reaction $aA + bB \rightleftharpoons cC + dD$, the **equilibrium constant K_c** is $K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$.
14. The **K_c** is the ratio of the rate constant of the forward reaction (k_f) to the rate constant of the reverse reaction (k_r), i.e., $K_c = k_f / k_r$.
15. In the K_c expression, the **concentrations of products are in the numerator** and reactants in the denominator.
16. The value of K_c is **constant at a given temperature** and is independent of initial concentrations or the presence of a catalyst.
17. **Pure solids and liquids** do not appear in the equilibrium constant expression as their concentrations are constant.
18. If $K_c \gg 1$, the reaction favors the formation of **products** at equilibrium.
19. If $K_c \ll 1$, the reaction favors the **reactants** at equilibrium.
20. If $K_c \approx 1$, significant amounts of both **reactants and products** are present at equilibrium.

Equilibrium Constant in Terms of Pressure (K_p)

21. For reactions involving gases, the equilibrium constant can be expressed in terms of **partial pressures**, denoted as **K_p** .
22. For $aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g)$, $K_p = \frac{(P_C)^c (P_D)^d}{(P_A)^a (P_B)^b}$.
23. The relationship between K_p and K_c is given by $K_p = K_c (RT)^{\Delta n}$, where R is the gas constant, T is temperature, and Δn is the change in the number of moles of gas.
24. Δn is calculated as (moles of gaseous products - moles of gaseous reactants).
25. If $\Delta n = 0$, then **$K_p = K_c$** .

Reaction Quotient (Q)

26. The **Reaction Quotient (Q)** has the same form as K_c but uses initial concentrations instead of equilibrium concentrations.
27. If $Q < K_c$, the reaction will proceed in the **forward direction** to reach equilibrium.
28. If $Q > K_c$, the reaction will proceed in the **reverse direction** to reach equilibrium.
29. If $Q = K_c$, the reaction is **at equilibrium**.

Le Chatelier's Principle

5. The pH of a neutral solution at 25°C is:

- A) 0
- B) 7
- C) 10
- D) 14

Answer: 7

6. For a reaction where the number of moles of gaseous reactants and products are equal

($\Delta n = 0$):

- A) $K_p > K_c$
- B) $K_p < K_c$
- C) $K_p = K_c$
- D) $K_p = 1/K_c$

Answer: $K_p = K_c$

7. A catalyst added to a reversible reaction at equilibrium will:

- A) Shift the equilibrium to the right.
- B) Shift the equilibrium to the left.
- C) Increase the equilibrium constant.
- D) Decrease the time required to reach equilibrium.

Answer: Decrease the time required to reach equilibrium.

8. The solubility product constant (K_{sp}) expression for $PbCl_2$ is:

- A) $K_{sp} = [Pb^{2+}][Cl^-]$
- B) $K_{sp} = [Pb^{2+}][Cl^-]^2$
- C) $K_{sp} = [Pb^{2+}]^2[Cl^-]$
- D) $K_{sp} = [Pb^{2+}]^2[Cl^-]^2$

Answer: $K_{sp} = [Pb^{2+}][Cl^-]^2$

9. If the reaction quotient Q_c is less than K_c , the reaction will proceed:

- A) In the reverse direction.
- B) In the forward direction.
- C) To a point where Q_c becomes zero.
- D) In a direction that increases the pressure.

Answer: In the forward direction.

10. The common ion effect is used to explain the:

- A) Increase in solubility of a salt.
- B) Decrease in the ionization of a weak electrolyte.
- C) Increase in the rate of a reaction.
- D) Decrease in the boiling point of a solution.

Answer: Decrease in the ionization of a weak electrolyte.

11. The equilibrium constant for a reaction is very large ($K_c \gg 1$). This indicates that at equilibrium:

- A) Reactants are favored.
- B) Products are favored.
- C) Concentrations of reactants and products are equal.
- D) The reaction is very slow.

Answer: Products are favored.

12. In the Haber process, the formation of ammonia is favored by:

- A) Low pressure and high temperature.
- B) High pressure and low temperature.
- C) High pressure and high temperature.
- D) Low pressure and low temperature.

Answer: High pressure and low temperature.

13. Which of the following is a correct expression for the base dissociation constant, K_b , for ammonia?

- A) $K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$
- B) $K_b = \frac{[NH_3][H_2O]}{[NH_4^+][OH^-]}$
- C) $K_b = \frac{[NH_4^+][H_3O^+]}{[NH_3]}$
- D) $K_b = \frac{[NH_3]}{[NH_4^+][OH^-]}$

Answer: $K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$

14. A buffer solution can be prepared by mixing:

- A) Strong acid and strong base.
- B) Strong acid and its salt.
- C) Weak acid and its salt with a strong base.
- D) Weak base and water.

Answer: Weak acid and its salt with a strong base.

15. The ionic product of water, K_w , at 25°C is:

- A) 1×10^{-7}
- B) 1×10^{-14}
- C) 7
- D) 14

Answer: 1×10^{-14}

16. For the reaction $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$, an increase in pressure will shift the equilibrium:

- A) To the left.
- B) To the right.
- C) Will have no effect.
- D) First to the left, then to the right.

Answer: To the right.

17. The value of the equilibrium constant changes with a change in:

- A) Concentration of reactants.



Chemical Kinetics

Introduction to Chemical Kinetics

1. **Chemical kinetics** is the branch of chemistry that deals with the rates of chemical reactions, the factors affecting these rates, and the reaction mechanisms.
2. Reaction rates vary greatly, from instantaneous (e.g., $\text{AgNO}_3 + \text{NaCl}$) to very slow (e.g., rusting of iron).
3. The **rate of a reaction** is never constant; it decreases as the concentration of reactants decreases.
4. Knowledge of kinetics is crucial in industry to determine the most economical conditions for a reaction.

Rate of Reaction

5. The **rate of a reaction** is defined as the change in concentration of a reactant or product per unit time.
6. Its units are typically $\text{mol dm}^{-3} \text{s}^{-1}$.
7. The **average rate** is the rate of reaction over a specific, finite time interval.
8. The **instantaneous rate** is the rate at a particular instant, given by dx/dt or the slope of the tangent on a concentration-time graph.
9. For a reaction, $aA \rightarrow bB$, the rate can be expressed as $\text{Rate} = -(1/a) d[A]/dt = +(1/b) d[B]/dt$.
10. The negative sign indicates a decrease in reactant concentration, while the positive sign indicates an increase in product concentration.

Rate Law, Rate Constant, and Order of Reaction

11. The **rate law** or **rate equation** is an experimental expression showing the relationship between the reaction rate and the concentrations of reactants.
12. The **rate law** cannot be deduced from the stoichiometry of the balanced equation.
13. The **rate constant (k)** is the proportionality constant in the rate law.
14. The **specific rate constant** is the rate of reaction when the concentrations of all reactants are unity (1 M).
15. The **order of a reaction** is the sum of the powers to which the concentration terms are raised in the experimentally determined rate law.
16. Order can be zero, a positive integer, or a fraction.
17. The **molecularity** of a reaction is the number of reacting species (atoms, ions, or molecules) involved in an elementary step (slowest step).
18. Molecularity is always a whole number (1, 2, 3), while order can be fractional.
19. A **zero-order reaction** has a rate independent of the concentration of reactants (e.g., decomposition of NH_3 on a hot tungsten surface).
20. A **first-order reaction** has a rate directly proportional to the first power of a single reactant's concentration (e.g., decomposition of N_2O_5).
21. A **second-order reaction** has a rate proportional to the square of a single reactant's concentration or to the product of the first powers of two reactants (e.g., $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$).
22. A **third-order reaction** has a rate proportional to the cube of a single reactant's concentration or a combination of three concentration terms (e.g., $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$).
23. A **pseudo-first-order reaction** is a reaction that is actually bimolecular but appears first-order because one reactant (often the solvent) is in large excess (e.g., hydrolysis of ester).

Half-Life Period

24. The **half-life ($t_{1/2}$)** of a reaction is the time required for the concentration of a reactant to reduce to half its initial value.
25. For a **first-order reaction**, the half-life is constant and independent of the initial concentration ($t_{1/2} = 0.693/k$).
26. For a **second-order reaction**, the half-life is inversely proportional to the initial concentration ($t_{1/2} = 1/(k a)$).
27. For an **nth-order reaction**, the half-life is inversely proportional to the initial concentration raised to the power (n-1), i.e., $t_{1/2} \propto 1/a^{(n-1)}$.

55. A catalyst **does not** affect the position of equilibrium (ΔG) or the equilibrium constant; it only helps achieve equilibrium faster.
56. A catalyst increases the rates of both the forward and reverse reactions equally.
57. **Homogeneous catalysis** occurs when the catalyst and reactants are in the same phase (e.g., NO(g) catalyzing the formation of SO₃ from SO₂ and O₂).
58. **Heterogeneous catalysis** occurs when the catalyst and reactants are in different phases, typically with a solid catalyst and gaseous reactants (e.g., Ni in the hydrogenation of ethene).
59. A **promoter** is a substance that increases the activity of a catalyst (e.g., Mo in Haber's process).
60. A **catalytic poison** is a substance that decreases the activity of a catalyst (e.g., CO poisoning the Fe catalyst in Haber's process).
61. **Autocatalysis** occurs when a product of the reaction acts as its own catalyst (e.g., Mn²⁺ in the reaction between KMnO₄ and oxalic acid).
62. **Enzyme catalysis** involves biological catalysts called enzymes, which are complex protein molecules.
63. Enzyme catalysis is highly **specific** and efficient, with maximum activity at an **optimum temperature** and **optimum pH**.
64. The **Lock and Key model** explains the specificity of enzyme action, where the substrate fits into the active site of the enzyme.

Practice MCQs

1. What is the primary focus of the branch of chemistry known as chemical kinetics?

- A) The study of energy changes in reactions
- B) The study of reaction rates and mechanisms
- C) The identification of elements in compounds
- D) The synthesis of new chemical compounds

Answer: The study of reaction rates and mechanisms

2. Which of the following best describes the instantaneous rate of a reaction?

- A) The total time taken for the reaction to complete
- B) The average speed of the reaction over a long period
- C) The rate at a specific moment in time, given by the slope of the tangent to a concentration-time curve
- D) The change in concentration when half the reactant is consumed

Answer: The rate at a specific moment in time, given by the slope of the tangent to a concentration-time curve

3. For the reaction $A \rightarrow B$, how is the rate of reaction expressed with respect to the disappearance of A?

- A) Rate = $+d[A]/dt$
- B) Rate = $-d[A]/dt$
- C) Rate = $+d[B]/dt$
- D) Rate = $k[A]$

Answer: Rate = $-d[A]/dt$

4. The units for the rate constant 'k' for a zero-order reaction are:

- A) s⁻¹
- B) mol dm⁻³ s⁻¹
- C) dm³ mol⁻¹ s⁻¹
- D) dm⁶ mol⁻² s⁻¹

Answer: mol dm⁻³ s⁻¹

5. If the rate equation for a reaction is Rate = $k[X][Y]^2$, what is the overall order of the reaction?

- A) 1
- B) 2
- C) 3
- D) 4

Answer: 3

6. A reaction where the rate is independent of the concentration of the reactants is known as a:

- A) First-order reaction
- B) Second-order reaction
- C) Pseudo-first-order reaction
- D) Zero-order reaction

Answer: Zero-order reaction

7. The hydrolysis of ethyl acetate in the presence of a large excess of water is an example of a:

- A) Second-order reaction
- B) Zero-order reaction



Chemical Energetics & Thermochemistry

Introduction to Energetics & Thermochemistry

1. The study of energy changes accompanying physical and chemical changes is called **Energetics** or **Thermochemistry**.
2. The SI unit of heat or thermal energy is the **Joule (J)**.
3. Another common unit of heat is the **calorie**, where 1 calorie = 4.18 Joules.
4. A chemical reaction that proceeds with the evolution of heat is called an **exothermic reaction**.
5. A chemical reaction that proceeds with the absorption of heat is called an **endothermic reaction**.
6. In an exothermic reaction, the **enthalpy change (ΔH)** is negative.
7. In an endothermic reaction, the **enthalpy change (ΔH)** is positive.
8. The **First Law of Thermodynamics** states that energy can neither be created nor destroyed, only converted from one form to another.
9. The **First Law of Thermodynamics** is also known as the **Law of Conservation of Energy**.

System, Surroundings, and State Functions

10. The specific part of the universe under study is called the **system**.
11. The rest of the universe outside the system is called the **surroundings**.
12. The real or imaginary surface separating the system from the surroundings is called the **boundary**.
13. A **state function** is a property whose value depends only on the current state of the system, not on the path taken to reach that state.
14. Examples of state functions include **Pressure (P)**, **Volume (V)**, **Temperature (T)**, **Internal Energy (E)**, and **Enthalpy (H)**.
15. **Heat (q)** and **Work (w)** are path functions and are **not state functions**.

Internal Energy (E) and Enthalpy (H)

16. The sum of all kinetic and potential energies of the particles within a system is called its **Internal Energy (E)**.
17. The change in internal energy is given by $\Delta E = q + w$, where q is heat and w is work.
18. **Enthalpy (H)** is defined as the heat content of a system at constant pressure, given by $H = E + PV$.
19. The heat change at constant volume (q_v) is equal to the change in internal energy (ΔE).
20. The heat change at constant pressure (q_p) is equal to the change in enthalpy (ΔH).
21. For reactions involving solids and liquids, $\Delta H \approx \Delta E$ because the change in volume (ΔV) is negligible.

Standard Enthalpy Changes

22. **Standard conditions** are defined as a temperature of 25°C (298 K) and a pressure of 1 atmosphere.
23. The **Standard Enthalpy of Reaction (ΔH°_r)** is the enthalpy change when molar quantities of reactants, as shown in the balanced equation, react under standard conditions.
24. The **Standard Enthalpy of Formation (ΔH°_f)** is the enthalpy change when one mole of a compound is formed from its elements in their standard states.
25. The standard enthalpy of formation of any element in its most stable form is **zero**.
26. The **Standard Enthalpy of Combustion (ΔH°_c)** is the enthalpy change when one mole of a substance is completely burnt in excess oxygen under standard conditions.
27. The **Standard Enthalpy of Neutralization (ΔH°_n)** is the enthalpy change when one mole of H^+ ions from an acid reacts with one mole of OH^- ions from a base to form one mole of water.
28. For strong acids and strong bases, the standard enthalpy of neutralization is approximately **-57.4 kJ mol⁻¹**.
29. The **Standard Enthalpy of Atomization (ΔH°_{at})** is the enthalpy change when one mole of gaseous atoms is formed from an element under standard conditions.
30. The **Standard Enthalpy of Solution (ΔH°_{sol})** is the enthalpy change when one mole of a substance dissolves in a solvent to form a solution of infinite dilution.



Practice MCQs

1. What is the study of heat changes accompanying chemical reactions called?

- A) Thermodynamics
- B) Kinetics
- C) Thermochemistry
- D) Electrochemistry

Answer: Thermochemistry

2. The SI unit of thermal energy is the:

- A) Calorie
- B) Joule
- C) Newton
- D) Pascal

Answer: Joule

3. A reaction that releases heat to the surroundings is known as:

- A) Endothermic
- B) Exothermic
- C) Isothermal
- D) Adiabatic

Answer: Exothermic

4. For an endothermic process, the sign of ΔH is:

- A) Positive
- B) Negative
- C) Zero
- D) Cannot be predicted

Answer: Positive

5. Which of the following is a state function?

- A) Work
- B) Heat
- C) Enthalpy
- D) Both A and B

Answer: Enthalpy

6. The rest of the universe outside the system under study is called the:

- A) Boundary
- B) Surroundings
- C) Interface
- D) Environment

Answer: Surroundings

7. The change in internal energy (ΔE) is equal to the heat supplied at:

- A) Constant pressure
- B) Constant volume
- C) Constant temperature
- D) All of these

Answer: Constant volume

8. The enthalpy change (ΔH) is equal to the heat supplied at:

- A) Constant pressure
- B) Constant volume
- C) Constant temperature
- D) All of these

Answer: Constant pressure

9. The relationship between enthalpy (H), internal energy (E), pressure (P), and volume (V) is:

- A) $H = E / PV$
- B) $H = E - PV$
- C) $H = E + PV$
- D) $H = PV - E$

Answer: $H = E + PV$

10. Standard conditions for thermochemical measurements are:

- A) 0°C and 1 atm
- B) 25°C and 1 atm
- C) 0 K and 1 atm
- D) 25°C and 760 atm

Answer: 25°C and 1 atm

11. The enthalpy change for the formation of one mole of a compound from its elements is the:

- A) Enthalpy of combustion
- B) Enthalpy of formation
- C) Enthalpy of reaction
- D) Enthalpy of neutralization

Answer: Enthalpy of formation

12. The standard enthalpy of formation of an element in its most stable form is:

- A) Positive
- B) Negative
- C) Zero
- D) Different for each element

Answer: Zero

13. The heat evolved when one mole of a substance is completely burnt in oxygen is its:

- A) Enthalpy of formation
- B) Enthalpy of combustion
- C) Enthalpy of neutralization
- D) Enthalpy of solution

Answer: Enthalpy of combustion

14. The heat change when one mole of H^+ ions neutralizes one mole of OH^- ions is the:

M
K

P

R

E

P

A

R

A

T

I

O

N

S



Electrochemistry

Introduction to Electrochemistry

1. **Electrochemistry** deals with the interconversion of electrical energy and chemical energy.
2. An **electrolytic cell** converts electrical energy into chemical energy.
3. A **galvanic** or **voltaic cell** converts chemical energy into electrical energy.
4. **Electrolysis** is a non-spontaneous process driven by electrical energy.
5. A spontaneous redox reaction produces electricity in a **galvanic cell**.

Oxidation and Reduction

6. **Oxidation** is the loss of electrons or an increase in oxidation number.
7. **Reduction** is the gain of electrons or a decrease in oxidation number.
8. A **redox reaction** involves simultaneous oxidation and reduction.
9. An **oxidizing agent** accepts electrons and gets reduced.
10. A **reducing agent** donates electrons and gets oxidized.
11. According to the classical concept, oxidation is the addition of oxygen or removal of hydrogen.
12. According to the classical concept, reduction is the removal of oxygen or addition of hydrogen.

Oxidation State (Oxidation Number)

13. The **oxidation number** is the apparent charge on an atom in a molecule or ion.
14. The oxidation number of a free element (e.g., Na, O₂, H₂) is zero.
15. The oxidation number of a monatomic ion equals its charge (e.g., Na⁺ is +1, S²⁻ is -2).
16. The oxidation number of hydrogen is +1, except in metal hydrides (e.g., NaH) where it is -1.
17. The oxidation number of oxygen is -2, except in peroxides (e.g., H₂O₂) where it is -1 and in OF₂ where it is +2.
18. The algebraic sum of oxidation numbers of all atoms in a neutral molecule is zero.
19. The algebraic sum of oxidation numbers of all atoms in a polyatomic ion equals the charge on the ion.
20. In its compounds, fluorine always has an oxidation number of -1.

Balancing Redox Reactions

21. Redox equations can be balanced by the **Oxidation Number Method**.
22. Redox equations can be balanced by the **Ion-Electron (Half-Reaction) Method**.
23. The Ion-Electron method is suitable for reactions in acidic or basic media.
24. In the Ion-Electron method, the equation is split into oxidation and reduction half-reactions.
25. In acidic medium, H⁺ ions and H₂O are used to balance oxygen and hydrogen atoms.
26. In basic medium, OH⁻ ions and H₂O are used to balance oxygen and hydrogen atoms.
27. The number of electrons lost in the oxidation half-reaction must equal the number gained in the reduction half-reaction.

Electrolytes and Electrolytic Conduction

28. An **electrolyte** is a substance that in solution or molten state conducts electricity by the movement of ions.
29. **Strong electrolytes** (e.g., NaCl, H₂SO₄) are completely ionized in solution.
30. **Weak electrolytes** (e.g., CH₃COOH, NH₄OH) are partially ionized in solution.
31. **Non-electrolytes** (e.g., sugar, urea) do not conduct electricity.
32. **Electrolytic conduction** is the movement of ionic charges through a liquid upon application of electricity.
33. **Metallic conduction** is due to the flow of electrons and involves no chemical change.

Electrolytic Cell and Electrolysis

34. An **electrolytic cell** is used to carry out a non-spontaneous redox reaction.
35. The **anode** in an electrolytic cell is positive and connected to the positive terminal of the battery.
36. The **cathode** in an electrolytic cell is negative and connected to the negative terminal of the battery.
37. **Oxidation** occurs at the **anode**.



Practice MCQs

1. What is the primary focus of the branch of science known as electrochemistry?

- A) Study of electric charge at rest
- B) Interconversion of electrical and chemical energy
- C) Properties of elements in the periodic table
- D) Synthesis of organic compounds

Answer: Interconversion of electrical and chemical energy

2. In an electrolytic cell, what type of energy conversion takes place?

- A) Chemical to electrical
- B) Electrical to chemical
- C) Heat to electrical
- D) Light to chemical

Answer: Electrical to chemical

3. In a galvanic cell, what is the source of the electrical energy produced?

- A) An external battery
- B) A spontaneous redox reaction
- C) A non-spontaneous redox reaction
- D) Heat from the surroundings

Answer: A spontaneous redox reaction

4. Which process involves the forcing of a non-spontaneous chemical reaction using an electric current?

- A) Galvanization
- B) Electrolysis
- C) Metallic conduction
- D) Corrosion

Answer: Electrolysis

5. According to the electron transfer concept, what defines oxidation?

- A) Gain of electrons
- B) Loss of electrons
- C) Gain of oxygen
- D) Loss of hydrogen

Answer: Loss of electrons

6. A substance that gets reduced during a redox reaction acts as a/an?

- A) Reducing agent
- B) Oxidizing agent
- C) Electrolyte
- D) Catalyst

Answer: Oxidizing agent

7. What is the oxidation number of any free element in its standard state?

- A) +1
- B) -1
- C) 0
- D) Its group number

Answer: 0

8. What is the oxidation number of hydrogen in sodium hydride (NaH)?

- A) +1
- B) 0
- C) -1
- D) +2

Answer: -1

9. In which compound does oxygen have an oxidation number of +2?

- A) H_2O
- B) H_2O_2
- C) OF_2
- D) MgO

Answer: OF_2

10. What is the oxidation number of chromium in the dichromate ion ($\text{Cr}_2\text{O}_7^{2-}$)?

- A) +3
- B) +6
- C) +7
- D) +2

Answer: +6

11. For a neutral molecule, what is the algebraic sum of the oxidation numbers of all its atoms?

- A) +1
- B) -1
- C) 0
- D) Equal to its molecular mass

Answer: 0

12. Which method for balancing redox reactions involves splitting the reaction into oxidation and reduction half-reactions?

- A) Oxidation Number Method
- B) Ion-Electron Method
- C) Inspection Method
- D) Titration Method

Answer: Ion-Electron Method



Analytical Chemistry & Spectroscopy

1. **Analytical Chemistry** deals with the identification and quantification of substances.
2. **Qualitative analysis** identifies what substances are present in a sample.
3. **Quantitative analysis** determines how much of a substance is present.
4. Classical methods include separations like precipitation, extraction, and distillation.
5. **Volumetric analysis (titrations)** and **gravimetric analysis** are classical quantitative methods.
6. Modern instrumental methods measure physical properties like light absorption or conductivity.
7. Modern methods are superior due to their speed, accuracy, and requirement of small sample amounts.

Classical Methods: Combustion Analysis & Formulas

8. **Combustion analysis** is used to find the percentage composition of Carbon and Hydrogen in an organic compound containing C, H, and O.
9. The organic compound is burned in oxygen, producing CO_2 and H_2O .
10. CO_2 is absorbed by KOH , and H_2O is absorbed by **Magnesium perchlorate** $[\text{Mg}(\text{ClO}_4)_2]$.
11. Percentage of Carbon is calculated as: $\%C = (\text{mass of } \text{CO}_2 / \text{mass of compound}) \times (12/44) \times 100$.
12. Percentage of Hydrogen is calculated as: $\%H = (\text{mass of } \text{H}_2\text{O} / \text{mass of compound}) \times (2.02/18.02) \times 100$.
13. Percentage of Oxygen is found by difference: $\%O = 100 - (\%C + \%H)$.
14. The **Empirical Formula** gives the simplest whole-number ratio of atoms in a compound.
15. The **Molecular Formula** shows the actual number of atoms of each element in a molecule.
16. Molecular Formula = $n \times (\text{Empirical Formula})$, where $n = \text{Molecular Weight} / \text{Empirical Formula Weight}$.

Introduction to Modern Methods & Spectroscopy

17. Modern methods include IR, UV-Vis, NMR, Atomic Spectrometry, and Mass Spectrometry.
18. **Spectroscopy** involves the interaction of matter with **electromagnetic radiation**.
19. The energy of electromagnetic radiation is given by $E = h\nu$, where h is Planck's constant and ν is frequency.
20. The electromagnetic spectrum ranges from high-energy gamma rays to low-energy radio waves.
21. Different spectroscopic techniques use different regions of the electromagnetic spectrum.

Infrared (IR) Spectroscopy

22. **IR Spectroscopy** is used primarily for the identification of **functional groups**.
23. IR radiation causes **vibrational** changes (stretching and bending) in molecules.
24. The typical range for IR spectroscopy is 4000 cm^{-1} to 625 cm^{-1} (wave numbers).
25. A bond will absorb IR radiation only if its vibration causes a change in the **dipole moment** of the molecule.
26. The region from $1500\text{--}4000\text{ cm}^{-1}$ is the **functional group region**.
27. The region from $600\text{--}1500\text{ cm}^{-1}$ is the **fingerprint region**, which is unique for every compound.
28. A broad peak around $3200\text{--}3600\text{ cm}^{-1}$ indicates an **O-H** group (alcohols, phenols).
29. A strong, sharp peak around $1700\text{--}1750\text{ cm}^{-1}$ indicates a **C=O** group (carbonyl).
30. IR spectroscopy can be used to detect impurities and monitor the progress of chemical reactions.

Ultraviolet-Visible (UV-Vis) Spectroscopy

31. **UV-Vis Spectroscopy** involves the promotion of electrons from ground state to excited state.
32. It is used to study compounds with **conjugation** and to predict the color of complexes.
33. The useful wavelength range is from 200 nm to 800 nm.
34. The **Beer-Lambert Law** states that Absorbance (A) = Ecl , where E is molar absorptivity, c is concentration, and l is path length.
35. Electronic transitions involved are $\sigma \rightarrow \sigma$, $n \rightarrow \sigma$, $\pi \rightarrow \pi$, and $n \rightarrow \pi$.
36. **Transition metal complexes** are colored due to **d-d transitions**.
37. The color we observe is the **complementary color** to the wavelength absorbed.
38. If a complex absorbs violet light ($\sim 400\text{--}435\text{ nm}$), it will appear **yellow-green**.

Answer: Magnesium perchlorate

4. Which formula is used to calculate the percentage of carbon in combustion analysis?

- A) $(\text{mass of CO}_2 / \text{mass of compound}) \times (44/12) \times 100$
- B) $(\text{mass of CO}_2 / \text{mass of compound}) \times (12/44) \times 100$
- C) $(\text{mass of H}_2\text{O} / \text{mass of compound}) \times (2/18) \times 100$
- D) $(\text{mass of H}_2\text{O} / \text{mass of compound}) \times (18/2) \times 100$

Answer: $(\text{mass of CO}_2 / \text{mass of compound}) \times (12/44) \times 100$

5. The empirical formula of a compound is CH₂O. If its molecular mass is 180 g/mol, what is its molecular formula?

- A) C₃H₆O₃
- B) C₆H₁₂O₆
- C) C₅H₁₀O₅
- D) C₄H₈O₄

Answer: C₆H₁₂O₆

6. Which of the following is a key advantage of modern analytical methods over classical methods?

- A) They require larger sample sizes
- B) They are more time-consuming
- C) They provide more accurate results
- D) They involve complex chemical reactions

Answer: They provide more accurate results

7. Spectroscopy is based on the interaction of matter with what?

- A) Electric current
- B) Sound waves
- C) Electromagnetic radiation
- D) Magnetic fields only

Answer: Electromagnetic radiation

8. Which region of the IR spectrum (in cm⁻¹) is known as the fingerprint region?

- A) 1500-4000
- B) 4000-625
- C) 600-1500
- D) 2000-3000

Answer: 600-1500

9. A broad IR absorption peak around 3300 cm⁻¹ is characteristic of which functional group?

- A) C=O
- B) C-H
- C) O-H

D) C≡C

Answer: O-H

10. What is the primary use of Infrared (IR) Spectroscopy?

- A) Determining molecular mass
- B) Identifying functional groups
- C) Finding the number of protons
- D) Measuring concentration

Answer: Identifying functional groups

11. In UV-Vis spectroscopy, the Beer-Lambert law states the relationship between absorbance and what?

- A) Temperature
- B) Pressure
- C) Concentration
- D) Volume

Answer: Concentration

12. Which electronic transition requires the most energy?

- A) $n \rightarrow \pi^*$
- B) $\pi \rightarrow \pi^*$
- C) $\sigma \rightarrow \sigma^*$
- D) $n \rightarrow \sigma^*$

Answer: $\sigma \rightarrow \sigma^*$

13. If a transition metal complex appears yellow, what color of light is it most likely absorbing?

- A) Red
- B) Yellow
- C) Violet
- D) Green

Answer: Violet

14. What is the typical wavelength range for UV-Vis spectroscopy?

- A) 10-400 nm
- B) 400-800 nm
- C) 200-800 nm
- D) 800-1200 nm

Answer: 200-800 nm

15. Which nuclei are NMR active?

- A) Nuclei with even mass number
- B) Nuclei with zero spin quantum number
- C) Nuclei with non-zero spin quantum number
- D) Nuclei with an even number of protons and neutrons

Answer: Nuclei with non-zero spin quantum number



Environmental Chemistry

Introduction to Environmental Chemistry & Atmosphere

1. The branch of chemistry dealing with the study of the environment and the changes occurring in it is called **Environmental Chemistry**.
2. The environment is composed of four spheres: **Lithosphere, Hydrosphere, Biosphere, and Atmosphere**.
3. The **Atmosphere** is a protective blanket of air around the earth, composed mainly of **Nitrogen (78%)** and **Oxygen (21%)**.
4. The mass of the atmosphere is approximately **4.5 to 5 x 10¹⁵ metric tonnes**.
5. Atmospheric pressure **decreases** with an increase in altitude.
6. The atmosphere is divided into four main layers based on temperature: **Troposphere, Stratosphere, Mesosphere, and Thermosphere**.

Layers of the Atmosphere

7. The **Troposphere** is the lowest layer where all weather phenomena occur.
8. The average height of the troposphere is **10-11 km**.
9. The change in temperature with height is called the **Lapse Rate**.
10. The **Stratosphere** extends from 11 km to 50 km and contains the **Ozone Layer (Ozonosphere)**.
11. The temperature in the stratosphere **increases** with altitude due to the absorption of UV radiation by ozone.
12. The **Mesosphere** is the coldest layer, with temperatures dropping to **-92°C**.
13. The **Thermosphere** has very high temperatures (up to 1200°C) and is also called the **Ionosphere** due to the presence of ions.

Air Pollution and Pollutants

14. According to the WHO, **air pollution** is the release of substances into the air in sufficient concentration to cause harmful effects.
15. **Primary pollutants** are emitted directly into the air (e.g., CO, SO₂, NO₂).
16. **Secondary pollutants** are formed from primary pollutants through chemical reactions (e.g., Acid Rain, Photochemical Smog, O₃).
17. **Particulate Matter (PM)** consists of small solid or liquid particles suspended in the air.
18. **Carbon Monoxide (CO)** is a colorless, odorless, toxic gas that binds with hemoglobin more strongly than oxygen, forming **Carboxyhemoglobin**.
19. The major source of CO is the **incomplete combustion** of fuels in automobiles.
20. **Nitrogen Oxides (NO_x)** are produced during high-temperature combustion in vehicles and power plants.
21. **Sulfur Oxides (SO_x)** are produced mainly from the combustion of coal and the smelting of metals.
22. **Volatile Organic Compounds (VOCs)**, along with NO_x, are the primary ingredients for the formation of **photochemical smog**.
23. **Chlorofluorocarbons (CFCs)** are synthetic compounds that deplete the stratospheric ozone layer.

Acid Rain

24. Normal, unpolluted rain is slightly acidic with a pH of **5.6** due to dissolved CO₂ forming **carbonic acid**.
25. **Acid rain** is defined as rain with a pH **less than 5.6**.
26. The primary cause of acid rain is the atmospheric conversion of SO₂ to H₂SO₄ and NO_x to HNO₃.
27. Acid rain causes **corrosion of buildings, sculptures (made of marble/limestone), and metals**.
28. It leads to the **acidification of soil and water bodies**, releasing toxic ions like **Aluminium** which harms aquatic life.
29. Acid rain can **damage plant leaves and hinder growth**.

Ozone (O₃)

Practice MCQs

1. What is the primary reason that normal, unpolluted rainwater is slightly acidic?

- A) Dissolved Nitrogen
- B) Dissolved Sulfur Dioxide
- C) Dissolved Carbon Dioxide
- D) Dissolved Oxygen

Answer: Dissolved Carbon Dioxide

2. Which layer of the atmosphere contains the ozone layer that protects us from UV radiation?

- A) Troposphere
- B) Stratosphere
- C) Mesosphere
- D) Thermosphere

Answer: Stratosphere

3. What is the major gaseous component of the Earth's atmosphere by volume?

- A) Oxygen
- B) Argon
- C) Nitrogen
- D) Carbon Dioxide

Answer: Nitrogen

4. Which of the following is a secondary pollutant formed in the atmosphere by chemical reactions?

- A) Carbon Monoxide
- B) Sulfur Dioxide
- C) Ozone
- D) Nitric Oxide

Answer: Ozone

5. The brownish color of photochemical smog is primarily due to the presence of which gas?

- A) Carbon Monoxide
- B) Ozone
- C) Nitrogen Dioxide
- D) Sulfur Dioxide

Answer: Nitrogen Dioxide

6. Which industrial compound is primarily responsible for the depletion of the stratospheric ozone layer?

- A) Carbon Dioxide
- B) Sulfur Dioxide
- C) Chlorofluorocarbons (CFCs)
- D) Methane

Answer: Chlorofluorocarbons (CFCs)

7. What is the pH threshold used to define acid rain?

- A) pH 7.0
- B) pH 6.5
- C) pH 5.6
- D) pH 4.0

Answer: pH 5.6

8. The harmful effect of Carbon Monoxide (CO) is primarily due to its ability to:

- A) Cause acid rain
- B) Deplete the ozone layer
- C) Form carboxyhemoglobin
- D) Act as a greenhouse gas

Answer: Form carboxyhemoglobin

9. Which of the following is a potent greenhouse gas released from agricultural activities and landfills?

- A) Oxygen
- B) Nitrogen
- C) Methane
- D) Ozone

Answer: Methane

10. The phenomenon where a water body becomes rich in nutrients, leading to excessive algal growth, is called:

- A) Acidification
- B) Eutrophication
- C) Coagulation
- D) Sedimentation

Answer: Eutrophication

11. Temporary hardness of water is caused by the presence of:

- A) Chlorides of Calcium and Magnesium
- B) Sulfates of Calcium and Magnesium
- C) Bicarbonates of Calcium and Magnesium
- D) Nitrates of Calcium and Magnesium

Answer: Bicarbonates of Calcium and Magnesium

12. Which method is used to remove permanent hardness from water?

- A) Boiling
- B) Clark's Method
- C) Adding Washing Soda
- D) Filtration

Answer: Adding Washing Soda

13. In water analysis, BOD is a measure of:

M
K

P
R
E
P
A
R
A
T
I
O
N
S

12. Environmental Chemistry



Chemical Industries

13. Chemical Industries

Metallurgy (Copper)

1. The art and science of making metals and alloys from their ores is called **metallurgy**.
2. An aggregate of mineral and other impurities is known as an **ore**.
3. The most important method for the concentration of copper ore is the **Froth Floatation** method.
4. In the Froth Floatation process, the ore particles are wetted by **oil** and float to the top.
5. In copper extraction, the concentrated ore is mixed with **silica** and **calcium carbonate** and heated in a blast furnace to form **matte**.
6. The chemical reaction for the reduction of copper in a Bessemer converter is: $\text{Cu}_2\text{S} + \text{O}_2 \rightarrow 2\text{Cu} + \text{SO}_2$.
7. The porous, impure copper obtained after reduction is called **blister copper**.
8. Blister copper is purified by the process of **electro-refining**.
9. In the electro-refining of copper, the impure blister copper is made the **anode**.
10. The impurities that settle at the bottom during electro-refining are called **anode mud**, which contains **silver** and **gold**.

Solvay's Process (Sodium Carbonate)

11. Sodium carbonate is commercially manufactured by **Solvay's process**.
12. The raw materials for Solvay's process are **sodium chloride (NaCl)**, **limestone (CaCO₃)**, and **ammonia (NH₃)**.
13. Carbon dioxide gas for the Solvay's process is obtained by heating **limestone**.
14. The intermediate compound precipitated in the carbonating tower is **sodium bicarbonate (NaHCO₃)**.
15. Sodium bicarbonate is converted to sodium carbonate by **heating**.
16. The chemical reaction for the decomposition of sodium bicarbonate is: $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$.
17. Ammonia is recovered in the process by reacting **ammonium chloride** with **calcium hydroxide**.
18. The recovery of ammonia is represented by the reaction: $2\text{NH}_4\text{Cl} + \text{Ca(OH)}_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3$.

Urea

19. The chemical formula of urea is **NH₂CONH₂**.
20. Urea is the most important **nitrogenous** artificial fertilizer.
21. The raw materials for the production of urea are **carbon dioxide (CO₂)** and **ammonia (NH₃)**.
22. Urea is produced by the reaction of **liquid ammonia** with **gaseous carbon dioxide**.
23. The first product formed in urea manufacture is **ammonium carbamate**.
24. Urea contains about **46%** nitrogen, making it a highly concentrated fertilizer.
25. The process of forming solid urea pellets is called **prilling**.
26. Besides its use as a fertilizer, urea is used in the manufacture of **plastics**, **resins**, and **explosives** like urea nitrate.

Petroleum

27. **Petroleum** is a dark, viscous liquid found under the earth's crust and is also known as **crude oil** or **mineral oil**.
28. Petroleum is often called "**black gold**" or "**liquid gold**" due to its economic value.

- B) Copper Matte
C) Blister Copper
D) Copper Sulphide

Answer: Blister Copper

How is blister copper purified on an industrial scale?

- A) Roasting
B) Distillation
C) Electro-refining
D) Zone Refining

Answer: Electro-refining

Which of the following is NOT a raw material for the Solvay's process?

- A) Sodium Chloride
B) Limestone
C) Ammonia
D) Sodium Hydroxide

Answer: Sodium Hydroxide

What is the intermediate compound precipitated during Solvay's process?

- A) Sodium Carbonate
B) Sodium Chloride
C) Sodium Bicarbonate
D) Ammonium Chloride

Answer: Sodium Bicarbonate

How is ammonia recovered in the Solvay's process?

- A) By heating ammonium carbonate
B) By reacting ammonium chloride with calcium hydroxide
C) By distilling the filtrate
D) By electrolysis of ammonium chloride

Answer: By reacting ammonium chloride with calcium hydroxide

What is the chemical formula of Urea?

- A) $\text{NH}_2\text{COONH}_4$
B) NH_4Cl
C) NH_2CONH_2
D) $(\text{NH}_4)_2\text{CO}_3$

Answer: NH_2CONH_2

What are the raw materials for the commercial production of urea?

- A) CO and NH_3
B) CO_2 and N_2
C) CO_2 and NH_3
D) H_2 and N_2

Answer: CO_2 and NH_3

Which process is used to form solid urea pellets?

- A) Crystallization
B) Prilling
C) Sublimation
D) Compression

Answer: Prilling

What is the common name for the dark viscous liquid found under the earth's crust?

- A) Coal Tar
B) Petroleum
C) Kerosene
D) Biogas

Answer: Petroleum

Petroleum is primarily a mixture of which type of compounds?

- A) Carbohydrates
B) Hydrocarbons
C) Proteins
D) Esters

Answer: Hydrocarbons

How are different fractions of petroleum separated in a refinery?

- A) Filtration
B) Fractional Distillation
C) Sublimation
D) Chromatography

Answer: Fractional Distillation

Which petroleum fraction has the highest boiling point?

- A) Refinery Gas
B) Gasoline
C) Kerosene
D) Bitumen

Answer: Bitumen

What are the three primary macro-nutrients required for plant growth?

- A) Carbon, Hydrogen, Oxygen
B) Nitrogen, Phosphorus, Potassium
C) Calcium, Magnesium, Sulphur
D) Iron, Copper, Zinc

Answer: Nitrogen, Phosphorus, Potassium

Which nutrient is supplied by urea fertilizer?

- A) Phosphorus
B) Potassium
C) Nitrogen
D) Sulphur



Periodic Table & Periodicity

Historical Development

1. Hydrogen belongs to Group 1 but is **not** an alkali metal.
2. Helium is placed in Group 18 due to its stable $1s^2$ electronic configuration.
3. **Dobereiner** (1829) classified elements into groups of three called **triads**, where the atomic mass of the middle element was the average of the other two.
4. **Newlands** (1863) proposed the **Law of Octaves**, noting that every eighth element had properties similar to the first.
5. Newlands' Law of Octaves was applicable only up to **Calcium** (atomic number 20).
6. **Mendeleev** (1869) created the first successful periodic table based on **atomic mass** and left gaps for undiscovered elements.
7. Mendeleev is known as the "**Father of the Periodic Table**".
8. Mendeleev's **Periodic Law** stated that properties of elements are a periodic function of their **atomic weights**.
9. **Henry Moseley** (1913) established that atomic number is the fundamental property of an element.
10. The **Modern Periodic Law** states that properties of elements are a periodic function of their **atomic numbers**.
11. Moseley found a relationship between **X-ray wavelength** and **atomic number**.
12. The confusion in Mendeleev's table regarding elements like Be, Mg, Ca, Sr, Ba, Zn, Cd, Hg was resolved by creating **A and B subgroups**.
13. Mendeleev's table could not explain the position of **isotopes** and **rare earth metals**.
14. Tellurium (atomic mass 127.6) is placed before Iodine (atomic mass 126.9) in the modern periodic table because Te has atomic number **52** while I has **53**.
15. The **Long Form of Periodic Table** is also called **Bohr's Table**.

Structure of Modern Periodic Table

16. Horizontal rows are called **periods**; there are **7** periods.
17. Vertical columns are called **groups** or **families**; there are **18** groups.
18. **Group number** indicates the number of **valence electrons** for representative elements.
19. **Period number** indicates the number of **electron shells** (principal quantum number **n**).
20. The **1st period** is the shortest, containing only **2** elements (H and He).
21. The **2nd and 3rd periods** are short periods, each containing **8** elements.
22. The **4th and 5th periods** are long periods, each containing **18** elements.
23. The **6th period** contains **32** elements, including the **Lanthanides**.
24. The **7th period** is incomplete and contains the **Actinides**.
25. The **number of elements in each period** is twice the number of atomic orbitals available in that energy level.
26. Each period starts with an alkali metal (ns^1) and ends with a noble gas (ns^2np^6).
27. Elements in the same group have **similar chemical properties** due to the same number of valence electrons.

Blocks Classification

28. Elements are classified into four blocks: **s, p, d, and f-block**, based on the subshell in which the last electron enters.
29. **s-block** elements include **Groups 1 and 2** (alkali and alkaline earth metals).
30. **p-block** elements include **Groups 13 to 18**.
31. **d-block** elements include **Groups 3 to 12** and are called **transition elements**.



Q6. Which period is known as the shortest period?

- A. 1st
- B. 2nd
- C. 3rd
- D. 4th

Answer: A. 1st

Q7. The lanthanide series elements are placed in which period?

- A. 4th
- B. 5th
- C. 6th
- D. 7th

Answer: C. 6th

Q8. Elements with similar chemical properties are placed in the same:

- A. Period
- B. Group
- C. Block
- D. Shell

Answer: B. Group

Q9. Which of the following is an s-block element?

- A. Aluminum
- B. Sodium
- C. Chlorine
- D. Silicon

Answer: B. Sodium

Q10. The p-block elements contain groups from:

- A. 1 to 2
- B. 3 to 12
- C. 13 to 18
- D. 1 to 8

Answer: C. 13 to 18

Q11. The d-block elements are also known as:

- A. Alkali Metals
- B. Halogens
- C. Transition Elements
- D. Noble Gases

Answer: C. Transition Elements

Q12. Which group of elements is known as alkali metals?

- A. Group 1
- B. Group 2
- C. Group 17

D. Group 18

Answer: A. Group 1

Q13. The elements of Group 17 are commonly called:

- A. Chalcogens
- B. Halogens
- C. Noble Gases
- D. Alkaline Earth Metals

Answer: B. Halogens

Q14. Which of the following elements is a noble gas?

- A. Fluorine
- B. Chlorine
- C. Neon
- D. Bromine

Answer: C. Neon

Q15. The atomic radius generally _____ across a period from left to right.

- A. Increases
- B. Decreases
- C. Remains Constant
- D. First Increases then Decreases

Answer: B. Decreases

Q16. Down a group in the periodic table, the atomic radius:

- A. Increases
- B. Decreases
- C. Remains Constant
- D. First Decreases then Increases

Answer: A. Increases

Q17. A positive ion (cation) is always _____ than its parent atom.

- A. Larger
- B. Smaller
- C. The Same Size
- D. Heavier

Answer: B. Smaller

Q18. The energy required to remove an electron from a gaseous atom is called:

- A. Electron Affinity
- B. Electronegativity
- C. Ionization Energy
- D. Lattice Energy

Answer: C. Ionization Energy

Q19. Ionization energy _____ down a group.

- A. Increases
- B. Decreases



Fundamentals of Organic Chemistry

Introduction & Historical Background

1. **Organic chemistry** is the study of **hydrocarbons and their derivatives**.
2. Initially, organic compounds were defined as those obtained from **living organisms (plants and animals)**.
3. Inorganic compounds were those obtained from **mineral or non-living sources**.
4. The **Vital Force Theory**, proposed by Berzelius, stated that organic compounds could only be synthesized by living organisms.
5. **Friedrich Wohler** synthesized **urea** from ammonium cyanate in 1828, disproving the Vital Force Theory.
6. Urea is an organic compound found in **urine**.
7. The modern definition of organic chemistry is the study of **carbon compounds**, with a few exceptions.
8. Compounds like **CO, CO₂, carbonates, bicarbonates, cyanides, and carbides** are considered inorganic.

Sources of Organic Compounds

9. The major sources of organic compounds are **coal, petroleum, and natural gas** (fossil fuels).
10. **Fossil fuels** are formed by the **anaerobic decomposition of buried plants and animals** over millions of years.
11. **Coal** is a solid fossil fuel formed from the decay of plant matter, first converting into **peat**.
12. Types of coal include **lignite, bituminous, and anthracite** (highest carbon content).
13. **Destructive distillation of coal** yields **coke, coal tar, ammoniacal liquor, and coal gas**.
14. **Coal tar** is a source of **aromatic compounds** like benzene, toluene, and naphthalene.
15. **Petroleum** is a complex mixture of **hydrocarbons**, primarily alkanes, cycloalkanes, and aromatics.
16. **Natural gas** is mainly composed of **methane (85%)**, along with ethane, propane, and butane.
17. **Plants and animals** are direct sources of organic compounds, known as **natural products**.
18. **Biotechnology** uses living organisms to produce organic compounds like **antibiotics, insulin, and ethanol**.
19. The **Fischer-Tropsch process** converts **coal gas (CO + H₂)** into **liquid petroleum hydrocarbons**.

Characteristics of Organic Compounds

20. The vast number of organic compounds is due to carbon's unique property of **catenation**.
21. **Catenation** is the ability of carbon atoms to form **long chains and rings** with other carbon atoms.
22. Organic compounds are generally **covalent** in nature, leading to **non-ionic character**.
23. They typically have **low melting and boiling points** and are **volatile**.
24. Most organic compounds are **insoluble in water** but **soluble in non-polar solvents** like ether and benzene.
25. They are **poor conductors of electricity**.
26. Organic reactions are generally **slower** than inorganic reactions.
27. **Isomerism** is a common phenomenon where compounds have the **same molecular formula but different structures**.

28. Most organic compounds are **inflammable**.

Classification of Organic Compounds

29. Organic compounds are broadly classified into **Open Chain (Acyclic) and Closed Chain (Cyclic) compounds**.
30. **Open chain compounds** have straight or branched carbon chains and are also called **aliphatic compounds**.
31. **Closed chain compounds** contain rings of atoms and are subdivided into **Homocyclic and Heterocyclic**.
32. **Homocyclic compounds** have rings containing only carbon atoms (e.g., benzene, cyclohexane).
33. Homocyclic compounds are further divided into **Alicyclic** (aliphatic-like) and **Aromatic** (containing benzene rings).
34. **Aromatic compounds** contain at least one **benzene ring**.



66. In **sp² hybridization**, carbon forms three sigma bonds and one pi (π) bond with a **trigonal planar shape** and a bond angle of **120°** (e.g., alkenes).
67. In **sp hybridization**, carbon forms two sigma bonds and two pi bonds with a **linear shape** and a bond angle of **180°** (e.g., alkynes).
68. A **double bond** consists of **one sigma (σ) and one pi (π) bond**.
69. A **triple bond** consists of **one sigma (σ) and two pi (π) bonds**.

Practice MCQs

1. The first organic compound synthesized in the laboratory was:

- A) Acetic acid
- B) Sugar
- C) Urea
- D) Methane

Answer: Urea

2. The theory that organic compounds could only be produced by living organisms was called:

- A) Atomic Theory
- B) Vital Force Theory
- C) Molecular Theory
- D) Conservation Theory

Answer: Vital Force Theory

3. Which scientist successfully synthesized urea from an inorganic compound?

- A) Berzelius
- B) Lavoisier
- C) Wohler
- D) Dalton

Answer: Wohler

4. Which of the following is NOT considered an organic compound?

- A) Urea
- B) Methane
- C) Sodium Carbonate
- D) Glucose

Answer: Sodium Carbonate

5. The self-linking property of carbon atoms to form long chains is known as:

- A) Polymerization
- B) Catenation
- C) Isomerism
- D) Condensation

Answer: Catenation

6. The primary source of natural gas is:

- A) Coal tar
- B) Petroleum deposits

C) Plant decay

D) Volcanic rocks

Answer: Petroleum deposits

7. Which fraction of petroleum is used as a motor fuel?

- A) Kerosene
- B) Lubricating Oil
- C) Gasoline
- D) Asphalt

Answer: Gasoline

8. The process of breaking down larger hydrocarbons into smaller, more useful ones is called:

- A) Reforming
- B) Cracking
- C) Distillation
- D) Polymerization

Answer: Cracking

9. The main component of natural gas is:

- A) Ethane
- B) Propane
- C) Butane
- D) Methane

Answer: Methane

10. Destructive distillation of coal does NOT yield:

- A) Coal Gas
- B) Refinery Gas
- C) Coal Tar
- D) Coke

Answer: Refinery Gas

11. Which process is used to convert coal into petroleum?

- A) Haber Process
- B) Destructive Distillation
- C) Fischer-Tropsch Process
- D) Fractional Distillation

Answer: Fischer-Tropsch Process



Hydrocarbons

Introduction & Classification

1. **Hydrocarbons** are organic compounds composed exclusively of **carbon and hydrogen**.
2. They are broadly classified into **Aliphatic Hydrocarbons** and **Aromatic Hydrocarbons**.
3. **Aliphatic hydrocarbons** include open-chain (acyclic) and cyclic compounds that are not aromatic.
4. **Aromatic hydrocarbons** contain at least one **benzene ring** and are also known as **arenes**.
5. Aliphatic hydrocarbons are further divided into **saturated** and **unsaturated** types.
6. **Saturated hydrocarbons** contain only **single covalent bonds** (C-C and C-H).
7. **Unsaturated hydrocarbons** contain **carbon-carbon multiple bonds** (double or triple).
8. The three main homologous series of aliphatic hydrocarbons are **Alkanes, Alkenes, and Alkynes**.
9. **Cyclic hydrocarbons** are closed chain compounds classified as **Alicyclic** (non-aromatic) and **Aromatic**.

Nomenclature and Carbon Types

10. Carbon atoms are classified as **Primary (1°)**, **Secondary (2°)**, **Tertiary (3°)**, and **Quaternary (4°)** based on the number of carbon atoms attached to them.
11. The prefix '**n-**' denotes a straight-chain hydrocarbon.
12. The prefix '**iso-**' is often used for branched-chain alkanes with one **tertiary carbon**.
13. The prefix '**neo-**' is used for branched-chain alkanes with one **quaternary carbon**.
14. The **IUPAC system** provides a systematic set of rules for naming organic compounds.
15. The parent chain is the **longest continuous carbon chain**.
16. Numbering starts from the end **nearest to a substituent** in alkanes.
17. In alkenes and alkynes, the parent chain must contain the **multiple bond**, and numbering starts from the end nearest to it.

Alkanes (Paraffins)

18. **Alkanes** are saturated hydrocarbons with the general formula C_nH_{2n+2} .
19. Each carbon atom in an alkane is **sp³ hybridized** with a **tetrahedral geometry**.
20. Alkanes are relatively inert and are called **paraffins** (Latin: *parum affin* = little affinity).
21. The first four alkanes (Methane to Butane) are **gases** at room temperature.
22. Alkanes are **insoluble in water** but soluble in non-polar organic solvents.
23. Their melting and boiling points **increase with increasing molecular mass**.
24. Alkanes are prepared by the **hydrogenation of alkenes or alkynes** using a **Ni catalyst** (Sabatier-Senderens reaction).
25. Alkanes are prepared by the **reduction of alkyl halides** using **Zn+HCl**.
26. **Decarboxylation** of sodium salts of carboxylic acids with soda-lime produces alkanes.
27. **Kolbe's electrolytic method** is used for the preparation of symmetrical alkanes from carboxylate salts.
28. The major chemical reactions of alkanes are **substitution** (e.g., halogenation) and **combustion**.
29. **Halogenation** of alkanes is a **free radical substitution reaction** requiring **sunlight or UV light**.
30. The mechanism of chlorination of methane involves three steps: **Initiation, Propagation, and Termination**.
31. **Combustion** of alkanes in excess oxygen produces **CO₂, H₂O, and a large amount of heat**.

Alkenes (Olefins)

32. **Alkenes** are unsaturated hydrocarbons containing at least one **carbon-carbon double bond** with the general formula C_nH_{2n} .
33. The first member is **ethene (C₂H₄)**, and they are also called **olefins**.
34. They are more reactive than alkanes due to the presence of a weak **pi (π) bond**.
35. The carbon atoms in a double bond are **sp² hybridized**, and the molecule has a **planar geometry** with **~120° bond angles**.



B) Ammoniacal Cu_2Cl_2

C) Cold, dilute, alkaline KMnO_4

D) Concentrated HNO_3

Answer: Cold, dilute, alkaline KMnO_4

7. What is the hybridization state of carbon atoms in benzene?

A) sp

B) sp^2

C) sp^3

D) sp^3d

Answer: sp^2

8. The catalyst used in Friedel-Crafts acylation is:

A) FeBr_3

B) AlCl_3

C) Ni

D) H_2SO_4

Answer: AlCl_3

9. Which group is meta-directing in electrophilic aromatic substitution?

A) $-\text{OH}$

B) $-\text{CH}_3$

C) $-\text{NH}_2$

D) $-\text{NO}_2$

Answer: $-\text{NO}_2$

10. Resonance in benzene leads to:

A) Decreased stability

B) Increased reactivity

C) Equalization of bond lengths

D) Localization of π -electrons

Answer: Equalization of bond lengths

11. Which of the following will not decolorize bromine water?

A) Ethene

B) Propene

C) Ethane

D) 1-Butyne

Answer: Ethane

12. The final product of the complete hydrogenation of ethyne is:

A) Ethene

B) Ethane

C) Methane

D) Ethanol

Answer: Ethane

13. Dehydrohalogenation of an alkyl halide is carried out using:

A) $\text{Zn} + \text{HCl}$

B) Aqueous KOH

C) Alcoholic KOH

D) H_2SO_4

Answer: Alcoholic KOH

14. The carbon-carbon bond length in benzene is:

A) 1.54 Å

B) 1.34 Å

C) 1.39 Å

D) 1.20 Å

Answer: 1.39 Å

15. Which compound exhibits geometrical isomerism?

A) 1-Butene

B) Propene

C) 2-Butene

D) 2-Methylpropene

Answer: 2-Butene

16. The electrophile in the nitration of benzene is:

A) NO^+

B) NO_2^+

C) NO_2^-

D) HNO_3

Answer: NO_2^+

17. Alkanes are also known as paraffins because they have:

A) Little affinity (reactivity)

B) High reactivity

C) A pleasant smell

D) Oily nature

Answer: Little affinity (reactivity)

18. Terminal alkynes are acidic due to:

A) sp^3 hybridization of carbon

B) The high electronegativity of sp -hybridized carbon

C) The presence of two π -bonds

D) Their gaseous nature

Answer: The high electronegativity of sp -hybridized carbon

19. The major product of the reaction between propene and HBr is:

A) 1-Bromopropane

B) 2-Bromopropane

C) 1,2-Dibromopropane

D) 3-Bromopropane

Answer: 2-Bromopropane

20. Which of the following is an ortho-para director and a ring deactivator?

A) $-\text{NH}_2$



Alkyl Halides & Amines

Introduction & Classification of Alkyl Halides

1. **Alkyl halides** are halogen derivatives of alkanes with a hydrogen atom replaced by a halogen atom.
2. The general formula for a monohaloalkane is $R-X$ or $C_nH_{2n+1}X$.
3. Alkyl halides are classified as **primary (1°)**, **secondary (2°)**, or **tertiary (3°)** based on the carbon atom to which the halogen is bonded.
4. In a **primary alkyl halide**, the halogen is attached to a carbon that is attached to only **one other carbon** atom.
5. In a **secondary alkyl halide**, the halogen is attached to a carbon that is attached to **two other carbon** atoms.
6. In a **tertiary alkyl halide**, the halogen is attached to a carbon that is attached to **three other carbon** atoms.

Nomenclature of Alkyl Halides

7. In the **common naming system**, alkyl halides are named as two words: the alkyl group name followed by the halide name (e.g., Methyl chloride).
8. In the **IUPAC system**, the halogen is treated as a substituent (prefix: fluoro-, chloro-, bromo-, iodo-) on the parent alkane chain.
9. In IUPAC naming, the carbon chain is numbered to give the **halogen-bearing carbon the lowest possible number**.

Physical Properties of Alkyl Halides

10. Lower members like CH_3Cl , C_2H_5Cl , and CH_3F are gases at room temperature.
11. Alkyl halides up to C_{18} are colorless liquids, and higher members are colorless solids.
12. Alkyl halides are generally **insoluble in water** due to their inability to form hydrogen bonds with water molecules.
13. Alkyl chlorides and fluorides are **lighter than water**, while alkyl bromides and iodides are **denser than water**.
14. Boiling points increase with increasing size of the **alkyl group** for a given halogen.
15. For a given alkyl group, boiling points increase with increasing atomic mass of the halogen: $RI > RBr > RCl > RF$.

Preparation of Alkyl Halides

16. Alkyl halides can be prepared from **alcohols** by reaction with **hydrogen halides (HX)**.
17. **HCl** is the least reactive hydrogen halide with alcohols and often requires a catalyst like **anhydrous $ZnCl_2$** (Lucas reagent).
18. Alcohols react with **phosphorus trihalides (PX_3)** to form alkyl halides.
19. A preferred method for preparing alkyl chlorides is the reaction of alcohols with **thionyl chloride ($SOCl_2$)** in the presence of **pyridine**.
20. Alkanes undergo **free radical halogenation** with Cl_2 or Br_2 in the presence of UV light to yield alkyl halides.
21. Free radical halogenation of alkanes gives a **mixture of products**, making it a poor method for preparing pure alkyl halides.
22. Alkenes react with **hydrogen halides (HX)** via electrophilic addition to form alkyl halides, following **Markovnikov's rule**.
23. The reactivity order of HX in addition to alkenes is $HI > HBr > HCl$.
24. Alkyl iodides can be prepared by the reaction of alkyl chlorides/bromides with **sodium iodide (NaI)**.

Structure and Bonding in Alkyl Halides

25. The carbon atom in alkyl halides is **sp^3 hybridized**.
26. The **C-X bond** is polar due to the higher electronegativity of the halogen atom.
27. The bond polarity is represented as $C^{\delta+}-X^{\delta-}$.

Reactivity of Alkyl Halides

Practice MCQs

1. What is the general formula for a monohaloalkane?

- A) $C_nH_{2n}X$
- B) $C_nH_{2n+2}X$
- C) $C_nH_{2n+1}X$
- D) $C_nH_{2n-1}X$

Answer: $C_nH_{2n+1}X$

2. In a tertiary alkyl halide, the halogen-bearing carbon is attached to how many other carbon atoms?

- A) One
- B) Two
- C) Three
- D) Four

Answer: Three

3. Which of the following alkyl halides has the highest boiling point?

- A) CH_3Cl
- B) CH_3Br
- C) CH_3F
- D) CH_3I

Answer: CH_3I

4. The best method for preparing a pure alkyl chloride from an alcohol is by using:

- A) $HCl + ZnCl_2$
- B) PCl_5
- C) $SOCl_2 + Pyridine$
- D) PCl_3

Answer: $SOCl_2 + Pyridine$

5. Free radical chlorination of alkanes is not a preferred method for preparing alkyl halides because it gives:

- A) Only one product
- B) A mixture of isomeric products
- C) Unsaturated products
- D) Aromatic compounds

Answer: A mixture of isomeric products

6. The carbon-halogen bond in alkyl halides is polar due to:

- A) The high electronegativity of carbon
- B) The high electronegativity of halogen
- C) The sp^3 hybridization of carbon
- D) The presence of lone pairs on carbon

Answer: The high electronegativity of halogen

7. Which C-X bond has the highest bond energy?

- A) C-F
- B) C-Cl
- C) C-Br
- D) C-I

Answer: C-F

8. The overall order of reactivity of alkyl halides (for the same alkyl group) is:

- A) $RF > RCl > RBr > RI$
- B) $RCl > RF > RBr > RI$
- C) $RI > RBr > RCl > RF$
- D) $RBr > RI > RCl > RF$

Answer: $RI > RBr > RCl > RF$

9. A species that donates a pair of electrons to an electron-deficient carbon is called a/an:

- A) Electrophile
- B) Free radical
- C) Nucleophile
- D) Carbocation

Answer: Nucleophile

10. In an S_N2 reaction, the nucleophile attacks the substrate from:

- A) The same side as the leaving group
- B) The side opposite to the leaving group
- C) Either side with equal probability
- D) Perpendicular to the C-X bond

Answer: The side opposite to the leaving group

11. The kinetics of an S_N2 reaction are:

- A) Zero order
- B) First order
- C) Second order
- D) Third order

Answer: Second order

12. Which type of alkyl halide undergoes S_N2 mechanism most readily?

- A) Primary
- B) Secondary
- C) Tertiary
- D) All equally

Answer: Primary

13. The intermediate formed in an S_N1 reaction is a:

- A) Carbanion
- B) Carbocation
- C) Free radical
- D) Carbene



Alcohols, Phenols, and Ethers

ALCOHOLS

Introduction & Classification

1. **Alcohols** are organic compounds containing a hydroxyl (-OH) functional group attached to an aliphatic carbon atom.
2. The general formula for alcohols is $R-OH$ or $C_nH_{2n+1}OH$.
3. Alcohols containing one -OH group are called **monohydric alcohols**.
4. Alcohols containing two or more -OH groups are called **polyhydric alcohols**.
5. Monohydric alcohols are classified into **primary (1°)**, **secondary (2°)**, and **tertiary (3°)** alcohols.
6. In a **primary alcohol**, the carbon atom carrying the -OH group is attached to only **one** alkyl group.
7. In a **secondary alcohol**, the carbon atom carrying the -OH group is attached to **two** alkyl groups.
8. In a **tertiary alcohol**, the carbon atom carrying the -OH group is attached to **three** alkyl groups.
9. Examples of dihydric and trihydric alcohols are **1,2-ethanediol (Glycol)** and **1,2,3-propanetriol (Glycerol)**.

Nomenclature

10. In the **common system**, alcohols are named as 'Alkyl Alcohols' (e.g., Methyl alcohol, Isopropyl alcohol).
11. In the **IUPAC system**, alcohols are named as 'alkanols' by replacing the 'e' of the parent alkane with '**-ol**'.
12. The carbon chain is numbered to give the carbon carrying the -OH group the **lowest possible number**.
13. For polyhydric alcohols, prefixes like **di-**, **tri-**, are used with **-ol** (e.g., ethane-1,2-diol).

Physical Properties

14. Lower alcohols are colourless, toxic liquids with a characteristic sweet smell.
15. Alcohols have **higher boiling points** than corresponding alkanes due to **intermolecular hydrogen bonding**.
16. Boiling points of isomeric alcohols **decrease** with an increase in branching.
17. Lower alcohols (C1-C3) are **completely miscible** with water due to hydrogen bonding.
18. The solubility of higher alcohols in water **decreases rapidly** with an increase in the alkyl chain length.

Acidity of Alcohols

19. Alcohols are **weaker acids** than water.
20. The acidic character of alcohols is due to the **polar O-H bond**.
21. The alkyl group is **electron-donating**, which decreases the acidity of alcohols.
22. The order of acidity for alcohols is: **Primary > Secondary > Tertiary**.
23. Alcohols react with **active metals** like sodium (Na) or potassium (K) to form **alkoxides** and hydrogen gas.
24. Alcohols **do not react** with aqueous NaOH or KOH.

Preparation of Alcohols

25. Prepared by **electrophilic addition** of steam to alkenes in the presence of H_3PO_4 catalyst.
26. Prepared by the reaction of alkenes with **cold, dilute, acidified $KMnO_4$** to form **diols** (glycols).
27. Prepared by **hydrolysis** of haloalkanes using an aqueous solution of NaOH.
28. Prepared by the **reduction** of aldehydes to primary alcohols using $NaBH_4$ or $LiAlH_4$.
29. Prepared by the **reduction** of ketones to secondary alcohols using $NaBH_4$ or $LiAlH_4$.
30. Prepared by the **reduction** of carboxylic acids to primary alcohols using $LiAlH_4$.
31. Prepared by the **hydrolysis of esters** using dilute acid or dilute alkali and heat.
32. Prepared from **Grignard Reagents ($R-Mg-X$)** by reacting with formaldehyde to get primary alcohols, with other aldehydes to get secondary alcohols, and with ketones to get tertiary alcohols.
33. Methanol is prepared industrially from **water gas ($CO + H_2$)** using a $ZnO + Cr_2O_3$ catalyst at high temperature and pressure.
34. Ethanol is prepared industrially by the **fermentation** of sugars (e.g., from molasses or starch) using enzymes like **zymase**.



62. **Nitration:** With dilute HNO_3 , phenol gives a mixture of o-and p-nitrophenol; with conc. HNO_3 , it gives **2,4,6-trinitrophenol (Picric acid)**.
63. **Sulphonation:** Phenol reacts with conc. H_2SO_4 to give o-and p-phenol sulphonic acids.
64. **Kolbe's Reaction:** Sodium phenoxide on reaction with CO_2 under pressure gives **salicylic acid**.
65. **Riemer-Tiemann Reaction:** Phenol with chloroform in the presence of NaOH gives **salicylaldehyde**.
66. **Reaction with FeCl_3 :** Phenol gives a **violet colour** with neutral FeCl_3 , which is a characteristic test.
67. **Hydrogenation:** Phenol on catalytic hydrogenation gives **cyclohexanol**.
68. **Reaction with Formaldehyde:** Phenol reacts with HCHO to form a polymer called **Bakelite**.

ETHERS

Introduction & Nomenclature

69. **Ethers** are compounds with an oxygen atom connected to two alkyl or aryl groups (R-O-R').
70. In the **common naming system**, the two groups attached to oxygen are named alphabetically followed by 'ether'.
71. In the **IUPAC system**, ethers are named as **alkoxy alkanes**.

Preparation & Physical Properties

72. **Williamson's Synthesis:** The reaction of sodium alkoxide with an alkyl halide to form an ether.
73. **Dehydration of Alcohols:** By heating alcohols with conc. H_2SO_4 at **140°C** .
74. Lower ethers are **volatile, highly inflammable** liquids with pleasant odours.
75. Ethers have **much lower boiling points** than isomeric alcohols due to the **absence of hydrogen bonding** between ether molecules.
76. Ethers are **slightly soluble** in water as they can form **H-bonds with water molecules**.

Chemical Reactions

77. Ethers are **quite stable** towards bases, active metals, and reducing agents.
78. **Formation of Oxonium Salts:** Ethers react with cold concentrated HCl or H_2SO_4 to form **oxonium salts**.
79. **Reaction with HI:** Ethers are cleaved by hot concentrated HI to form an alcohol and an alkyl iodide.
80. In the cleavage of mixed ethers with HI , the **smaller alkyl group** forms the **alkyl iodide**.

Practice MCQs

1. What is the general formula for alcohols?

- A) R-O-R
- B) R-CHO
- C) R-COOH
- D) R-OH

Answer: R-OH

2. An alcohol in which the hydroxyl group is attached to a carbon atom that is attached to three alkyl groups is classified as:

- A) Primary alcohol
- B) Secondary alcohol
- C) Tertiary alcohol
- D) Dihydric alcohol

Answer: Tertiary alcohol

3. What is the IUPAC name for $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OH}$?

- A) Propanal
- B) 1-Propanol
- C) 2-Propanol
- D) Ethanol

Answer: 1-Propanol

4. The significantly higher boiling points of alcohols compared to alkanes of similar molecular weight are primarily due to:

- A) Ionic bonding
- B) Covalent bonding
- C) Hydrogen bonding
- D) Van der Waals forces

Answer: Hydrogen bonding

5. Which of the following is the correct order of acidity for alcohols?

- A) Primary < Secondary < Tertiary
- B) Tertiary < Secondary < Primary
- C) Primary = Secondary = Tertiary
- D) Secondary < Primary < Tertiary

Answer: Tertiary < Secondary < Primary

6. Which reagent is commonly used to reduce a carboxylic acid to a primary alcohol?

- A) NaBH_4
- B) LiAlH_4



Aldehydes and Ketones

Introduction to Carbonyl Compounds

1. The **carbonyl group** is a functional group composed of a carbon atom doubly bonded to an oxygen atom ($>C=O$).
2. Aldehydes, ketones, carboxylic acids, esters, amides, acid halides, and acid anhydrides are all **carbonyl compounds**.
3. In **aldehydes**, the carbonyl carbon is attached to at least one hydrogen atom.
4. The general formula for aldehydes is $R-CHO$, where R can be H or an alkyl group.
5. In **ketones**, the carbonyl carbon is attached to two alkyl or aryl groups.
6. The general formula for ketones is $R-COR'$, where R and R' can be the same or different alkyl/aryl groups.
7. The functional group of an aldehyde is the **formyl group** ($-CHO$).
8. The functional group of a ketone is the **keto group** ($-CO-$).

Nomenclature of Aldehydes

9. In the **common naming system**, aldehydes are named by replacing the "-ic acid" of the corresponding carboxylic acid with "-aldehyde" (e.g., Formic acid $\rightarrow$ Formaldehyde).
10. In the **IUPAC system**, the ending "-e" of the parent alkane is replaced with "-al" for aldehydes.
11. In IUPAC naming, the carbonyl carbon of an aldehyde is always carbon number 1.
12. The position of the aldehyde group is **not specified** in the name as it is always terminal.
13. In common names, the carbon adjacent to the formyl group is designated as the **α -carbon**.

Nomenclature of Ketones

14. In the **common naming system**, ketones are named by listing the alkyl groups attached to the carbonyl carbon followed by the word "ketone".
15. For similar alkyl groups, the prefix "**di-**" is used (e.g., dimethyl ketone).
16. A ketone with two identical alkyl groups is called a **symmetrical ketone**.
17. A ketone with two different alkyl groups is called an **unsymmetrical ketone**.
18. In the **IUPAC system**, the ending "-e" of the parent alkane is replaced with "-one" for ketones.
19. The parent chain for a ketone must contain the carbonyl carbon.
20. The chain is numbered such that the carbonyl carbon gets the **lowest possible number**.

Physical Properties

21. Lower aldehydes like formaldehyde and acetaldehyde have a **sharp, pungent odour**.
22. Formaldehyde is a **gas** at room temperature, while other low molecular weight aldehydes and ketones are liquids.
23. Acetone has a **pleasant odour**.
24. Lower carbonyl compounds (up to C_4) are **soluble in water** due to hydrogen bonding with water molecules.
25. Carbonyl compounds **cannot form hydrogen bonds with themselves** as there is no hydrogen attached to the oxygen.
26. Aldehydes and ketones have **higher boiling points** than alkanes and ethers of comparable molecular weight due to their strong dipole-dipole interactions.
27. Their boiling points are **lower than alcohols** of comparable molecular weight because alcohols can form hydrogen bonds.

Structure of the Carbonyl Group

28. The carbon atom of the carbonyl group is **sp^2 hybridized**.
29. The carbonyl group has a **trigonal planar** geometry with bond angles of approximately 120° .
30. The carbon-oxygen bond consists of one **sigma (σ) bond** and one **pi (π) bond**.
31. The $C=O$ bond length is **shorter** ($1.23 \text{ \AA}$) than the $C-O$ bond in alcohols and ethers ($1.43 \text{ \AA}$).



95. Acetaldehyde is used in the production of **acetic acid, acetic anhydride, and n-butanol**.

96. Acetaldehyde is used to make **paraldehyde** (a hypnotic drug) and **chloral hydrate**.

Practice MCQs

1. Which of the following statements accurately describes the carbonyl group in aldehydes and ketones?

- A) The carbon atom is sp^3 hybridized.
- B) The oxygen atom is electrophilic.
- C) The carbon atom is sp^2 hybridized and electrophilic.
- D) The group is non-polar.

Answer: The carbon atom is sp^2 hybridized and electrophilic.

2. What is the general formula for aldehydes?

- A) $R-COOH$
- B) $R-CO-R'$
- C) $R-CHO$
- D) $R-O-R'$

Answer: $R-CHO$

3. The IUPAC name for CH_3CH_2CHO is:

- A) Propanal
- B) Ethanal
- C) Propionaldehyde
- D) Butanal

Answer: Propanal

4. What is the common name for the simplest ketone, CH_3COCH_3 ?

- A) Dimethyl ketone
- B) Diethyl ketone
- C) Ethyl methyl ketone
- D) Acetaldehyde

Answer: Dimethyl ketone

5. Why do aldehydes have higher boiling points than alkanes of similar molecular weight?

- A) They have higher molecular mass.
- B) They are soluble in water.
- C) They possess strong dipole-dipole interactions.
- D) They can form hydrogen bonds with each other.

Answer: They possess strong dipole-dipole interactions.

6. Which of the following is a method for preparing aldehydes?

- A) Oxidation of tertiary alcohols
- B) Oxidation of primary alcohols
- C) Oxidation of secondary alcohols
- D) Reduction of ketones

Answer: Oxidation of primary alcohols

7. Acetone is commercially prepared by:

- A) Oxidation of propanol
- B) Dry distillation of calcium acetate
- C) Hydration of propyne
- D) Ozonolysis of alkenes

Answer: Dry distillation of calcium acetate

8. The hydration of acetylene (ethyne) in the presence of $HgSO_4$ and H_2SO_4 produces:

- A) Acetone
- B) Formaldehyde
- C) Acetaldehyde
- D) Glyoxal

Answer: Acetaldehyde

9. In nucleophilic addition reactions, the carbonyl carbon acts as a(n):

- A) Nucleophile
- B) Acid
- C) Electrophile
- D) Base

Answer: Electrophile

10. Why are aldehydes generally more reactive than ketones towards nucleophiles?

- A) Aldehydes are less polar.
- B) Ketones have greater steric hindrance and electron donation from two alkyl groups.
- C) Aldehydes have a higher molecular weight.
- D) Ketones are more soluble in water.

Answer: Ketones have greater steric hindrance and electron donation from two alkyl groups.

11. The product formed when formaldehyde ($HCHO$) reacts with HCN is:

- A) Formic acid
- B) Acetonitrile
- C) Formaldehyde cyanohydrin
- D) Glycolonitrile

Answer: Formaldehyde cyanohydrin

12. What type of alcohol is formed when a Grignard reagent reacts with formaldehyde?

- A) Tertiary alcohol
- B) Secondary alcohol
- C) Primary alcohol
- D) Diol

Carboxylic Acids

Introduction & Nomenclature

- Organic compounds containing the **carboxyl functional group** (-COOH) are called **carboxylic acids**.
- The carboxyl group is comprised of a **carbonyl group** (C=O) and a **hydroxyl group** (-OH).
- Carboxylic acids where the -COOH group is attached to an alkyl group are **aliphatic acids** (R-COOH).
- Carboxylic acids where the -COOH group is attached to an aryl group are **aromatic acids** (Ar-COOH).
- Acids containing one -COOH group are **monocarboxylic acids**, while those with two are **dicarboxylic acids**.
- In **IUPAC nomenclature**, aliphatic carboxylic acids are named as **alkanoic acids**.
- The carbon of the carboxyl group is always assigned number **1** in the parent chain.
- In common names, the positions of substituents are often indicated by Greek letters (α , β , γ), starting from the carbon adjacent to the -COOH group.
- Formic acid** (HCOOH) is derived from the Latin word *formica* (ant).
- Acetic acid** (CH₃COOH) is derived from the Latin word *acetum* (vinegar).
- Butyric acid** (C₃H₇COOH) is named after the Latin word *butyrum* (butter).
- Pure, anhydrous acetic acid solidifies at **17°C** and is known as **glacial acetic acid**.

Acidity of Carboxylic Acids

- Carboxylic acids are the **most acidic** simple organic compounds but are weaker than mineral acids.
- The acidity of carboxylic acids is due to the **resonance stabilization** of the carboxylate ion (R-COO⁻).
- The negative charge in a carboxylate ion is **delocalized equally between two oxygen atoms**.
- The **pK_a value** is used to compare the strength of weak acids; a **lower pK_a** means a **stronger acid**.
- The acidity order is: **Carboxylic acids > Phenols > Alcohols**.
- Electron-Withdrawing Groups (EWG)**, especially on the α -carbon, **increase acidity** by stabilizing the carboxylate ion.
- Electron-Donating Groups (EDG)**, like alkyl groups, **decrease acidity** by destabilizing the carboxylate ion.
- The acidity order of chloroacetic acids is: **CCl₃COOH > CHCl₂COOH > CH₂ClCOOH > CH₃COOH**.
- Fluoroethanoic acid** is a stronger acid than **chloroethanoic acid** due to higher electronegativity.
- Formic acid** (HCOOH) is stronger than **acetic acid** (CH₃COOH) because the -CH₃ group is electron-donating.

Physical Properties

- Lower members (C₁ to C₄) of aliphatic carboxylic acids are **miscible with water** due to hydrogen bonding.
- Solubility in water **decreases** with an increase in the size of the alkyl chain (molecular mass).
- Carboxylic acids have **higher boiling points** than alcohols of comparable molecular mass due to stronger **dimer formation via hydrogen bonding**.
- Carboxylic acids often exist as **cyclic dimers** in non-polar solvents and in the vapor state.
- Carboxylic acids with an **even number of carbon atoms** have higher melting points than adjacent acids with odd numbers.

Preparations of Carboxylic Acids

- Primary alcohols** can be oxidized to carboxylic acids using oxidizing agents like **K₂Cr₂O₇/H₂SO₄** or **KMnO₄**.
- Aldehydes** are readily oxidized to carboxylic acids, even by mild oxidizing agents like **Tollen's reagent**.
- Alkylbenzenes** (e.g., Toluene) are oxidized to **benzoic acid** using strong oxidizing agents like **hot alkaline KMnO₄**.
- The **carbonation of Grignard reagents** (R-MgX) with CO₂, followed by acidification, produces carboxylic acids.
- The acid formed via Grignard reagent carbonation has **one more carbon atom** than the original alkyl halide.
- Hydrolysis of nitriles (alkanenitriles)** in acidic or basic medium yields carboxylic acids.
- The acid formed from nitrile hydrolysis has **one more carbon atom** than the original alkyl halide.

- C) Larger molecular size
D) Van der Waals forces

Answer: Dimer formation through hydrogen bonding

4. Which reagent is used to convert a carboxylic acid directly into an acyl chloride?

- A) PCl_3
B) SOCl_2
C) PCl_5
D) All of these

Answer: All of these

5. The product of the reaction between acetic acid and ethanol in the presence of conc. H_2SO_4 is:

- A) Ethyl acetate
B) Methyl acetate
C) Acetic anhydride
D) Acetamide

Answer: Ethyl acetate

6. Which of the following is the strongest acid?

- A) CH_3COOH
B) CCl_3COOH
C) CH_2ClCOOH
D) $\text{CH}_3\text{CH}_2\text{COOH}$

Answer: CCl_3COOH

7. The oxidation of toluene ($\text{C}_6\text{H}_5\text{CH}_3$) with hot alkaline KMnO_4 gives:

- A) Benzaldehyde
B) Benzoic acid
C) Phenol
D) Benzyl alcohol

Answer: Benzoic acid

8. Which of the following can be oxidized by Tollen's reagent?

- A) Acetone
B) Ethanol
C) Methanoic acid
D) Acetic acid

Answer: Methanoic acid

9. The mechanism for the reaction of an acyl chloride with a nucleophile is:

- A) Electrophilic substitution
B) $\text{SN}1$
C) $\text{SN}2$
D) Nucleophilic addition-elimination

Answer: Nucleophilic addition-elimination

10. Which derivative of carboxylic acid is the least reactive?

- A) Acyl chloride
B) Acid anhydride
C) Ester
D) Amide

Answer: Amide

11. Pure acetic acid is called "glacial" because it:

- A) Is found in glaciers
B) Is highly soluble in water
C) Freezes to an ice-like solid at 17°C
D) Has a vinegar-like smell

Answer: Freezes to an ice-like solid at 17°C

12. Which compound is formed when acetic acid reacts with ammonia?

- A) Acetamide
B) Methyl cyanide
C) Ammonium acetate
D) Ethyl amine

Answer: Ammonium acetate

13. The hydrolysis of an ester in the presence of a base (NaOH) is called:

- A) Esterification
B) Saponification
C) Decarboxylation
D) Acetylation

Answer: Saponification

14. What is the product when ethanedioic acid is oxidized with warm acidified KMnO_4 ?

- A) Methanoic acid
B) Acetic acid
C) Carbon dioxide and water
D) Carbon dioxide only

Answer: Carbon dioxide only

15. The relative acidity of carboxylic acids, phenol, and ethanol is in the order:

- A) Ethanol > Phenol > Carboxylic acid
B) Carboxylic acid > Ethanol > Phenol
C) Phenol > Carboxylic acid > Ethanol
D) Carboxylic acid > Phenol > Ethanol

Answer: Carboxylic acid > Phenol > Ethanol

16. An electron-withdrawing group attached to the α -carbon of a carboxylic acid:

- A) Decreases its acidity
B) Increases its acidity
C) Has no effect on acidity
D) Makes it a base

Answer: Increases its acidity



Biochemistry

21. Biochemistry

Introduction to Macromolecules

1. **Macromolecules** are large molecules built up from small repeating units called **monomers**.
2. The **macromolecular hypothesis** was significantly advanced by **Staudinger** in the 1920s.
3. Macromolecules are classified into **Inorganic** (e.g., Diamond, Graphite) and **Organic** types.
4. **Organic Macromolecules** are further divided into **Biopolymers** and **Synthetic polymers**.
5. **Polymers** can have **linear, branched, or cross-linked** structures.
6. The **Degree of Polymerization (DP)** is the number of repeating units in a polymer chain.
7. A **homopolymer** is formed from a single type of monomer, e.g., polyvinyl acetate.
8. A **copolymer** is formed from two different monomers, e.g., vinyl acetate and butyl maleate.
9. A **terpolymer** is formed from three different monomers.
10. **Thermoplastic polymers** can be softened repeatedly by heating and hardened by cooling, e.g., PVC.
11. **Thermosetting polymers** become hard on heating and cannot be softened again, e.g., epoxy resins.
12. **Addition polymerization** involves initiation, propagation, and termination steps, e.g., polystyrene.
13. **Condensation polymerization** involves the reaction of two functional groups with the removal of a small molecule like water, e.g., Nylon and Polyester.

Carbohydrates

14. **Carbohydrates** are defined as **polyhydroxy aldehydes or ketones**.
15. The general formula for many carbohydrates is $C_x(H_2O)_y$, but this is not universal.
16. Carbohydrates are primarily produced by plants through **photosynthesis**.
17. The main functions of carbohydrates are to **provide energy** and **structural support**.
18. Carbohydrates are classified into **monosaccharides, oligosaccharides, and polysaccharides**.
19. **Monosaccharides** are the simplest sugars that cannot be hydrolyzed, e.g., glucose, fructose.
20. **Glucose** is an **aldohexose**, also known as dextrose, grape sugar, or blood sugar.
21. **Fructose** is a **ketohexose** and is the sweetest natural sugar.
22. **Oligosaccharides** yield 2 to 10 monosaccharide units upon hydrolysis.
23. **Disaccharides** are a type of oligosaccharide; examples include **sucrose, lactose, and maltose**.
24. **Sucrose** is a non-reducing sugar composed of **glucose and fructose**.
25. **Lactose** (milk sugar) is composed of **glucose and galactose**; its intolerance is due to **lactase deficiency**.
26. **Maltose** is composed of **two glucose units**.
27. **Polysaccharides** are polymers of monosaccharides, are tasteless, insoluble, and are called **non-sugars**.
28. **Starch** is a polymer of **α -D-glucose** and is a mixture of **amylose and amylopectin**.
29. **Cellulose** is a polymer of **β -D-glucose** and is the most abundant structural polysaccharide.
30. **Glycogen** is known as **animal starch** and is a highly branched polymer for glucose storage in the liver and muscles.
31. **Glycosidic linkage** is the covalent bond connecting two monosaccharide units.
32. One gram of carbohydrate provides approximately **4 kcal** of energy.
33. Excessive consumption of simple sugars is linked to **obesity, diabetes, and cardiovascular disease**.

Proteins

34. **Proteins** are complex **nitrogenous** biopolymers of **amino acids**.
35. The name protein is derived from the Greek word "**proteios**", meaning of prime importance.
36. All proteins contain **Carbon, Hydrogen, Oxygen, and Nitrogen**; some also contain **Sulfur**.
37. Amino acids are linked together by **peptide bonds** to form polypeptide chains.
38. The **primary structure** of a protein is the linear sequence of amino acids in a polypeptide chain.
39. The **secondary structure** involves coiling or folding (α -helix, β -pleated sheets) stabilized by **hydrogen bonds**.

81. **Nucleic Acids** are the primary information-carrying molecules in cells, essential for genes.
82. The two types of nucleic acids are **Deoxyribonucleic Acid (DNA)** and **Ribonucleic Acid (RNA)**.
83. A **nucleotide** is the monomer of nucleic acids, composed of a **pentose sugar**, a **nitrogenous base**, and a **phosphate group**.
84. The sugar in DNA is **deoxyribose**; in RNA, it is **ribose**.
85. Nitrogenous bases are divided into **Purines (Adenine, Guanine)** and **Pyrimidines (Cytosine, Thymine, Uracil)**.
86. **DNA contains A, T, G, C; RNA contains A, U, G, C** (Thymine is replaced by Uracil in RNA).
87. DNA is typically **double-stranded** with a **double helix** structure, as described by **Watson and Crick**.
88. RNA is typically **single-stranded**.
89. In DNA, **Adenine pairs with Thymine** via two hydrogen bonds, and **Guanine pairs with Cytosine** via three hydrogen bonds.
90. DNA's main function is the **storage and transmission of genetic information**.
91. **Replication** is the process by which DNA makes a copy of itself.
92. **RNA** is involved in **protein synthesis**; major types include **mRNA, tRNA, and rRNA**.
93. **mRNA** carries the genetic code from DNA to the ribosome.
94. **tRNA** brings amino acids to the ribosome during protein synthesis.
95. The process of protein synthesis from an mRNA template is called **translation**.
- Vitamins and Minerals**
96. **Vitamins** are organic compounds essential for normal metabolism that must be obtained from the diet.
97. **Fat-soluble vitamins** are A, D, E, and K; they can be stored in the body.
98. **Water-soluble vitamins** include the B-complex and Vitamin C; they are not stored significantly.
99. **Minerals** are inorganic nutrients essential for vital functions; they are classified as **macronutrients** and **micronutrients**.
100. **Iron** is a component of **hemoglobin** and **myoglobin**; its deficiency causes **anemia**.
101. **Calcium** is essential for **bones, teeth, blood coagulation, and nerve function**.
102. **Phosphorus** is a key component of **bones, teeth, DNA, RNA, and ATP**.
103. **Zinc** is a cofactor for many enzymes, supports immune function, and is involved in wound healing and taste acuity.

Practice MCQs

1. What are macromolecules built up from?

- A) Isomers
- B) Monomers
- C) Isotopes
- D) Polymers

Answer: Monomers

2. Which scientist is credited with proposing long-chain formulas for polymers like polystyrene?

- A) Watson and Crick
- B) Miescher
- C) Staudinger
- D) Fischer

Answer: Staudinger

3. A polymer formed from a single type of monomer is called a:

- A) Copolymer
- B) Homopolymer

C) Terpolymer

D) Elastomer

Answer: Homopolymer

4. Which type of polymer becomes permanently hard upon heating and cannot be reshaped?

- A) Thermoplastic
- B) Fibrous
- C) Thermosetting
- D) Linear

Answer: Thermosetting

5. Nylon and Polyester are classic examples of which type of polymerization?

- A) Addition polymerization
- B) Free-radical polymerization
- C) Condensation polymerization
- D) Co-polymerization

Answer: Condensation polymerization



PHYSICS



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>

Classical Mechanics

Summary of the concepts in the Chapter

Concept	Definition	Key Equation
Center of mass	Point that moves as if all mass concentrated there	$\vec{p} = m\vec{v}$
Linear momentum	Product of mass and velocity	$\vec{P}_i = \vec{P}_f$
Conservation of momentum	Total momentum constant for isolated system	$\vec{J} = \int \vec{F} dt$
Impulse	Integral of force over time	$\theta = s/r$
Angular displacement	Angle swept by position vector	$\omega = d\theta/dt$
Angular velocity	Rate of change of angular displacement	$\alpha = d\omega/dt$
Angular acceleration	Rate of change of angular velocity	$a_c = v^2/r = r\omega^2$
Centripetal acceleration	Acceleration toward center	$F_c = mv^2/r = mr\omega^2$
Centripetal force	Net force causing circular motion	$I = \sum m_i r_i^2 = \int r^2 dm$
Moment of inertia	Rotational analog of mass	$\tau = I\alpha$
Torque	Rotational analog of force	$L = I\omega$
Angular momentum	Rotational analog of momentum	$I_i\omega_i = I_f\omega_f$
Conservation of angular momentum	L constant for no external torque	$F = Gm_1m_2/r^2$
Gravitational force	Attraction between masses	$g = GM/r^2$
Gravitational field strength	Force per unit mass	$v_o = \sqrt{GM/r}$
Orbital velocity	Speed for circular orbit	$v_{esc} = \sqrt{2GM/R}$
Escape velocity	Speed to escape gravity	$V = -GM/r$
Gravitational potential	Potential energy per unit mass	$T^2 = (4\pi^2/GM)a^3$
Kepler's 3rd law	Relation between period and orbit size	$E = (F/A)/(\Delta L/L)$
Lagrangian	$L = T - V$	Energy difference; fundamental function of mechanics
Euler-Lagrange equation	$\frac{d}{dt} \left(\frac{\partial L}{\partial \dot{q}_i} \right) - \frac{\partial L}{\partial q_i} = 0$	Generalization of Newton's second law
Hamiltonian	$H = \sum p_i \dot{q}_i - L$	Total energy (usually)
Hamilton's equations	$\dot{q}_i = \frac{\partial H}{\partial p_i}, \dot{p}_i = -\frac{\partial H}{\partial q_i}$	First-order equations of motion
Central force orbit	$r(\theta) = \frac{p}{1 + e \cos \theta}$	Conic sections: circle, ellipse, parabola, hyperbola
Euler's equations	$I_i \dot{\omega}_i + (I_j - I_k) \omega_j \omega_k = \tau_i$	Rotational dynamics of rigid bodies
Gyroscope precession	$\Omega_p = \frac{Mgr}{I\omega}$	Conservation of angular momentum with torque

1. Classical Mechanics

COMPREHENSIVE FORMULA SHEET

Center of Mass and Linear Momentum

Quantity	Formula
Center of mass (discrete)	$\vec{r}_{com} = \frac{1}{M} \int \vec{r} dm$
Center of mass (continuous)	$\vec{p} = m\vec{v}$



2. The complicated motion of a system like a car or ballerina is simplified by determining its center of mass.
3. The center of mass is the point that moves as though all of the system's mass were concentrated there and all external forces were applied there.
4. For two particles, the center of mass from mass m_1 is $x_{\text{com}} = \frac{m_2}{m_1+m_2}d$.
5. The generalized coordinate for the center of mass of two particles is $x_{\text{com}} = \frac{m_1x_1+m_2x_2}{m_1+m_2}$.
6. In three dimensions, the center of mass vector is $\vec{r}_{\text{com}} = \frac{1}{M}\sum m_i\vec{r}_i$.
7. For a continuous body, the center of mass is found using integrals of the form $x_{\text{com}} = \frac{1}{M}\int x\,dm$.
8. For bodies with uniform density, volume integrals can be used to find the center of mass.
9. A point of symmetry in a body places the center of mass at that exact point.
10. If a body has a line of symmetry, the center of mass lies on that line.
11. A key insight is that the center of mass need not lie within the physical object itself (e.g., a doughnut).
12. The motion of the center of mass of a system is governed solely by the net external force.
13. Newton's Second Law for a system is $\vec{F}_{\text{net}} = M\vec{a}_{\text{com}}$.
14. In an exploding firework, the fragments' center of mass follows the same parabolic path as the unexploded rocket.
15. In a ballet grand jeté, the dancer's center of mass follows a parabolic path.
16. The center of gravity is the point where the gravitational force effectively acts on a body.
17. If the gravitational field $\vec{g}$ is uniform, the center of gravity coincides with the center of mass.
18. Linear momentum is defined as the product of mass and velocity: $\vec{p} = m\vec{v}$.
19. The SI unit for linear momentum is kilogram-meter per second (kg·m/s).
20. Momentum is a vector quantity, sharing the direction of the velocity vector.
21. Newton's Second Law in its most general form is $\vec{F}_{\text{net}} = \frac{d\vec{p}}{dt}$.
22. The net force on an object equals the time rate of change of its momentum.
23. The total linear momentum of a system is the vector sum of the individual momenta.
24. The total momentum of a system can be expressed as $\vec{P} = M\vec{v}_{\text{com}}$.
25. Impulse is the integral of force over time: $\vec{J} = \int_{t_i}^{t_f} \vec{F}(t)dt$.
26. The impulse-linear momentum theorem states $\Delta\vec{p} = \vec{J}$.
27. For a constant force, impulse can be calculated as $J = F_{\text{avg}}\Delta t$.
28. When a projectile rebounds with the same speed, its change in velocity is $\Delta v = -2v$.
29. In a karate chop, the large momentum is reduced to zero in a short time, producing a large force.
30. For a closed and isolated system, the total linear momentum is conserved.
31. The law of conservation of momentum is a consequence of Newton's third law.
32. If the net external force component along an axis is zero, the momentum component along that axis is conserved.
33. Rockets work by expelling mass backward, gaining an equal and opposite forward momentum.
34. Rockets do not require an external medium like air to push against.
35. In all types of collisions, linear momentum is always conserved.
36. Kinetic energy is only conserved in elastic collisions.
37. In elastic collisions, the relative speed of approach equals the relative speed of separation.
38. In a perfectly inelastic collision, the objects stick together and move with a common velocity.
39. The common final velocity in a perfectly inelastic collision is $V = \frac{m_1u_1+m_2u_2}{m_1+m_2}$.
40. The velocity of the center of mass is unchanged by a collision.

2. For two particles of masses m_1 and m_2 , the center of mass from m_1 is located at:

- A) $\frac{m_1}{m_1+m_2}d$
- B) $\frac{m_2}{m_1+m_2}d$
- C) $\frac{m_1 m_2}{m_1+m_2}d$
- D) $\frac{m_1+m_2}{m_1 m_2}d$

Correct Answer: B

3. The vector form for the center of mass of a system is:

- A) $\vec{r}_{com} = \sum m_i \vec{r}_i$
- B) $\vec{r}_{com} = \frac{1}{M} \sum m_i \vec{r}_i$
- C) $\vec{r}_{com} = \frac{\sum \vec{r}_i}{M}$
- D) $\vec{r}_{com} = \frac{1}{M} \sum \frac{\vec{r}_i}{m_i}$

Correct Answer: B

4. Which of the following is true for the center of mass of a doughnut?

- A) It lies at the geometric center of the doughnut.
- B) It lies exactly at the center of the hole.
- C) It lies on the surface of the doughnut.
- D) It lies outside the physical material of the doughnut.

Correct Answer: D

5. Newton's second law for a system of particles is $\vec{F}_{net} = M\vec{a}_{com}$. Here, $\vec{F}_{net}$ is the:

- A) Sum of all internal and external forces.
- B) Sum of all internal forces only.
- C) Sum of all external forces only.
- D) Net force on the heaviest particle.

Correct Answer: C

6. The center of gravity coincides with the center of mass when:

- A) The body is in free fall.
- B) The body is in a non-inertial frame.
- C) The gravitational field is uniform over the body.
- D) The body is symmetric about an axis.

Correct Answer: C

7. The SI unit of impulse is equivalent to:

- A) $\text{kg} \cdot \text{m/s}$
- B) $\text{J} \cdot \text{s}$
- C) N/s
- D) Both A and B

Correct Answer: D

8. A ball of mass 0.5 kg is moving with a velocity of 10 m/s. It hits a wall and rebounds with the same speed. The change in momentum is:

- A) $5 \text{ kg} \cdot \text{m/s}$
- B) $10 \text{ kg} \cdot \text{m/s}$
- C) $0 \text{ kg} \cdot \text{m/s}$

D) $-10 \text{ kg} \cdot \text{m/s}$

Correct Answer: D (Change = $-5 - 5 = -10 \text{ kg} \cdot \text{m/s}$)

9. A machine gun fires bullets at a rate of 10 bullets per second. Each bullet has a mass of 20 g and a velocity of 300 m/s. The force required to hold the gun in place is:

- A) 60 N
- B) 600 N
- C) 0.6 N
- D) 6 N

Correct Answer: A ($F = dm/dt \cdot v = 0.2 \text{ kg/s} \cdot 300 \text{ m/s} = 60 \text{ N}$)

10. The conservation of linear momentum is a direct consequence of:

- A) Newton's First Law.
- B) Newton's Second Law.
- C) Newton's Third Law.
- D) The Work-Energy theorem.

Correct Answer: C

11. A rocket of mass 1000 kg ejects gas at a rate of 10 kg/s with a velocity of 500 m/s. The thrust on the rocket is:

- A) 5000 N
- B) 50,000 N
- C) 500 N
- D) 5,000,000 N

Correct Answer: A (Thrust = $R \cdot v_{rel} = 10 \text{ kg/s} \cdot 500 \text{ m/s} = 5000 \text{ N}$)

12. In a perfectly inelastic collision of two bodies, which of the following is maximized?

- A) Total linear momentum.
- B) Relative velocity of separation.
- C) Loss of kinetic energy.
- D) Coefficient of restitution.

Correct Answer: C

13. In an elastic collision between two bodies of equal mass where one is initially at rest, what happens after the collision?

- A) Both bodies move with half the initial velocity.
- B) The moving body stops and the target moves with the initial velocity.
- C) The moving body rebounds with the same speed.
- D) Both bodies stick together.

Correct Answer: B

14. The coefficient of restitution for a perfectly elastic collision is:

- A) 0
- B) 0.5
- C) 1
- D) -1

Correct Answer: C

Vector Analysis

SUMMARY OF VECTOR OPERATIONS

Operation	Method	Result
Addition	$\vec{a} + \vec{b} = (a_x + b_x)\hat{i} + (a_y + b_y)\hat{j} + (a_z + b_z)\hat{k}$	Vector
Subtraction	$\vec{a} - \vec{b} = \vec{a} + (-\vec{b})$	Vector
Scalar multiplication	$s\vec{a} = (sa_x)\hat{i} + (sa_y)\hat{j} + (sa_z)\hat{k}$	Vector
Resolution	$a_x = a \cos \theta, a_y = a \sin \theta$	Scalars
Dot product	$\vec{a} \cdot \vec{b} = ab \cos \phi = a_x b_x + a_y b_y + a_z b_z$	Scalar
Cross product	$\vec{a} \times \vec{b} = ab \sin \phi \hat{n}$ (right-hand rule)	Vector
Scalar triple product	$\vec{a} \cdot (\vec{b} \times \vec{c}) = \det \begin{pmatrix} a_x & a_y & a_z \\ b_x & b_y & b_z \\ c_x & c_y & c_z \end{pmatrix}$	Scalar
Vector triple product	$\vec{a} \times (\vec{b} \times \vec{c}) = \vec{b}(\vec{a} \cdot \vec{c}) - \vec{c}(\vec{a} \cdot \vec{b})$	Vector
Derivative	$\frac{d\vec{a}}{dt} = \frac{da_x}{dt}\hat{i} + \frac{da_y}{dt}\hat{j} + \frac{da_z}{dt}\hat{k}$	Vector

Quick Reference: Dot vs. Cross Product

Feature	Dot Product	Cross Product
Result	Scalar	Vector
Formula	$ab \cos \phi$	$ab \sin \phi \hat{n}$
Parallel (0°)	ab	0
Perpendicular (90°)	0	ab
Commutative?	Yes	No

Advanced Formulas

$$\text{Lagrange: } |\vec{a} \times \vec{b}|^2 = a^2 b^2 - (\vec{a} \cdot \vec{b})^2$$

$$\text{BAC-CAB: } \vec{a} \times (\vec{b} \times \vec{c}) = \vec{b}(\vec{a} \cdot \vec{c}) - \vec{c}(\vec{a} \cdot \vec{b})$$

$$\text{Lami: } \frac{F_1}{\sin \alpha} = \frac{F_2}{\sin \beta} = \frac{F_3}{\sin \gamma}$$

Vector Analysis: One-Liners

Nature of Physical Theories and Models

1. Physics is an experimental science where physicists observe phenomena and try to find patterns called physical theories.
2. A theory is an explanation of natural phenomena based on observation and accepted fundamental principles.
3. No theory is ever regarded as the ultimate truth; new observations may require a theory to be revised or discarded.
4. A model is a simplified version of a physical system that would be too complicated to analyze in full detail.
5. A useful model simplifies a problem enough to make it manageable yet keeps its essential features.

Scalars and Vectors

6. Scalars are physical quantities that have magnitude only and obey the rules of ordinary arithmetic.
7. Examples of scalars include temperature, pressure, energy, mass, time, speed, work, power, electric potential, and density.
8. Vectors are physical quantities that have both magnitude and direction and obey the rules of vector algebra.
9. Examples of vectors include displacement, velocity, acceleration, force, momentum, torque, electric field, and magnetic field.

2. Vector Analysis

D) Opposite magnitude and opposite direction.

Correct Answer: B

5. The zero vector has:

- A) Zero magnitude and zero direction.
- B) Zero magnitude and undefined direction.
- C) Unit magnitude and zero direction.
- D) Infinite magnitude and undefined direction.

Correct Answer: B

6. Vector addition is:

- A) Commutative only.
- B) Associative only.
- C) Both commutative and associative.
- D) Neither commutative nor associative.

Correct Answer: C

7. The magnitude of the sum of two

vectors $\vec{a}$ and $\vec{b}$ is maximum when the angle between them is:

- A) 0°
- B) 90°
- C) 180°
- D) 270°

Correct Answer: A

8. The magnitude of the sum of two

vectors $\vec{a}$ and $\vec{b}$ is minimum when the angle between them is:

- A) 0°
- B) 90°
- C) 180°
- D) 270°

Correct Answer: C

9. If two vectors of magnitudes 3 and 4 are perpendicular, the magnitude of their sum is:

- A) 1
- B) 5
- C) 7
- D) 12

Correct Answer: B ($\sqrt{3^2 + 4^2} = 5$)

10. The vector subtraction $\vec{a} - \vec{b}$ is equivalent to:

- A) $\vec{a} + \vec{b}$
- B) $\vec{a} + (-\vec{b})$
- C) $-\vec{a} + \vec{b}$
- D) $-(\vec{a} + \vec{b})$

Correct Answer: B

11. The component of a vector $\vec{a}$ along the x-axis is given by:

A) $a_x = a \sin \theta$

B) $a_x = a \cos \theta$

C) $a_x = a \tan \theta$

D) $a_x = a \sec \theta$

Correct Answer: B

12. The component of a vector $\vec{a}$ along the y-axis is given by:

A) $a_y = a \sin \theta$

B) $a_y = a \cos \theta$

C) $a_y = a \tan \theta$

D) $a_y = a \sec \theta$

Correct Answer: A

13. In Quadrant II, the components of a vector are:

- A) Both positive.
- B) Both negative.
- C) a_x negative, a_y positive.
- D) a_x positive, a_y negative.

Correct Answer: C

14. In Quadrant III, the components of a vector are:

- A) Both positive.
- B) Both negative.
- C) a_x negative, a_y positive.
- D) a_x positive, a_y negative.

Correct Answer: B

15. The magnitude of a vector with components $a_x = 3$ and $a_y = 4$ is:

- A) 1
- B) 5
- C) 7
- D) 12

Correct Answer: B ($\sqrt{3^2 + 4^2} = 5$)

16. The direction of a vector with components $a_x = 3$ and $a_y = 4$ measured from the +x-axis is:

- A) $\tan^{-1}(3/4)$
- B) $\tan^{-1}(4/3)$
- C) $\sin^{-1}(3/5)$
- D) $\cos^{-1}(4/5)$

Correct Answer: B

17. In three dimensions, the magnitude of a vector is:

- A) $a = a_x + a_y + a_z$
- B) $a = \sqrt{a_x^2 + a_y^2}$

Motion and Force

Kinematics Summary

Quantity	1D Definition	2D/3D Definition	Vector?
Position	x	$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$	Yes
Displacement	$\Delta x = x_2 - x_1$	$\Delta \vec{r} = \vec{r}_2 - \vec{r}_1$	Yes
Average Velocity	$v_{\text{avg}} = \Delta x / \Delta t$	$\vec{v}_{\text{avg}} = \Delta \vec{r} / \Delta t$	Yes
Instantaneous Velocity	$v = dx/dt$	$\vec{v} = d\vec{r}/dt$	Yes
Average Acceleration	$a_{\text{avg}} = \Delta v / \Delta t$	$\vec{a}_{\text{avg}} = \Delta \vec{v} / \Delta t$	Yes
Instantaneous Acceleration	$a = dv/dt$	$\vec{a} = d\vec{v}/dt$	Yes

Dynamics Summary

Quantity	Symbol	Formula	Notes
Newton's 1st Law	—	$\vec{F}_{\text{net}} = 0 \Rightarrow \vec{a} = 0$	Law of inertia
Newton's 2nd Law	—	$\vec{F}_{\text{net}} = m\vec{a}$	$F \propto a$
Newton's 3rd Law	—	$\vec{F}_{AB} = -\vec{F}_{BA}$	Action-reaction
Weight	W	$W = mg$	Depends on g
Static Friction	f_s	$f_s \leq \mu_s F_N$	Opposes attempted motion
Kinetic Friction	f_k	$f_k = \mu_k F_N$	Opposes actual motion
Centripetal Acceleration	a_c	$a_c = v^2/R$	Toward centre
Centripetal Force	F_c	$F_c = mv^2/R$	Net inward force
Momentum	$\vec{p}$	$\vec{p} = m\vec{v}$	Quantity of motion
Impulse	$\vec{J}$	$\vec{J} = \vec{F}\Delta t = \Delta \vec{p}$	Force over time
Drag Force	D	$D = \frac{1}{2} C \rho A v^2$	Opposes motion
Terminal Speed	v_t	$v_t = \sqrt{2mg/C\rho A}$	Maximum fall speed
Moment (Torque)	τ	$\tau = F \times d$	Turning effect

Newton's Laws Summary

Law	Statement	Equation
First Law (Inertia)	Object remains at rest or uniform motion unless acted by net external force	$\vec{F}_{\text{net}} = 0 \Rightarrow \vec{a} = 0$
Second Law	Acceleration $\propto$ net force, inversely $\propto$ mass	$\vec{F}_{\text{net}} = m\vec{a}$
Third Law	Action and reaction are equal and opposite	$\vec{F}_{AB} = -\vec{F}_{BA}$

16.4 Conservation Laws

- **Momentum** conserved when net external force = 0: $m_1 v_1 + m_2 v_2 = m_1 v'_1 + m_2 v'_2$
- **Kinetic energy** conserved only in elastic collisions

Common Sign Conventions

Situation	Positive Direction	a	g
Free fall upward	Upward	$-g$	$+9.8$
Free fall downward	Downward	$+g$	$+9.8$
Elevator up	Upward	$+a$ or $-a$	$F_N = m(g \pm a)$

Motion and Force: ONE-LINERS

Physics of Motion and Fundamental Concepts

1. Physics is fundamentally the study of motion—how objects move, what causes them to move, and how their motion changes over time.
2. A force is a push or a pull that one object exerts on another, serving as the fundamental cause of changes in motion.
3. Dynamics is the systematic study of the relationship between force and motion.
4. Kinematics describes *how* an object moves (position, velocity, acceleration), while dynamics explains *why* it moves (forces, mass, momentum).
5. Newton's laws were published in 1686 in *Philosophiae Naturalis Principia Mathematica*.
6. An object is at rest if its position does not change with respect to a chosen reference point as time passes.
7. An object is in motion if its position changes with respect to a reference point with the passage of time.
8. Rest and motion are relative terms—there is no absolute state of rest.
9. Translatory motion occurs when all points move uniformly in the same direction with orientation unchanged.
10. Rotatory motion occurs when an object rotates about its own axis.
11. Vibratory motion is back-and-forth motion about a mean position.
12. Translatory motion includes rectilinear, curvilinear, circular, and random motion.
13. The particle model treats objects as point-like masses with no internal structure, valid when size is negligible and rotation/deformation are ignored.

Scalars and Vectors

14. Scalars are described completely by magnitude alone (mass, distance, speed, time, temperature, energy).
15. Vectors require both magnitude and direction for complete specification (displacement, velocity, acceleration, force, momentum).
16. Displacement is the change in position: $\Delta x = x_2 - x_1$, with sign indicating direction.
17. Distance is a scalar (total path length, always positive), while displacement is a vector (net change with direction).
18. Average speed is total distance divided by total time.
19. Instantaneous speed is the speed at a specific instant (what a speedometer shows).
20. Average velocity is displacement divided by time: $v_{\text{avg}} = \Delta x / \Delta t$.
21. Instantaneous velocity is $v = dx/dt$, the derivative of position with respect to time.
22. Velocity is a vector; speed is its magnitude (scalar).
23. A satellite moving at constant speed in a circular orbit does NOT have constant velocity because direction changes continuously.
24. Acceleration is the rate of change of velocity and can result from changes in speed, direction, or both.
25. Average acceleration is $a_{\text{avg}} = \Delta v / \Delta t$.
26. Instantaneous acceleration is $a = dv/dt = d^2x/dt^2$.
27. The SI unit of acceleration is m/s^2 (metres per second per second).
28. When velocity and acceleration have the same sign, speed increases.
29. When velocity and acceleration have opposite signs, speed decreases.

Kinematic Equations (Constant Acceleration)

30. The first equation of motion: $v = v_0 + at$.
31. The second equation of motion: $x - x_0 = v_0 t + \frac{1}{2} at^2$.
32. The third equation of motion: $v^2 = v_0^2 + 2a(x - x_0)$.
33. The fourth equation: $x - x_0 = \frac{1}{2}(v_0 + v)t$.

Moments, Torque, and Equilibrium

147. Moment (torque) = $F \times d$, where d is perpendicular distance from pivot to line of action.
148. Unit of torque: newton-metre (N·m).
149. Maximum turning effect: largest force, greatest distance, perpendicular application.
150. Principle of Moments: sum of clockwise moments equals sum of anticlockwise moments for equilibrium.
151. Complete equilibrium requires no resultant force and no resultant torque.
152. Centre of mass is where entire mass can be considered concentrated; under gravity it's the centre of gravity.
153. Lower centre of mass and wider base increase stability.
154. An object topples if the line of action of weight falls outside its base.

M
K

P
R
E
P
A
R
A
T
I
O
N
S

Practice MCQs

1. Physics is fundamentally the study of:

- A) Forces only
- B) Motion and its causes
- C) Energy only
- D) Matter composition

Correct Answer: B

2. A force is defined as:

- A) A scalar quantity measuring energy
- B) A push or pull that one object exerts on another
- C) The rate of change of position
- D) The amount of matter in an object

Correct Answer: B

3. Dynamics is the branch of mechanics that studies:

- A) How objects move (position, velocity, acceleration)
- B) Why objects move (forces, mass, momentum)
- C) The shape of objects
- D) The composition of matter

Correct Answer: B

4. Kinematics is the branch of mechanics that studies:

- A) Forces and their effects
- B) How objects move without considering causes
- C) The nature of energy
- D) The structure of matter

Correct Answer: B

5. Rest and motion are:

- A) Absolute concepts
- B) Relative concepts
- C) Independent of reference frame

- D) Always the same for all observers

Correct Answer: B

6. A person sitting in a moving train is:

- A) At rest relative to the ground
- B) In motion relative to the train
- C) At rest relative to the train and in motion relative to the ground
- D) Neither at rest nor in motion

Correct Answer: C

7. Which type of motion involves all points moving uniformly in the same direction with orientation unchanged?

- A) Rotatory motion
- B) Vibratory motion
- C) Translatory motion
- D) Random motion

Correct Answer: C

8. The particle model is valid when:

- A) The object's rotation is significant
- B) All parts move at different rates
- C) The object's size is negligible compared to distances involved
- D) The object is deformable

Correct Answer: C

9. Which of the following is a scalar quantity?

- A) Displacement
- B) Velocity
- C) Speed
- D) Acceleration

Correct Answer: C

10. Which of the following is a vector quantity?

- A) Mass

Work and Energy

CONCEPTUAL SUMMARY

Term	Definition
Work	Energy transferred by a force; $W = \vec{F} \cdot \vec{d} = Fd\cos\phi$
Kinetic energy	Energy of motion; $K = \frac{1}{2}mv^2$
Potential energy	Energy of configuration; associated with conservative forces
Conservative force	Force for which work is path-independent (e.g., gravity, spring)
Nonconservative force	Force for which work depends on path (e.g., friction)
Mechanical energy	$E_{\text{mec}} = K + U$
Power	Rate of energy transfer; $P = dW/dt = \vec{F} \cdot \vec{v}$
Efficiency	$\eta = \text{useful output/input}$

Fundamental Principles

- Work-Energy Theorem:** $W_{\text{net}} = \Delta K$
- Potential Energy Change:** $\Delta U = -W_c$
- Force from Potential:** $F(x) = -dU/dx$
- Conservation of Mechanical Energy:** $\Delta K + \Delta U = 0$ (isolated system, only conservative forces)
- Work-External Energy:** $W_{\text{ext}} = \Delta E_{\text{mec}} + \Delta E_{\text{th}} + \Delta E_{\text{int}}$
- Conservation of Total Energy:** E_{total} is constant for an isolated system

Work and Energy: One-Liners

Introduction to Energy and Work

- Energy is a scalar quantity associated with the state or condition of one or more objects.
- Energy can be transformed from one type to another and transferred from one object to another, but the total amount always remains constant.
- The conservation of energy is one of the most fundamental and well-tested laws in all of physics.
- The work-energy approach focuses on initial and final states of a system rather than detailed path analysis.
- Work is energy transferred to or from an object by means of a force acting on the object.
- For work to be done, a force must act on the object and the object must move while the force acts.
- Pushing against a wall that does not move results in no work done on the wall in the physics sense.
- The SI unit of work is the joule (J), where $1 \text{ J} = 1 \text{ N} \cdot \text{m} = 1 \text{ kg} \cdot \text{m}^2/\text{s}^2$.
- One joule is approximately the work required to lift a small apple (about 100 g) vertically by one meter.

Work Done by a Constant Force

- Work done by a constant force: $W = Fd\cos\phi = \vec{F} \cdot \vec{d}$, where ϕ is the angle between force and displacement.
- Only the component of force parallel to the displacement does work; the perpendicular component contributes nothing to energy transfer.
- Work is positive when $0^\circ \leq \phi < 90^\circ$ — energy is transferred **to** the object.
- Work is zero when $\phi = 90^\circ$ — force is perpendicular to motion, no energy transfer.
- Work is negative when $90^\circ < \phi \leq 180^\circ$ — energy is transferred **from** the object.
- A satellite orbiting Earth experiences zero work done by gravity because gravity is perpendicular to velocity at every instant.
- When several forces act on an object, the net work is the sum of the work done by each individual force.
- Net work can also be calculated as $W_{\text{net}} = \vec{F}_{\text{net}} \cdot \vec{d} = F_{\text{net}}d\cos\phi_{\text{net}}$.

Kinetic Energy and the Work-Energy Theorem

- Kinetic energy is the energy associated with the motion of an object: $K = \frac{1}{2}mv^2$.

Efficiency

91. Efficiency is the ratio of useful output energy (or work) to total input energy.
92. $\eta = \text{useful output/input} = W_{\text{out}}/W_{\text{in}} = P_{\text{out}}/P_{\text{in}}$.
93. Efficiency is dimensionless, between 0 and 1, often expressed as a percentage.
94. No real machine has 100% efficiency; some energy is always lost to thermal energy, sound, or other forms.
95. Friction converts mechanical energy to thermal energy, reducing efficiency.
96. A machine with 100% efficiency would be a perpetual motion machine of the first kind, impossible due to conservation of energy.
97. Incandescent light bulbs have typical efficiency of about 5%.
98. Fluorescent lights have typical efficiency of about 20%.
99. LED lights have typical efficiency of 80–90%.
100. Car engines (gasoline) have typical efficiency of 20–30%.
101. Electric motors have typical efficiency of 70–95%.

Energy Resources

102. Nonrenewable energy resources are finite: fossil fuels (coal, oil, natural gas) and nuclear fuels.
103. Renewable energy resources are naturally replenished: solar, wind, hydroelectric, geothermal, biomass, tidal, and wave energy.
104. Fossil fuel conversion: Chemical $\rightarrow$ Thermal $\rightarrow$ Mechanical $\rightarrow$ Electrical.
105. Nuclear conversion: Nuclear $\rightarrow$ Thermal $\rightarrow$ Mechanical $\rightarrow$ Electrical.
106. Hydroelectric conversion: Gravitational potential $\rightarrow$ Kinetic $\rightarrow$ Mechanical $\rightarrow$ Electrical.
107. Solar PV conversion: Radiant $\rightarrow$ Electrical.
108. Wind conversion: Kinetic $\rightarrow$ Mechanical $\rightarrow$ Electrical.
109. Geothermal conversion: Thermal $\rightarrow$ Mechanical $\rightarrow$ Electrical.
110. Biomass conversion: Chemical $\rightarrow$ Thermal $\rightarrow$ Mechanical $\rightarrow$ Electrical.
111. The law of conservation of energy applies to all energy conversions.
112. Total energy input equals useful output plus waste heat plus other non-useful forms.

Practice MCQs

1. Energy is best described as:

- A) A vector quantity associated with motion
- B) A scalar quantity associated with the state of one or more objects
- C) The rate of doing work
- D) The force required to move an object

Correct Answer: B

2. The conservation of energy states that:

- A) Energy can be created and destroyed
- B) Energy can be transformed but total amount remains constant
- C) Energy can only be converted to heat
- D) Energy is always lost in any process

Correct Answer: B

3. Work is defined as:

- A) The force applied to an object
- B) Energy transferred by a force acting on an object
- C) The rate of energy transfer

- D) The product of mass and acceleration

Correct Answer: B

4. For work to be done in the physics sense:

- A) A force must act and the object must move
- B) The object must move a large distance
- C) A large force must be applied
- D) The object must be at rest

Correct Answer: A

5. Pushing against a wall that does not move results in:

- A) Positive work on the wall
- B) Negative work on the wall
- C) Zero work on the wall
- D) Maximum work on the wall

Correct Answer: C

6. The SI unit of work is the:

- A) Newton
- B) Watt
- C) Joule

Rotational and Circular Motion

Summary of Key Equations

Concept	Equation
Angular displacement	$\Delta\theta = \theta_2 - \theta_1$
Angular velocity (average)	$\omega_{\text{avg}} = \Delta\theta / \Delta t$
Angular velocity (instantaneous)	$\omega = d\theta / dt$
Angular acceleration (average)	$\alpha_{\text{avg}} = \Delta\omega / \Delta t$
Angular acceleration (instantaneous)	$\alpha = d\omega / dt = d^2\theta / dt^2$
Radian relation	$s = r\theta$
Tangential speed	$v = r\omega$
Tangential acceleration	$a_t = r\alpha$
Centripetal (radial) acceleration	$a_r = v^2 / r = r\omega^2$
Period	$T = 2\pi / \omega = 2\pi r / v$
Centripetal force	$F_c = mv^2 / r = mr\omega^2$
Banking angle (frictionless)	$\tan\theta = v^2 / (rg)$
Moment of inertia (point mass)	$I = mr^2$
Moment of inertia (continuous)	$I = \int r^2 dm$
Parallel-axis theorem	$I = I_{\text{com}} + Mh^2$
Rotational kinetic energy	$K_{\text{rot}} = \frac{1}{2} I \omega^2$
Torque (definition)	$\tau = rF \sin\phi = rF_{\perp} = r_{\perp} F$
Newton's second law (rotation)	$\tau_{\text{net}} = I\alpha$
Rotational work	$W = \int \tau d\theta$
Rotational power	$P = \tau\omega$
Angular momentum (particle)	$\vec{L} = \vec{r} \times \vec{p}$
Angular momentum (rigid body)	$L = I\omega$
Torque-angular momentum relation	$\tau_{\text{net}} = dL / dt$
Conservation of angular momentum	$I_i \omega_i = I_f \omega_f$ (if $\tau_{\text{ext}} = 0$)
Rolling without slipping	$v_{\text{cm}} = R\omega$
Orbital speed	$v = \sqrt{GM_E / r}$
Artificial gravity	$\omega = \sqrt{g / r}$

Rotational and Circular Motion: One-Liners

Introduction to Rotational Motion

1. Rotational motion is a fundamental type of motion where an object rotates about an axis, with examples including spinning wheels, ceiling fans, and planetary rotation.
2. A rigid body is one that can rotate with all its parts locked together without any change in shape.
3. Every particle in a rotating rigid body moves in a circle whose center lies on the axis of rotation.
4. The angular position θ is the angle a reference line in the body makes with a fixed external reference direction.
5. Arc length relates to angular position by $s = r\theta$ where θ is in radians.
6. One complete revolution equals $360^\circ = 2\pi$ radians.
7. One radian equals approximately 57.3° .
8. Angular displacement is $\Delta\theta = \theta_2 - \theta_1$.
9. Counterclockwise rotation is positive; clockwise rotation is negative.
10. Average angular velocity is $\omega_{\text{avg}} = \Delta\theta / \Delta t$.
11. Instantaneous angular velocity is $\omega = d\theta / dt$.
12. Angular velocity has SI units of rad/s; direction is given by the right-hand rule.

1. A rigid body is one in which:

- A) The shape can change
- B) All parts are locked together without change in shape
- C) Only the center moves
- D) Rotation is impossible

Correct Answer: B

2. Every particle in a rotating rigid body moves in:

- A) A straight line
- B) An ellipse
- C) A circle whose center lies on the axis of rotation
- D) A parabola

Correct Answer: C

3. Angular position θ is measured in:

- A) Degrees only
- B) Radians
- C) Revolutions
- D) Both B and C are valid units

Correct Answer: B (Radians are the SI unit)

4. One complete revolution equals:

- A) $180^\circ = \pi \text{ rad}$
- B) $360^\circ = 2\pi \text{ rad}$
- C) $90^\circ = \pi/2 \text{ rad}$
- D) $270^\circ = 3\pi/2 \text{ rad}$

Correct Answer: B

5. One radian is approximately:

- A) 57.3°
- B) 45°
- C) 60°
- D) 90°

Correct Answer: A

6. Angular displacement is:

- A) $\Delta\theta = \theta_2 + \theta_1$
- B) $\Delta\theta = \theta_2 - \theta_1$
- C) $\Delta\theta = \theta_2/\theta_1$
- D) $\Delta\theta = \theta_1 - \theta_2$

Correct Answer: B

7. Counterclockwise rotation has:

- A) Positive angular displacement
- B) Negative angular displacement
- C) Zero angular displacement
- D) Undefined angular displacement

Correct Answer: A

8. Clockwise rotation has:

- A) Positive angular displacement
- B) Negative angular displacement
- C) Zero angular displacement

D) Undefined angular displacement

Correct Answer: B

9. Average angular velocity is:

- A) $\omega_{\text{avg}} = \Delta\theta \times \Delta t$
- B) $\omega_{\text{avg}} = \Delta\theta/\Delta t$
- C) $\omega_{\text{avg}} = \Delta t/\Delta\theta$
- D) $\omega_{\text{avg}} = \Delta\theta + \Delta t$

Correct Answer: B

10. Instantaneous angular velocity is:

- A) $\omega = \Delta\theta/\Delta t$
- B) $\omega = d\theta/dt$
- C) $\omega = \int \theta dt$
- D) $\omega = \theta/t$

Correct Answer: B

11. The SI unit of angular velocity is:

- A) m/s
- B) rad/s
- C) rev/s
- D) m/s²

Correct Answer: B

12. Average angular acceleration is:

- A) $\alpha_{\text{avg}} = \Delta\omega/\Delta t$
- B) $\alpha_{\text{avg}} = \Delta\theta/\Delta t$
- C) $\alpha_{\text{avg}} = \Delta t/\Delta\omega$
- D) $\alpha_{\text{avg}} = \omega t$

Correct Answer: A

13. Instantaneous angular acceleration is:

- A) $\alpha = d\omega/dt$
- B) $\alpha = d\theta/dt$
- C) $\alpha = \Delta\omega/\Delta t$
- D) $\alpha = \omega t$

Correct Answer: A

14. Angular acceleration has SI units of:

- A) rad/s
- B) rad/s²
- C) m/s²
- D) rad·s

Correct Answer: B

15. When ω and α have the same sign:

- A) Rotation slows down
- B) Rotation speeds up
- C) Rotation stops
- D) Direction reverses

Correct Answer: B

16. When ω and α have opposite signs:

- A) Rotation speeds up

Fluid Mechanics

Equations Summary

Equation	Name	When to Use
$\rho = m/V$	Density definition	Always
$p = F/A$	Pressure definition	Uniform pressure on flat surface
$p = p_0 + \rho gh$	Hydrostatic pressure	Fluid at rest, uniform density
$F_2 = (A_2/A_1)F_1$	Hydraulic lift	Pascal's principle, enclosed fluid
$F_b = \rho_f V_{\text{sub}} g$	Archimedes' principle	Object partially/completely submerged
$A_1 v_1 = A_2 v_2$	Continuity equation	Incompressible steady flow
$p + \frac{1}{2} \rho v^2 + \rho gy = \text{constant}$	Bernoulli's equation	Ideal fluid, steady flow
$v = \sqrt{2gh}$	Torricelli's theorem	Efflux from hole in tank
$F_d = 6\pi\eta r v$	Stokes' law	Small sphere in viscous fluid
$v_t = \frac{2r^2(\rho - \rho_f)g}{9\eta}$	Terminal velocity	Sphere falling in viscous fluid

Fluid Mechanics: ONE-LINERS

Introduction to Fluids

1. A fluid is a substance that can flow and conforms to the boundaries of any container in which it is placed.
2. A fluid cannot sustain a shearing stress (a force tangential to its surface); it can only exert a force perpendicular to its surface.
3. Both liquids and gases are fluids, but liquids maintain constant volume while gases expand to fill any container.
4. Fluid mechanics is divided into fluid statics (fluids at rest) and fluid dynamics (fluids in motion).
5. The behavior of fluids is governed by the conservation of mass, conservation of energy, and Newton's laws of motion.

Density

6. Density is defined as mass per unit volume: $\rho = m/V$.
7. The SI unit of density is kilogram per cubic meter (kg/m^3).
8. One gram per cubic centimeter equals 1000 kg/m^3 : $1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$.
9. Specific gravity (relative density) is the ratio of a material's density to the density of water at 4.0°C (1000 kg/m^3).
10. Specific gravity is a pure number without units.
11. Water at 20°C has density approximately 998 kg/m^3 ; seawater has density approximately 1030 kg/m^3 .
12. Mercury has density $13.6 \times 10^3 \text{ kg/m}^3$, about 13.6 times denser than water.
13. Air at 20°C and 1 atm has density approximately 1.20 kg/m^3 .

Pressure

14. Pressure is defined as force per unit area: $p = F/A$.
15. At a given point in a fluid at rest, pressure has the same value regardless of the orientation of the surface—pressure is a scalar quantity.
16. The SI unit of pressure is the pascal (Pa): $1 \text{ Pa} = 1 \text{ N/m}^2$.
17. One atmosphere (atm) equals $1.013 \times 10^5 \text{ Pa} = 760 \text{ torr} = 14.7 \text{ lb/in}^2$.
18. Gauge pressure is the difference between absolute pressure and atmospheric pressure.
19. Absolute pressure = gauge pressure + atmospheric pressure.

Hydrostatic Pressure

20. In a fluid at rest, pressure increases with depth: $dp/dy = -\rho g$, where y is measured upward.

D) The density of oil

Correct Answer: B

8. Specific gravity is:

- A) A unitless number
- B) Measured in kg/m^3
- C) Measured in N/m^3
- D) Always greater than 1

Correct Answer: A

9. Pressure is defined as:

- A) Force per unit volume
- B) Force per unit area
- C) Mass per unit volume
- D) Force times area

Correct Answer: B

10. Pressure at a point in a fluid at rest is:

- A) Different in different directions
- B) The same in all directions
- C) Zero
- D) Maximum horizontally

Correct Answer: B

11. Pressure is a:

- A) Vector quantity
- B) Scalar quantity
- C) Tensor quantity
- D) Complex quantity

Correct Answer: B

12. The SI unit of pressure is the:

- A) Newton
- B) Joule
- C) Pascal
- D) Watt

Correct Answer: C

13. One pascal equals:

- A) $1 \text{ N} \cdot \text{m}$
- B) 1 N/m
- C) 1 N/m^2
- D) 1 kg/m^3

Correct Answer: C

14. One atmosphere equals approximately:

- A) $1.013 \times 10^3 \text{ Pa}$
- B) $1.013 \times 10^5 \text{ Pa}$
- C) $1.013 \times 10^7 \text{ Pa}$
- D) $1.013 \times 10^9 \text{ Pa}$

Correct Answer: B

15. One atmosphere equals:

- A) 76 torr

B) 760 torr

C) 7.6 torr

D) 0.76 torr

Correct Answer: B

16. Gauge pressure is:

- A) Absolute pressure
- B) Absolute pressure minus atmospheric pressure
- C) Atmospheric pressure minus absolute pressure
- D) Pressure at depth

Correct Answer: B

17. Hydrostatic pressure at depth h is given by:

- A) $p = p_0 + \rho gh$
- B) $p = p_0 - \rho gh$
- C) $p = \rho gh$
- D) $p = p_0 + \rho gh^2$

Correct Answer: A

18. In a fluid at rest, pressure:

- A) Is constant everywhere
- B) Increases with depth
- C) Decreases with depth
- D) Depends on horizontal position

Correct Answer: B

19. Pressure depends only on:

- A) Container shape
- B) Horizontal dimensions
- C) Depth and fluid density
- D) Volume of fluid

Correct Answer: C

20. Pascal's principle states that:

- A) Pressure is highest at the bottom
- B) Pressure applied to an enclosed fluid is transmitted undiminished
- C) Pressure depends on depth
- D) Fluids are incompressible

Correct Answer: B

21. A hydraulic lift multiplies force by the ratio of:

- A) Volumes
- B) Areas
- C) Heights
- D) Densities

Correct Answer: B

22. In a hydraulic lift, $F_2 =$:

- A) $(A_1/A_2)F_1$
- B) $(A_2/A_1)F_1$
- C) $(A_2/A_1)^2 F_1$

Heat, Thermodynamics and Statistical Mechanics

Summary of Formulas

Concept		Formula
Pressure from kinetic theory		$p = \frac{1}{3} \frac{mN}{V} \langle v^2 \rangle = \frac{1}{3} \rho \langle v^2 \rangle$
RMS speed		$v_{\text{rms}} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3p}{\rho}}$
Average kinetic energy		$\langle E_k \rangle = \frac{3}{2} kT$
Ideal gas equation		$pV = nRT = NkT$
First Law		$\Delta U = Q - W$
Isothermal work		$W = nRT \ln(V_f/V_i)$
Adiabatic relation		$pV^\gamma = \text{constant}$
Carnot efficiency		$\eta = 1 - T_C/T_H$
Entropy change (reversible)		$\Delta S = \int dQ_{\text{rev}}/T$
Boltzmann entropy		$S = k \ln W$
Van der Waals equation		$(p + an^2/V^2)(V - nb) = nRT$
Multiplicity	$\Omega = \frac{N!}{n_1! n_2!}$	Number of microstates for a given macrostate
Boltzmann entropy	$S = k_B \ln \Omega$	Entropy is the logarithm of the number of microstates
Maxwell-Boltzmann	$f(v) = 4\pi \left(\frac{m}{2\pi k_B T}\right)^{3/2} v^2 e^{-mv^2/2k_B T}$	Speed distribution for classical particles
Bose-Einstein	$\langle n \rangle = \frac{1}{e^{(\epsilon - \mu)/k_B T} - 1}$	Distribution for bosons
Fermi-Dirac	$\langle n \rangle = \frac{1}{e^{(\epsilon - \mu)/k_B T} + 1}$	Distribution for fermions (Pauli exclusion)
Planck's law	$u(\nu) = \frac{8\pi h \nu^3}{c^3} \frac{1}{e^{h\nu/k_B T} - 1}$	Blackbody radiation (photons)
Helmholtz free energy	$F = U - TS$	Useful work at constant T, V
Gibbs free energy	$G = H - TS = U + PV - TS$	Useful work at constant T, P
Maxwell relation	$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$	Relates thermodynamic properties

7. Heat, Thermodynamics and Statistical Mechanics

Clausius-Clapeyron	$\frac{dP}{dT} = \frac{L}{T(V_2 - V_1)}$	Phase equilibrium
--------------------	--	-------------------

Key Equations Reference Sheet

$$\begin{aligned} \langle E_k \rangle &= \frac{3}{2} kT & p &= \frac{1}{3} \rho v_{\text{rms}}^2 & v_{\text{rms}} &= \sqrt{\frac{3RT}{M}} \\ pV &= nRT & \Delta U &= Q - W & W &= \int p dV \\ \Delta U &= nC_V \Delta T & W_{\text{isothermal}} &= nRT \ln \frac{V_f}{V_i} & pV^\gamma &= \text{constant} \\ \eta &= 1 - \frac{Q_c}{Q_H} = 1 - \frac{T_c}{T_H} & \Delta S &= \int \frac{dQ_{\text{rev}}}{T} & S &= k \ln W \\ \left(p + \frac{an^2}{V^2}\right) &(V - nb) &= nRT \end{aligned}$$

Heat And Thermodynamics: One-Liners

Fundamental Concepts and Temperature

1. Thermodynamics studies the relationships between heat, work, temperature, and energy in physical systems.
2. The system is the portion of the universe under investigation; the surroundings constitute everything outside the system.
3. An isolated system exchanges neither matter nor energy with its surroundings.
4. A closed system exchanges energy but not matter with its surroundings.
5. An open system exchanges both matter and energy with its surroundings.
6. State variables are measurable quantities such as pressure, volume, temperature, and number of moles.
7. A state function depends only on the current state of the system, not on how that state was achieved.
8. Internal energy and entropy are state functions; heat and work are path-dependent quantities.
9. The Zeroth Law of Thermodynamics: If two systems are each in thermal equilibrium with a third system, then they are in thermal equilibrium with each other.
10. The Zeroth Law establishes that temperature is a meaningful and measurable property.
11. Temperature is related to the average kinetic energy of the molecules of a substance.
12. The Kelvin scale is based on the triple point of water, defined as $T_3 = 273.16 \text{ K}$.
13. Absolute zero is $0 \text{ K} = -273.15^\circ\text{C}$, the temperature of minimum possible total energy.
14. The relationship between Kelvin and Celsius is $T_K = T_C + 273.15$.
15. Celsius to Fahrenheit conversion: $T_F = \frac{9}{5}T_C + 32^\circ$.
16. Temperature differences are the same on Kelvin and Celsius scales; $1 \text{ K} = 1^\circ\text{C}$.

Thermal Expansion

17. Linear expansion: $\Delta L = \alpha L_0 \Delta T$, where α is the coefficient of linear expansion.
18. The final length is $L = L_0(1 + \alpha \Delta T)$.
19. All linear dimensions of an object—including holes—expand by the same fractional amount when heated.
20. Volume expansion: $\Delta V = \beta V_0 \Delta T$, where β is the coefficient of volume expansion.
21. For isotropic solids, $\beta = 3\alpha$.
22. Water exhibits anomalous expansion; between 0°C and 4°C , it contracts as temperature increases.
23. Water has maximum density at 4°C .
24. Thermal stress in a clamped rod: $F/A = -Y\alpha\Delta T$, where Y is Young's modulus.

6. The Zeroth Law of Thermodynamics establishes:

- A) Conservation of energy
- B) The direction of heat flow
- C) Temperature as a meaningful property
- D) The impossibility of perpetual motion

Correct Answer: C

7. The triple point of water is defined as:

- A) 273.15 K
- B) 273.16 K
- C) 373.15 K
- D) 0 K

Correct Answer: B

8. Absolute zero is:

- A) 0°C
- B) -273.15°C
- C) 273.15 K
- D) -273.15 K

Correct Answer: B

9. The relationship between Kelvin and Celsius is:

- A) $T_K = T_C - 273.15$
- B) $T_K = T_C + 273.15$
- C) $T_K = T_C$
- D) $T_K = T_C + 273$

Correct Answer: B

10. Celsius to Fahrenheit conversion is:

- A) $T_F = \frac{9}{5}T_C + 32$
- B) $T_F = \frac{5}{9}(T_C - 32)$
- C) $T_F = T_C + 32$
- D) $T_F = \frac{9}{5}T_C - 32$

Correct Answer: A

11. Linear expansion is given by:

- A) $\Delta L = \alpha L_0 \Delta T$
- B) $\Delta L = \beta L_0 \Delta T$
- C) $\Delta L = \alpha L_0 T$
- D) $\Delta L = \alpha \Delta T / L_0$

Correct Answer: A

12. For isotropic solids, the volume expansion coefficient is:

- A) $\beta = \alpha$
- B) $\beta = 2\alpha$
- C) $\beta = 3\alpha$
- D) $\beta = \alpha/3$

Correct Answer: C

13. Water has maximum density at:

- A) 0°C
- B) 4°C
- C) 100°C
- D) -4°C

Correct Answer: B

14. Heat is defined as:

- A) The total energy of a system
- B) Energy transferred due to temperature difference
- C) The temperature of a system
- D) The work done by a system

Correct Answer: B

15. The SI unit of heat is the:

- A) Calorie
- B) Joule
- C) Watt
- D) Kelvin

Correct Answer: B

16. One calorie equals:

- A) 4.186 J
- B) 4.186×10^3 J
- C) 4.186×10^6 J
- D) 4.186×10^{-3} J

Correct Answer: A

17. Specific heat is given by:

- A) $Q = mc\Delta T$
- B) $Q = mL$
- C) $Q = nC\Delta T$
- D) $Q = mcT$

Correct Answer: A

18. Latent heat is:

- A) Heat required for temperature change
- B) Heat required for phase change without temperature change
- C) Heat required to raise temperature by 1°C
- D) Heat lost to the surroundings

Correct Answer: B

19. Heat of fusion for water is approximately:

- A) 2.256×10^6 J/kg
- B) 3.34×10^5 J/kg
- C) 4.186×10^3 J/kg
- D) 1.00×10^3 J/kg

Correct Answer: B

20. Heat of vaporization for water is approximately:

- A) 3.34×10^5 J/kg

Electromagnetism

Key Formulas and Equations

Quantity	Symbol	SI Unit	Key Equation(s)
Magnetic field	$\vec{B}$	tesla (T)	$\vec{F} = q\vec{v} \times \vec{B}$
Magnetic flux	Φ_B	weber (Wb)	$\Phi_B = \int \vec{B} \cdot d\vec{A}$
Magnetic constant	μ_0	T·m/A	$\mu_0 = 4\pi \times 10^{-7}$
Magnetic dipole moment	$\vec{\mu}$	A·m ²	$\vec{\mu} = NI\vec{A}$
Magnetization	$\vec{M}$	A/m	$\vec{M} = \vec{\mu}_{\text{total}}/V$
Induced emf	$\mathcal{E}$	volt (V)	$\mathcal{E} = -d\Phi_B/dt$
Inductance	L	henry (H)	$\mathcal{E}_L = -L di/dt, U_B = \frac{1}{2}LI^2$
Displacement current	I_d	ampere (A)	$I_d = \epsilon_0 d\Phi_E/dt$
Wave equation (E)	$\nabla^2 E = \mu_0 \epsilon_0 \frac{\partial^2 E}{\partial t^2}$		EM waves propagate at speed c
Wave equation (B)	$\nabla^2 B = \mu_0 \epsilon_0 \frac{\partial^2 B}{\partial t^2}$		B-field also propagates as a wave
Speed of light	$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$		Maxwell's great synthesis
E-B relationship	$E_0 = cB_0$		Ratio of amplitudes
Plane wave	$E = E_0 \cos(kx - \omega t)$		Transverse wave solution
Poynting vector	$S = \frac{1}{\mu_0} E \times B$		Energy flow per unit area
Average intensity	$S_{\text{avg}} = \frac{1}{2} \epsilon_0 c E_0^2$		Time-averaged power per area
Energy density	$u = \epsilon_0 E^2$		Energy per unit volume
Radiation pressure (absorb)	$P = S_{\text{avg}}/c$		Pressure from absorbed light
Radiation pressure (reflect)	$P = 2S_{\text{avg}}/c$		Pressure from reflected light

Fundamental Constants

$$\mu_0 = 4\pi \times 10^{-7} \text{ N/A}^2, \epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2, c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} = 2.998 \times 10^8 \text{ m/s}$$

Electromagnetism: One-Liners

Magnetic Fields and Their Sources

1. A magnetic field is a vector field created by moving electric charges and intrinsic magnetic moments.
2. The SI unit of magnetic field is the tesla (T): $1 \text{ T} = 1 \text{ N}/(\text{A} \cdot \text{m})$.
3. One tesla equals 10^4 gauss (G); Earth's magnetic field is approximately 0.5 G.
4. Magnetic fields are produced only by moving charges or intrinsic magnetic moments; stationary charges produce only electric fields.
5. Magnetic field lines form continuous closed loops; they never have endpoints, reflecting the absence of magnetic monopoles.
6. Magnetic force on a moving charge is perpendicular to both velocity and magnetic field.
7. Magnetic forces do no work on charges; they change direction but not speed.
8. Magnetic flux: $\Phi_B = \int \vec{B} \cdot d\vec{A} = BA \cos \phi$ for uniform field.
9. The SI unit of magnetic flux is the weber (Wb): $1 \text{ Wb} = 1 \text{ T} \cdot \text{m}^2$.
10. Oersted discovered in 1820 that a current-carrying wire deflects a compass needle, linking electricity and magnetism.
11. The magnetic field of a current-carrying wire forms concentric circles centered on the wire.

93. An AC generator produces sinusoidal emf: $\mathcal{E} = NBA\omega \sin(\omega t)$.
94. A DC generator uses a split-ring commutator to produce pulsating DC.
95. Transformer equation: $V_s/V_p = N_s/N_p$.
96. Ideal transformer power: $V_p I_p = V_s I_s$.
97. Step-up transformers increase voltage; step-down transformers decrease voltage.
98. High-voltage transmission reduces $I^2 R$ losses.
99. A galvanometer converts current to deflection: $I \propto \phi$.
100. An ammeter uses a shunt resistor in parallel; a voltmeter uses a multiplier resistor in series.
101. A cathode ray oscilloscope displays voltage waveforms using an electron beam deflected by electric fields.

Practice MCQs

1. A magnetic field is produced by:

- A) Stationary electric charges
- B) Moving electric charges
- C) Electric fields only
- D) Gravitational fields

Correct Answer: B

2. The SI unit of magnetic field is the:

- A) Gauss
- B) Tesla
- C) Weber
- D) Henry

Correct Answer: B

3. One tesla is equal to:

- A) 10^2 gauss
- B) 10^4 gauss
- C) 10^6 gauss
- D) 10^8 gauss

Correct Answer: B

4. Magnetic field lines:

- A) Begin on positive charges and end on negative charges
- B) Form continuous closed loops
- C) Are straight lines
- D) Never form loops

Correct Answer: B

5. The absence of magnetic monopoles implies:

- A) $\oint \vec{E} \cdot d\vec{A} = Q/\epsilon_0$
- B) $\oint \vec{B} \cdot d\vec{A} = 0$
- C) $\oint \vec{B} \cdot d\vec{l} = \mu_0 I$
- D) $\oint \vec{E} \cdot d\vec{l} = -d\Phi_B/dt$

Correct Answer: B

6. The magnetic force on a moving charge:

- A) Does work on the charge
- B) Does no work on the charge
- C) Changes the speed of the charge

- D) Is parallel to the velocity

Correct Answer: B

7. Oersted's experiment showed that:

- A) Electric charges produce electric fields
- B) A current-carrying wire produces a magnetic field
- C) Magnetic fields produce electric currents
- D) Light is an electromagnetic wave

Correct Answer: B

8. The magnetic field of a long straight wire:

- A) Decreases as $1/r^2$
- B) Decreases as $1/r$
- C) Is constant
- D) Increases as r

Correct Answer: B

9. The Biot-Savart law gives the magnetic field due to:

- A) A point charge
- B) A current element
- C) A changing electric field
- D) A magnetic dipole

Correct Answer: B

10. The permeability of free space μ_0 is:

- A) $4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$
- B) $8.85 \times 10^{-12} \text{ C}^2/(\text{N} \cdot \text{m}^2)$
- C) $6.67 \times 10^{-11} \text{ N} \cdot \text{m}^2/\text{kg}^2$
- D) $1.38 \times 10^{-23} \text{ J/K}$

Correct Answer: A

11. The speed of light is related to μ_0 and ϵ_0 by:

- A) $c = \mu_0 \epsilon_0$
- B) $c = 1/\sqrt{\mu_0 \epsilon_0}$
- C) $c = \sqrt{\mu_0/\epsilon_0}$
- D) $c = \sqrt{\epsilon_0/\mu_0}$

Correct Answer: B

12. For an infinitely long straight wire carrying current I , the magnetic field at distance r is:

M
K

P
R
E
P
A
R
A
T
I
O
N
S

8. Electromagnetism



COMPUTER SCIENCE



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>



COMPUTER SCIENCE PRACTICE MCQs

Chapter 1: Computer Fundamentals and History

1. The term 'Computer' is derived from which language?

A) Greek
B) German
C) French
D) Latin

Answer: Latin

2. Who is known as the "Father of the Computer"?

A) Alan Turing
B) Charles Babbage
C) John von Neumann
D) Blaise Pascal

Answer: Charles Babbage

3. The basic operations performed by a computer are:

A) Arithmetic operation
B) Logical operation
C) Storage and retrieval
D) All of the above

Answer: All of the above

4. Who is considered the "Father of the Internet"?

A) Tim Berners-Lee
B) Vint Cerf
C) Charles Babbage
D) Bill Gates

Answer: Vint Cerf

5. A computer with more than one processor is known as:

A) Uni-process
B) Multiprocessor
C) Multi-threaded
D) Multi-programming

Answer: Multiprocessor

6. The basic architecture of computer was developed by:

A) John Von Neumann
B) Charles Babbage
C) Blaise Pascal
D) None of these

Answer: John Von Neumann

7. The first mechanical calculating machine was made by:

A) Charles Babbage
B) Blaise Pascal
C) Howard Aiken
D) None of these

Answer: Blaise Pascal

8. The first electronic computer was developed by:

A) J.V. Attansoff
B) Bill Gates
C) Charles Babbage
D) Alan Turing

Answer: J.V. Attansoff

9. Who designed the first electronics computer - ENIAC?

A) Van- Neumann
B) Joseph M. Jacquard
C) J. Presper Eckert and John W Mauchly
D) None of these

Answer: J. Presper Eckert and John W Mauchly

10. UNIVAC is an abbreviation for:

A) Universal Automatic Computer
B) Universal Array Computer
C) Unique Automatic Computer
D) Unvalued Automatic Computer

Answer: Universal Automatic Computer

11. Who invented the microprocessor?

A) Marcian E Hoff
B) Herman H Goldstein
C) Joseph Jacquard
D) Charles Babbage

Answer: Marcian E Hoff

12. Who invented the first compiler?

A) Grace Hopper
B) Ada Lovelace
C) Charles Babbage
D) None of these

Answer: Grace Hopper

13. The word 'Computer' was used for the first time in:

A) 1613
B) 1614
C) 1615
D) 1616

Answer: 1613

14. Who was the World's first Computer Programmer?

A) Niklaus Wirth
B) Ada Lovelace
C) Bill Gates
D) Dennis Ritchie

Answer: Ada Lovelace

15. The first completely 64-bit compatible version of Android was:

A) Android 4.0 Ice Cream Sandwich
B) Android 5.0 Lollipop
C) Android 3.0 Honeycomb



D) Dynamic Read Access Memory
Answer: Dynamic Random Access Memory

160. Which of the following is a type of ROM?

- A) PROM
- B) EPROM
- C) EEPROM
- D) All of these

Answer: All of these

161. What is the full form of PROM?

- A) Programmable Read Only Memory
- B) Programmable Random Only Memory
- C) Programmable Read Only Memory
- D) Programmable Random Access Memory

Answer: Programmable Read Only Memory

162. What is the full form of EPROM?

- A) Erasable Programmable Read Only Memory
- B) Electrically Programmable Read Only Memory
- C) Erasable Programmable Random Only Memory
- D) Electrically Programmable Random Only Memory

Answer: Erasable Programmable Read Only Memory

163. What is the full form of EEPROM?

- A) Electrically Erasable Programmable Read Only Memory
- B) Electrically Erasable Programmable Random Only Memory
- C) Electrically Erasable Programmable Read Only Memory
- D) None of these

Answer: Electrically Erasable Programmable Read Only Memory

164. Which of the following is a system bus?

- A) Data bus
- B) Address bus
- C) Control bus
- D) All of these

Answer: All of these

165. Which bus carries data between the CPU and memory?

- A) Data bus
- B) Address bus
- C) Control bus
- D) System bus

Answer: Data bus

166. Which bus carries memory addresses from the CPU to memory?

- A) Data bus

- B) Address bus
- C) Control bus
- D) System bus

Answer: Address bus

167. Which bus carries control signals from the CPU to other components?

- A) Data bus
- B) Address bus
- C) Control bus
- D) System bus

Answer: Control bus

168. What is the full form of PCI?

- A) Peripheral Component Interconnect
- B) Peripheral Computer Interconnect
- C) Personal Component Interconnect
- D) Personal Computer Interconnect

Answer: Peripheral Component Interconnect

169. What is the full form of ISA?

- A) Industry Standard Architecture
- B) Industrial Standard Architecture
- C) Industry System Architecture
- D) Industrial System Architecture

Answer: Industry Standard Architecture

170. What is the full form of SATA?

- A) Serial Advanced Technology Attachment
- B) Serial Advanced Technology Adapter
- C) Serial Advanced Technology Adapter
- D) None of these

Answer: Serial Advanced Technology Attachment

171. What is the full form of PATA?

- A) Parallel Advanced Technology Attachment
- B) Parallel Advanced Technology Adapter
- C) Parallel Advanced Technology Adapter
- D) None of these

Answer: Parallel Advanced Technology Attachment

172. Which of the following is a power supply unit connector for the motherboard?

- A) ATX connector
- B) SATA connector
- C) PCIe connector
- D) USB connector

Answer: ATX connector

173. What is the full form of UPS?

- A) Uninterruptible Power Supply
- B) Uninterrupted Power Supply
- C) Uninterruptible Power System
- D) Uninterrupted Power System

Answer: Uninterruptible Power Supply



- B) .txt
- C) .html
- D) .rtf

Answer: .txt

206. Which of the following is a utility program?

- A) Disk Cleanup
- B) MS Word
- C) PowerPoint
- D) Excel

Answer: Disk Cleanup

207. Linus Torvalds developed which operating system?

- A) Linux
- B) iOS
- C) UNIX
- D) Windows

Answer: Linux

208. The most recent version of macOS is based on which operating system?

- A) Linux
- B) UNIX
- C) MS-DOS
- D) Windows NT

Answer: UNIX

209. File management is the responsibility of:

- A) Task Manager
- B) RAM
- C) BIOS
- D) Operating System

Answer: Operating System

210. Which of the following is an example of real-time operating system?

- A) Windows 10
- B) VxWorks
- C) macOS
- D) Linux

Answer: VxWorks

211. The programs which are as permanent as hardware and stored in ROM are known as:

- A) Hardware
- B) Software
- C) Firmware
- D) ROM ware

Answer: Firmware

212. Unix Operating system was developed by:

- A) Dennis Ritchie & Ken Thompson
- B) Bill Gates & Paul Allen
- C) Steve Jobs & Steve Wozniak
- D) Linus Torvalds

Answer: Dennis Ritchie & Ken Thompson

213. Which of the following is not a multitasking operating system?

- A) Windows
- B) Linux
- C) DOS
- D) UNIX

Answer: DOS

214. Which of the following is a disk compression tool?

- A) DriveSpace
- B) ScanDisk
- C) Defrag
- D) Format

Answer: DriveSpace

215. The primary purpose of an operating system is:

- A) To make the most efficient use of the computer hardware
- B) To provide a user interface
- C) To manage files
- D) All of the above

Answer: To make the most efficient use of the computer hardware

216. Which of the following is not a system tool?

- A) Scandisk
- B) Drive space
- C) Disk fragment
- D) MS Word

Answer: MS Word

217. The memory resident portion of the operating system is called the:

- A) Kernel
- B) Shell
- C) BIOS
- D) Loader

Answer: Kernel

218. Which of the following is a popular mobile operating system?

- A) Android
- B) iOS
- C) Windows Phone
- D) All of these

Answer: All of these

219. The process of starting a computer and loading the operating system is called:

- A) Booting
- B) Formatting
- C) Debugging
- D) Processing

Answer: Booting

220. Which of the following is not an operating system?



311. Which of the following is a logical function in Excel?

- A) IF
- B) AND
- C) OR
- D) All of these

Answer: All of these

312. Which of the following is a lookup function in Excel?

- A) VLOOKUP
- B) HLOOKUP
- C) XLOOKUP
- D) All of these

Answer: All of these

313. What is the function of COUNTIF in Excel?

- A) Counts cells that meet a condition
- B) Counts all cells
- C) Counts non-empty cells
- D) Counts empty cells

Answer: Counts cells that meet a condition

314. What is the function of SUMIF in Excel?

- A) Sums cells that meet a condition
- B) Sums all cells
- C) Sums non-empty cells
- D) Sums empty cells

Answer: Sums cells that meet a condition

315. Which of the following is a date function in Excel?

- A) DATE
- B) DAY
- C) MONTH
- D) All of these

Answer: All of these

316. Which of the following is a statistical function in Excel?

- A) AVERAGE
- B) MEDIAN
- C) MODE
- D) All of these

Answer: All of these

317. What is the function of the ROUND function in Excel?

- A) Rounds a number to a specified number of digits
- B) Rounds a number up
- C) Rounds a number down
- D) Returns the integer part of a number

Answer: Rounds a number to a specified number of digits

318. What is the function of the TRUNC function in Excel?

- A) Truncates a number to an integer
- B) Rounds a number
- C) Returns the absolute value
- D) Returns the square root

Answer: Truncates a number to an integer

319. What is the function of the ABS function in Excel?

- A) Returns the absolute value of a number
- B) Returns the square root of a number
- C) Returns the exponential of a number
- D) Returns the logarithm of a number

Answer: Returns the absolute value of a number

Chapter 5: Internet, Networking, and Email

321. HTML stands for Hypertext Markup Language; it is used for creating:

- A) Web pages
- B) Web server
- C) Client server
- D) Database

Answer: Web pages

322. Gmail, Hotmail and Yahoo are:

- A) Email Server
- B) Client Server
- C) Email Programmer
- D) Email Service Providers

Answer: Email Service Providers

323. DNS stands for:

- A) Domain Name Service
- B) Domain Name Server
- C) Domain Name System
- D) Digital Network Service

Answer: Domain Name System

324. A computer on the Internet is identified by:

- A) IP address
- B) Street address
- C) E-mail address
- D) MAC address

Answer: IP address

325. The first network that provided the basis for the Internet is:

- A) ARAPANET
- B) ARPANET
- C) PARA NET
- D) NSFNET

Answer: ARPANET

326. Which protocol provides e-mail facility among different hosts?

- A) TELNET
- B) SMTP



D) Business Carbon Copy

Answer: Blind Carbon Copy

343. Which of the following is a search engine?

- A) Facebook
- B) Google
- C) Twitter
- D) Instagram

Answer: Google

344. What is the maximum length of an IP address (IPv4) in bits?

- A) 16 bits
- B) 32 bits
- C) 64 bits
- D) 128 bits

Answer: 32 bits

345. Which of the following is a top-level domain?

- A) .com
- B) .gov
- C) .org
- D) All of these

Answer: All of these

346. Who is known as the founder of the World Wide Web?

- A) Vint Cerf
- B) Tim Berners-Lee
- C) Robert Kahn
- D) Mark Zuckerberg

Answer: Tim Berners-Lee

347. Which device is required to connect a computer to the internet via a telephone line?

- A) Router
- B) Switch
- C) Modem
- D) Hub

Answer: Modem

348. What does ISP stand for?

- A) Internet Server Provider
- B) Internal Service Provider
- C) Internet Service Provider
- D) International Service Provider

Answer: Internet Service Provider

349. Which network topology requires a central hub or switch?

- A) Bus
- B) Ring
- C) Star
- D) Mesh

Answer: Star

350. The internet is a:

- A) Network of networks
- B) Single large computer

C) Type of software

D) Type of browser

Answer: Network of networks

351. Which protocol is used to transfer files from the internet to your computer?

- A) FTP
- B) IP
- C) HTTP
- D) SMTP

Answer: FTP

352. What is the term used for unsolicited bulk email?

- A) Spam
- B) Junk
- C) Trash
- D) Both A and B

Answer: Spam

353. The oldest internet search engine is:

- A) Google
- B) Yahoo
- C) Archie
- D) AltaVista

Answer: Archie

354. What does Wi-Fi stand for?

- A) Wireless Fidelity
- B) Wireless Function
- C) Wireless Finder
- D) Wired Fidelity

Answer: Wireless Fidelity

355. Which of the following is an example of a social network?

- A) Google
- B) Facebook
- C) Bing
- D) Yahoo

Answer: Facebook

356. What does VoIP stand for?

- A) Voice over Internet Protocol
- B) Video over Internet Protocol
- C) Voice on Internet Protocol
- D) Video on Internet Protocol

Answer: Voice over Internet Protocol

357. Which key is used to refresh a web page?

- A) F1
- B) F5
- C) F2
- D) F12

Answer: F5

358. The project that allows access to the universe of online information is:

- A) World-Wide-Web
- B) Web browser
- C) IP address



GENERAL KNOWLEDGE



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>

GENERAL KNOWLEDGE

Pakistan History

1. When did Pakistan become independent?

- A. August 11, 1947
- B. August 14, 1947
- C. August 15, 1947
- D. August 17, 1947

Answer: B

2. Who was the first Governor-General of Pakistan?

- A. Liaquat Ali Khan
- B. Quaid-e-Azam Muhammad Ali Jinnah
- C. Khawaja Nazimuddin
- D. Iskander Mirza

Answer: B

3. Who was the first Prime Minister of Pakistan?

- A. Quaid-e-Azam Muhammad Ali Jinnah
- B. Liaquat Ali Khan
- C. Khawaja Nazimuddin
- D. Chaudhry Muhammad Ali

Answer: B

4. On August 11, 1947, Quaid-e-Azam advocated for which kind of state?

- A. Theocratic state
- B. Secular and inclusive state
- C. Military state
- D. Communist state

Answer: B

5. Which language did Jinnah declare would be the sole national language of Pakistan in a 1948 Dhaka speech?

- A. Bengali
- B. Punjabi
- C. Urdu
- D. English

Answer: C

6. Who was the first Chief Justice of Pakistan's Supreme Court?

- A. Sir Zafrulla Khan
- B. Chaudhry Muhammad Ali
- C. Sir Abdul Rashid
- D. S.A. Rahman

Answer: C

7. What was Quaid-e-Azam's foreign policy principle?

- A. "Peace with India only"
- B. "Friendship with all, malice towards none"
- C. "Alignment with USSR only"
- D. "Support only Muslim countries"

Answer: B

8. When did Quaid-e-Azam Muhammad Ali Jinnah die?

- A. September 11, 1948
- B. October 16, 1951
- C. August 14, 1948
- D. July 9, 1967

Answer: A

9. Approximately how many people crossed borders during the 1947 refugee crisis?

- A. 5 million
- B. 14 million
- C. 20 million
- D. 1 million

Answer: B

10. As per the Radcliffe Award, what percentage of undivided India's assets did Pakistan receive?

- A. 25%
- B. 10%
- C. 17.5%
- D. 33%

Answer: C

11. India delayed the transfer of how many rupees to Pakistan after partition?

- A. Rs. 750 million
- B. Rs. 400 million
- C. Rs. 550 million
- D. Rs. 100 million

Answer: C

12. Whose fast forced the Indian government to release Pakistan's cash balance in 1948?

- A. Jawaharlal Nehru
- B. Mahatma Gandhi
- C. Vallabhbhai Patel
- D. Indira Gandhi

Answer: B

13. Who was the ruler of Kashmir at the time of the 1947 tribal invasion?

- A. Sheikh Abdullah
- B. Hari Singh
- C. Ghulam Abbas
- D. Karan Singh

Answer: B

14. When did Hari Singh sign the Instrument of Accession to India?

- A. October 26, 1947
- B. August 14, 1947
- C. January 1, 1949
- D. October 27, 1947

Answer: A

15. Which UN Resolution called for a ceasefire and plebiscite in Kashmir?

- A. Resolution 47

Constitution of Pakistan

Pakistan was founded in 1947 as a Dominion (an independent realm or kingdom) within the British Commonwealth. The same was true in independent India. During its first few years of existence the British monarch was also Pakistan's head of state, as is still the case in Canada, Australia etc. Before writing a constitution, a Constituent Assembly passed the Objectives Resolution, on the insistence of the ulama and Jamaat-e-Islami, in March 1949 to define the basic directive principles of the new state and to declare state recognition of the sovereignty of Allah over the universe. The Objectives Resolution affirmed the role of democracy and contained religious provisions to enable society to adhere to the teachings of the Quran and Sunnah. The Objectives Resolution has henceforth been inserted as a preamble into each of Pakistan's subsequent constitutions.

1. Introduction

Need for a Constitution after Independence (1947)

- A newly independent state required a **written constitution** to define:
 - The **form of government**
 - Distribution of powers among state institutions
 - Fundamental rights and duties of citizens
 - Relations between federation and provinces

Role of Government of India Act 1935 as Interim Constitution

- Adopted on **14 August 1947** as Pakistan's provisional constitutional framework.
- Provided continuity in administration.
- Allowed Pakistan to function until a new constitution was framed.
- Governor-General held wide powers.

Challenges in Constitution-Making

1. **Refugee Crisis**
 - Millions migrated from India to Pakistan.
 - Economic and social instability delayed constitution-making.
2. **Integration of Princely States**
 - States like **Kalat, Bahawalpur, Khairpur, Swat** had to be merged.
 - Political disputes slowed down national unification.
3. **Lack of Experienced Lawmakers**
 - Most senior politicians and experts remained in India.
 - Pakistan faced shortage of trained administrators and legal experts.
4. **Political Instability**
 - Frequent changes in Prime Ministers and Cabinets.
 - Struggle for power between **Governor-General, Prime Minister, and Assembly**.

2. Objectives Resolution (1949)

Basic Information

- **Passed by:** Constituent Assembly of Pakistan
- Prime Minister Liaquat Ali Khan presented the Objectives Resolution on 7 March 1949, adopted on 12 March 1949.
- **Proposed by:** Liaquat Ali Khan (First PM of Pakistan)
- **Chairman of Assembly:** Maulvi Tamizuddin Khan
- **Dissolved by:** Ghulam Muhammad (Governor-General) in 1954
- **Case:** Maulvi Tamizuddin Khan vs Federation of Pakistan
- **Verdict:** Federal Court upheld dissolution (Justice Munir → Doctrine of Necessity)

Twenty-Second	8 June 2016	Mamnoon Hussain	Allowed non-judges (bureaucrats/technocrats) as CEC/ECP members; set retirement ages.
Twenty-Third	March 2017	Mamnoon Hussain	Granted legal cover to military courts.
Twenty-Fourth	2017	Mamnoon Hussain	Adjusted parliamentary seats based on 2017 Census (Punjab lost seats; KP/Balochistan gained).
Twenty-Fifth	31 May 2018	Mamnoon Hussain	Merged FATA and PATA with Khyber Pakhtunkhwa; repealed Article 247; abolished FCR.
Twenty-Sixth	21 October 2024	Shehbaz Sharif	Removed SC <i>suo motu</i> power; capped CJ tenure at 3 years; established constitutional bench; added right to clean environment.
Twenty-Seventh	13 November 2025	Shehbaz Sharif	Abolished SC role in constitutional cases; created Federal Constitutional Court; amended Article 243 (armed forces command).

Most Important MCQ

1. Who expressed the view that Pakistan's constitution would be of a democratic type embodying essential principles of Islam in a radio talk broadcast in February 1948?

- A. Liaquat Ali Khan
- B. Allama Iqbal
- C. Muhammad Ali Jinnah
- D. Maulvi Tamizuddin Khan

Answer: C

2. Which act was adopted as Pakistan's interim constitution on 14 August 1947?

- A. Indian Independence Act 1947
- B. Government of India Act 1935
- C. Pakistan Interim Constitution Act 1947
- D. Objectives Resolution 1949

Answer: B

3. The Objectives Resolution was passed by the Constituent Assembly of Pakistan on which date?

- A. 14 August 1947
- B. 7 March 1949
- C. 12 March 1949
- D. 23 March 1956

Answer: C

4. Who presented the Objectives Resolution in the Constituent Assembly?

- A. Muhammad Ali Jinnah
- B. Maulvi Tamizuddin Khan
- C. Liaquat Ali Khan
- D. Khawaja Nazimuddin

Answer: C

5. The Objectives Resolution declared that sovereignty belongs to:

- A. The people of Pakistan
- B. The Parliament
- C. Allah Almighty
- D. The Constitution

Answer: C

6. Under which constitutional amendment did the Objectives Resolution become a substantive part of the 1973 Constitution?

- A. 6th Amendment
- B. 8th Amendment
- C. 10th Amendment
- D. 18th Amendment

Answer: B

7. The first Constituent Assembly of Pakistan was dissolved by which Governor-General in 1954?

- A. Khawaja Nazimuddin
- B. Malik Ghulam Muhammad
- C. Iskander Mirza
- D. Muhammad Ali Jinnah

Answer: B

8. The Federal Court's decision that upheld the dissolution of the first Constituent Assembly was based on which legal principle?

- A. Rule of law
- B. Doctrine of necessity
- C. Parliamentary sovereignty
- D. Judicial review

Answer: B

M
K

99. The doctrine of necessity was first applied in Pakistan in the case of:

- A. Maulvi Tamizuddin Khan vs Federation of Pakistan (1954)
- B. Dosso vs PLD 1958
- C. Asma Jilani vs Government of Punjab (1972)
- D. Zafar Ali Shah vs General Pervez Musharraf (2000)

Answer: A

100. Which amendment is known for restoring the parliamentary system and removing the President's power to dissolve the National Assembly?

- A. Thirteenth Amendment
- B. Seventeenth Amendment
- C. Eighteenth Amendment
- D. Twenty-Fifth Amendment

Answer: C

P
R
E
P
A
R
A
T
I
O
N
S

Balochistan: Land, People, and Progress

Balochistan, the westernmost province of Pakistan, occupies a position of profound geographical and strategic importance. Covering an area of **347,190 square kilometers**, it is the largest province of Pakistan, constituting approximately **44 percent** of the country's total landmass. Despite its immense size, it remains the most sparsely populated province, a fact that shapes every aspect of its social and economic development.

International and Provincial Boundaries

The province is bordered by four international and provincial entities:

- **West:** The Islamic Republic of Iran
- **Northwest:** The Islamic Republic of Afghanistan
- **Northeast and East:** Khyber Pakhtunkhwa and Punjab provinces
- **Southeast:** Sindh province
- **South:** The Arabian Sea

Strategic Gateway

Balochistan's location places it at the crossroads of four major regions: the Middle East, Southwest Asia, Central Asia, and South Asia. Chief Minister Sarfraz Bugti has described Balochistan as "Pakistan's gateway to regional and global trade," emphasizing that the province "offers immense investment opportunities and has the potential to become a leading economic hub for the global community".

The province's southern border constitutes approximately two-thirds of Pakistan's national coastline along the Arabian Sea. This coastal frontage, combined with its proximity to the Strait of Hormuz, offers the shortest land route from seaports to Central Asia, making Balochistan an indispensable link in regional and global trade networks.

Administrative Divisions

Balochistan is administratively divided into **eight divisions**, which are further subdivided into **34 districts** and **133 tehsils** (including 47 sub-tehsils). The provincial capital is **Quetta**, a city nestled in the Sulaiman Mountain range near the historically significant Bolan Pass.

Physical Geography and Topography

Four Major Physical Regions

Balochistan's landscape can be divided into four distinct physical regions, each with its own characteristics and human adaptations:

1. The Upper Highlands

The upper highlands occupy the central and northeastern areas of the province. They are bounded by the Sulaiman Range to the east and the Toba Kakar Range to the northwest. This region includes the Zhob-Loralai basin, which forms a trellis-patterned lobe surrounded on all sides by mountain ranges.

2. The Lower Highlands

The lower highlands include the eastern slopes of the Sulaiman Range; the lower ranges of the Makran, Kharan, and Chagai on the west; and the Pab and Kirthar ranges on the southeast. These highland regions are primarily inhabited by nomadic herdsman.

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Challenges

The overall literacy rate in Balochistan is approximately **42 percent**, with female literacy at only **33 percent**. There are large urban-rural disparities independent of sex:

Category	Urban	Rural
Male literacy	65.5%	44.2%
Female literacy	46.5%	26.6%

17 of the 20 most deprived districts of Pakistan are in Balochistan. Girls in rural districts face the longest journeys to high and higher secondary schools.

Recent Initiatives

- **500 scholarships** for youth, including 400 designated for women
- **Two additional classrooms** constructed in 3,000 government schools
- **Balochistan Education Foundation** activated 1,200 schools with Rs2.5 billion
- **AI-based recruitment** introduced for merit-based hiring

Healthcare Sector

Historical Context

At independence, Balochistan had only nine health facilities. Today, the province has approximately 1,500 hospitals, rural health centres, basic health units, and dispensaries.

Current Status

Health Infrastructure

- **2,800+ healthcare workers** recruited
- **4,519 doctors** promoted
- **164 basic health units** revived with Rs2 billion
- Modern trauma center in Quetta operational
- Cancer institute completed
- Satellite telemedicine services launched
- All pharmacies digitized

Health Indicators

Indicator	Rate
Maternal mortality	298 per 100,000 live births
Neonatal mortality	34 per 1,000 live births
Infant mortality	66 per 1,000 live births
Under-five mortality	78 per 1,000 live births
Skilled birth attendance	18%

Immunization

- **No polio case** reported since November 2024
- Vaccination rate increased from **38 percent to 56 percent**

Medicine Availability

Medicine availability increased from **46 percent to 89 percent**. Essential equipment in maternal and child healthcare centers rose from **11 percent to 86 percent**.

Healthcare Budget

The 2025-26 budget allocated **Rs71 billion** for health, with Rs16 billion under PSDP.

Infrastructure Development

Road Network

Historical Progress



In Balochistan, **23.4 percent** of households experienced moderate or severe food insecurity in 2019-2020, which is slightly higher than the average of 16.4 percent for the four provinces.

Governance Reforms

Administrative Improvements

- Government office attendance improved from **45 percent to 82 percent**
- Healthcare facility attendance surpassed **80 percent**
- Decision-making time dropped from **92 days to 13 days**
- Development funds utilization reached **100 percent** (compared to 65 percent previously)

Digital Reforms

The Department of Finance introduced groundbreaking digital reforms:

- **Pension automation**
- **Cashless economy systems**
- **Online billing**
- **Finance Management Information System (FMIS)**
- **Finance GPT**
- **AI-based recruitment** for merit-based hiring

Green Pakistan Initiative

Under the Green Pakistan Initiative, **21,000 acres** of land in South Balochistan are being irrigated through solar tube wells, while **Rs1.9 billion** in loans have been distributed among **513 families**.

Flood Rehabilitation

The Government of Pakistan has completed construction of **5,000 houses** for flood-affected families in Balochistan, with **27,000 more under construction**.

Future Prospects — Balochistan as an Economic Hub

CPEC Phase-II Vision

Balochistan is being positioned as a future hub for regional connectivity, trade, logistics, and investment under CPEC Phase-II. The Ministry of Planning's vision for Balochistan was outlined during the Balochistan Investment Conference 2026, where the province was presented as "a strategic gateway for regional economic integration and sustainable development".

Investment Opportunities

Investment opportunities span multiple sectors:

- **Logistics**
- **Renewable energy**
- **Mining**
- **Fisheries**
- **Agriculture**
- **Transport infrastructure**

Strategic Importance

As Chief Minister Bugti emphasized: "Balochistan, the largest province of Pakistan, covering 44 percent of the country's landmass, is rich in natural resources, holds a strategic location, and offers vast economic potential. It is undoubtedly Pakistan's gateway to regional and global trade".

The Gwadar Factor

Gwadar Port is described as "the cornerstone of the China-Pakistan Economic Corridor (CPEC)". Pakistan could become a **\$40 billion transit economy by 2035** if Gwadar is developed effectively.

The Challenge

Despite its immense potential, Balochistan faces significant challenges. As one analysis observed: "Balochistan remains one of the most underdeveloped provinces. Despite its abundance of natural resources, it continues to lag

behind in terms of development indicators, peace, prosperity, and overall socio-economic progress". What ought to be the country's richest province, at least in per capita terms, remains the poorest.

CONCLUSION

Balochistan presents a study in contrasts. It is Pakistan's largest province by area yet most sparsely populated. It is extraordinarily rich in natural resources yet remains the country's poorest province. It occupies a position of supreme strategic importance yet faces profound development challenges. Its young population offers a demographic dividend, yet educational and health indicators lag behind national averages.

Multiple Choice Questions

1. What is the total area of Balochistan province?

- A) 247,190 square kilometers
- B) 347,190 square kilometers
- C) 447,190 square kilometers
- D) 547,190 square kilometers

Answer: B) 347,190 square kilometers

2. What percentage of Pakistan's total land area does Balochistan cover?

- A) 34%
- B) 44%
- C) 54%
- D) 64%

Answer: B) 44%

3. Which country borders Balochistan to the west?

- A) Afghanistan
- B) India
- C) Iran
- D) China

Answer: C) Iran

4. Which country borders Balochistan to the northwest?

- A) Iran
- B) Afghanistan
- C) India
- D) Turkmenistan

Answer: B) Afghanistan

5. Which body of water lies to the south of Balochistan?

- A) Persian Gulf
- B) Arabian Sea
- C) Indian Ocean
- D) Bay of Bengal

Answer: B) Arabian Sea

6. What is the capital city of Balochistan?

- A) Gwadar
- B) Turbat
- C) Quetta
- D) Kalat

Answer: C) Quetta

7. In which year was Balochistan established as a separate province in its present form?

- A) 1947
- B) 1956
- C) 1970
- D) 1980

Answer: C) 1970

8. Which mountain range bounds the upper highlands of Balochistan to the east?

- A) Himalayan Range
- B) Sulaiman Range
- C) Karakoram Range
- D) Hindu Kush

Answer: B) Sulaiman Range

9. What is the lowest temperature recorded in northern regions of Balochistan?

- A) -10°C
- B) -15°C
- C) -20°C
- D) -25°C

Answer: C) -20°C

10. What is the highest temperature recorded in Pakistan, and where did it occur?

- A) 50°C in Quetta
- B) 53°C in Sibi
- C) 55°C in Turbat
- D) 48°C in Gwadar

Answer: B) 53°C in Sibi

11. Which of the following is NOT one of the four major physical regions of Balochistan?

- A) Upper highlands
- B) Lower highlands
- C) Coastal plains
- D) Deserts

Answer: C) Coastal plains

12. What is the annual precipitation range in Balochistan?

- A) 100-150 mm
- B) 200-350 mm

- A) 5
B) 10
C) 15
D) 20

Answer: C) 15

95. What percentage of households in Balochistan live in mud or temporary structures?

- A) 45%
B) 55%
C) 65%
D) 75%

Answer: C) 65%

96. What is the average household size in Balochistan?

- A) 4.4 members
B) 5.4 members
C) 6.4 members
D) 7.4 members

Answer: C) 6.4 members

97. The Pak-China Friendship Hospital provided free treatment to how many patients in 2025?

- A) 13,000
B) 23,000
C) 33,000

- D) 43,000

Answer: D) 43,000

98. What is Balochistan's Human Development Index (HDI) value?

- A) 0.340
B) 0.444
C) 0.540
D) 0.640

Answer: B) 0.444

99. What percentage of development funds did Balochistan utilize during FY 2025-26?

- A) 85%
B) 95%
C) 105%
D) 115%

Answer: D) 115%

100. Which project has desalinated over 5 million gallons of water per day in Balochistan?

- A) Green Pakistan Initiative
B) Clean Green Gwadar project
C) Pak-China Friendship Hospital
D) Gwadar Free Zone

Answer: B) Clean Green Gwadar project

Personal & Collective Health

Health has evolved over the centuries from a narrow individual concern to a worldwide social goal that encompasses the whole quality of life. The World Health Organization (WHO) defines health not merely as the absence of disease or infirmity, but as "a resource for everyday life, not the objective of living; it is a positive concept, emphasising social and personal resources as well as physical capabilities".

This broader understanding recognizes that health is:

- A **resource** for living a productive and meaningful life
- A **positive concept** encompassing physical, mental, and social well-being
- **Multi-dimensional**, involving not just the body but the mind and social relationships
- Both a **personal responsibility** and a **collective societal goal**

The Two Pillars of Health

Health can be understood through two complementary lenses:

Aspect	Personal Health	Collective (Public/Population) Health
Focus	The individual person	Groups, communities, populations
Scope	Physical, mental, social well-being of a single person	Health outcomes of a group, including distribution within the group
Primary Concern	Personal behaviors, genetic predispositions, immediate environment	Broader social, economic, environmental determinants
Key Question	"What can I do to be healthy?"	"What can we do to make our community healthy?"

Personal Health



Personal health and wellness is an approach that centers the individual and the different actions a person can take to improve their health and the health of their family. The emphasis is on **personal responsibility for health**. It encompasses decisions one makes about their health and aims for the same outcomes as public health: preventing illness, improving physical well-being, and increasing lifespan.

Dimensions of Personal Health

Personal health is multi-dimensional and includes:

1. Physical Health

- Nutrition and diet
- Physical activity and exercise
- Sleep and rest
- Avoidance of harmful substances
- Regular medical check-ups

2. Mental and Emotional Health

- Stress management
- Emotional regulation
- Mental resilience
- Seeking help when needed

3. Social Health

- Building and maintaining relationships
- Social support networks
- Community engagement

4. Spiritual Health

- Sense of purpose and meaning
- Values and beliefs
- Inner peace and harmony

Personal Health Activities

Examples of personal health activities include:

- Choosing salad instead of french fries
- Increasing variety in one's diet
- Going for a walk or engaging in physical activity
- Dancing with friends or playing a sport
- Getting enough sleep
- Practicing meditation or stress reduction techniques
- Brushing and flossing teeth
- Reading aloud to children
- Selecting preferred form of contraception

The Limits of Personal Health

While personal responsibility is crucial, individual health is **heavily influenced** by genetics, personal beliefs, knowledge, and behaviors. However, a person's health is also shaped by factors beyond their control — the environment they live in, the food available to them, the safety of their community, and access to healthcare. This is where collective health becomes essential.

Collective Health

Public health is the science and art of preventing disease, prolonging life, and promoting health through the organized efforts of society. While personal health services focus on the individual, public health focuses on population needs.



- Discrimination and social exclusion

4. Health and Healthcare

- Access to healthcare services
- Health literacy
- Quality of care

5. Neighborhood and Built Environment

- Access to healthy food
- Quality of housing
- Environmental conditions
- Transportation

The Impact of Social Determinants

Research shows that health outcomes are deeply rooted in socioeconomic disparities. Household wealth contributes the largest share (45.6%) to overall health inequality. Approximately 65% of explained health disparity is attributed to household wealth status, maternal education, and geographic region.

HEALTH IN PAKISTAN — CONTEXT AND CHALLENGES

Pakistan's Healthcare Landscape

The Healthcare System

Pakistan has a mixed health system comprising tax-funded free government health services and a robust private sector that includes both for-profit and not-for-profit organizations. However, the healthcare system faces significant challenges.

The Shift from "Sick-Care" to Prevention

Pakistan is fundamentally transforming its healthcare system by shifting from a hospital-dependent "sick-care model" to a comprehensive preventive framework focused on vaccination, clean water, and nationwide digital medical records.

The Health Minister emphasized that "true healthcare begins outside hospital walls, starting with environmental and preventive measures". Due to the lack of a functional healthcare system, hospitals are overburdened with patients.

Key Initiatives

1. National Immunization Program

The program has been extended to include 13 free vaccines. Ensuring every child completes the full vaccination schedule is a priority.

2. National Electronic Medical Record (EMR) System

A major pillar of the new strategy is the launch of a national Electronic Medical Record system, which will create a Universal Medical Record (UMR) for every citizen by linking individual health data to the National Identity Card.

3. Primary Healthcare Focus

Quality primary healthcare is the foundation to improve maternal and child health and nutrition. Pakistan is committed to revitalizing primary healthcare as a cornerstone for achieving Universal Health Coverage.

Challenges

Pakistan's healthcare system faces persistent strain, with a majority of patients paying for treatment out of pocket. The system is far from ideal.

Health in Balochistan — A Province in Crisis

Balochistan, Pakistan's largest province by area with a population of 14.8 million, faces a concerning rise in health challenges exacerbated by socioeconomic challenges, political instability, climate change, and limited access to developmental infrastructure.

Over the past few decades, the region has faced socioeconomic challenges, political instability, an influx of refugees, and restricted access to developmental infrastructure and human resources, contributing to a state of hopelessness.

Health System Constraints

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

The Vision

The future of Pakistan's health system lies in strong primary healthcare. The goal is to move from a hospital-dependent "sick-care model" to a comprehensive preventive framework. This requires:

- **Increased investment:** Healthcare spending should be at least 2% of GDP
- **Systemic reforms:** Strengthening primary healthcare as the cornerstone of the system
- **Collective action:** Government, communities, and individuals working together
- **Sustainability:** Reducing dependence on international donors

Multiple Choice Questions on Personal & Collective Health

1. According to the WHO, health is defined as:

- A) The absence of disease or infirmity
- B) A resource for everyday life, emphasizing social and personal resources as well as physical capabilities
- C) The ability to run a marathon
- D) Freedom from mental illness

Answer: B) A resource for everyday life, emphasizing social and personal resources as well as physical capabilities

2. Which of the following best describes personal health?

- A) Health outcomes of a group of people
- B) The physical, mental, and social well-being of a single person
- C) Health policies affecting entire nations
- D) Environmental health interventions

Answer: B) The physical, mental, and social well-being of a single person

3. Population health focuses on:

- A) Individual medical treatments
- B) The collective well-being of groups and broader social/environmental factors
- C) Only genetic factors
- D) Only infectious diseases

Answer: B) The collective well-being of groups and broader social/environmental factors

4. Which of the following is a characteristic of personal health?

- A) Emphasis on population-level interventions
- B) Focus on personal behaviors, genetic predispositions, and immediate environmental factors
- C) Use of epidemiological studies
- D) Consideration of socioeconomic status across populations

Answer: B) Focus on personal behaviors, genetic predispositions, and immediate environmental factors

5. Public health is best described as:

- A) The treatment of individual patients
- B) The science and art of preventing disease, prolonging life, and promoting health through organized societal efforts
- C) A branch of hospital administration
- D) Only concerned with infectious diseases

Answer: B) The science and art of preventing disease, prolonging life, and promoting health through organized societal efforts

6. Community health involves:

- A) Only clinical treatment
- B) Collective responsibility for promoting health with emphasis on prevention
- C) Individual lifestyle choices only
- D) Hospital-based care exclusively

Answer: B) Collective responsibility for promoting health with emphasis on prevention

7. Which of the following is an example of a personal health activity?

- A) Installing speed bumps to slow traffic
- B) Going for a walk
- C) Monitoring disease rates
- D) Banning smoking indoors

Answer: B) Going for a walk

8. Which of the following is an example of a community/public health activity?

- A) Brushing and flossing teeth
- B) Choosing salad instead of french fries
- C) Health fair
- D) Getting enough sleep

Answer: C) Health fair

9. The relationship between individual and population health is:

- A) Unrelated and separate
- B) Largely relative and dynamic
- C) Static and unchanging



Management Principles

Management is the process of planning, organizing, leading, and controlling the efforts of organization members and of using all other organizational resources to achieve stated organizational goals. It is both an art and a science, requiring a blend of knowledge, skills, and practical experience.

Key Definitions

- **Henri Fayol:** "To manage is to forecast and plan, to organize, to command, to coordinate, and to control."
- **Peter Drucker:** "Management is a multi-purpose organ that manages business, manages managers, and manages workers and work."
- **Mary Parker Follett:** "Management is the art of getting things done through people."

Characteristics of Management

1. Goal-Oriented

Management is directed towards the achievement of predetermined goals. Every activity in management is aimed at reaching specific objectives.

2. Universal Activity

Management is required in all organizations—whether business, government, educational, or religious institutions. The principles of management are applicable everywhere.

3. Continuous Process

Management is an ongoing process that never ends. It involves a series of continuous activities from planning to controlling.

4. Multi-Dimensional

Management involves managing work, people, and operations. It encompasses various functions and activities.

5. Group Activity

Management is concerned with group efforts. It involves coordinating the efforts of multiple individuals working together.

6. Dynamic Function

Management adapts to changing environments. It is flexible and responsive to external and internal changes.

7. Intangible Force

Management cannot be seen but its presence can be felt through the results achieved. It is a force that drives the organization.

Evolution of Management Thought

Classical Approaches

1. Scientific Management (Frederick W. Taylor)

Taylor, known as the "Father of Scientific Management," focused on improving efficiency and productivity through scientific methods.

- **Principles:**
 - Develop a science for each element of work
 - Scientifically select, train, and develop workers
 - Cooperate with workers to ensure work is done according to scientific principles
 - Divide work and responsibility between management and workers

2. Administrative Management (Henri Fayol)

Fayol developed a comprehensive theory of management based on his experience as a mining engineer.

- **Five Functions of Management:** Planning, Organizing, Commanding, Coordinating, Controlling
- **Fourteen Principles of Management:** Division of work, Authority and responsibility, Discipline, Unity of command, Unity of direction, Subordination of individual interest to general interest, Remuneration, Centralization, Scalar chain, Order, Equity, Stability of tenure, Initiative, Esprit de corps



Answer: B) Forecast and plan, organize, command, coordinate, and control

3. Peter Drucker described management as:

- A) A single-purpose organ
- B) A multi-purpose organ that manages business, managers, and workers
- C) A simple process of supervision
- D) A bureaucratic function

Answer: B) A multi-purpose organ that manages business, managers, and workers

4. Which of the following is NOT a characteristic of management?

- A) Goal-oriented
- B) Universal activity
- C) Static process
- D) Continuous process

Answer: C) Static process

5. Management is considered a universal activity because:

- A) It is only applicable in business
- B) It is required in all organizations
- C) It is only applicable in manufacturing
- D) It is only applicable in large corporations

Answer: B) It is required in all organizations

6. Management is described as an intangible force because:

- A) It has no effect on organizations
- B) It cannot be seen but its presence can be felt through results
- C) It is not important
- D) It is only theoretical

Answer: B) It cannot be seen but its presence can be felt through results

7. Which of the following best describes management?

- A) A single function
- B) A multi-dimensional process involving work, people, and operations
- C) A purely technical activity
- D) A financial function only

Answer: B) A multi-dimensional process involving work, people, and operations

8. Management is a dynamic function because:

- A) It remains unchanged over time
- B) It adapts to changing environments
- C) It ignores external changes

D) It follows rigid rules

Answer: B) It adapts to changing environments

9. According to Mary Parker Follett, management is:

- A) A science
- B) The art of getting things done through people
- C) A profession
- D) A mathematical formula

Answer: B) The art of getting things done through people

10. Which of the following is NOT a characteristic of management?

- A) Group activity
- B) Continuous process
- C) Static function
- D) Goal-oriented

Answer: C) Static function

11. Management is necessary because:

- A) Organizations do not need leadership
- B) Resources need to be coordinated to achieve goals
- C) Employees always know what to do
- D) Goals are automatically achieved

Answer: B) Resources need to be coordinated to achieve goals

12. Which statement about management is true?

- A) Management is only needed in large organizations
- B) Management is required in all types of organizations
- C) Management is optional for government organizations
- D) Management is only needed in profit-making organizations

Answer: B) Management is required in all types of organizations

13. Management involves the coordination of:

- A) Only financial resources
- B) Human, physical, and financial resources
- C) Only human resources
- D) Only physical resources

Answer: B) Human, physical, and financial resources

14. The primary goal of management is to:

- A) Maximize profits at any cost
- B) Achieve organizational goals efficiently and effectively
- C) Minimize employee satisfaction
- D) Reduce the workforce

Personal Hygiene for Disease Prevention and a Clean Environment

Personal hygiene refers to the practice of maintaining cleanliness of one's body and clothing to preserve overall health and well-being. It encompasses regularly washing parts of the body and hair with soap and water (including washing hands and feet), grooming nails, facial cleanliness, covering coughs and sneezes, and menstrual hygiene. Hygiene is multi-faceted and comprises many behaviours, including hand- and face washing, menstrual hygiene, and food hygiene. Poor personal hygiene practices can lead to soil-transmitted helminth infections, respiratory diseases, and contribute to malnutrition and other diseases.

Why Personal Hygiene Matters

Personal hygiene is important for several critical reasons:

1. Disease Prevention

Maintaining personal hygiene helps prevent the spread of infectious diseases. Lack of oral hygiene causes oral thrush and dental caries. Poor personal hygiene may cause foul odours and affects appearance.

2. Breaking the Chain of Infection

Good hygiene practices break the chain of infection transmission. Many diseases spread through dirty hands and contaminated surfaces, making clean hands an effective way to stay healthy.

3. Promoting Overall Well-being

Personal hygiene contributes to physical health, mental well-being, and social acceptance. It enables individuals to live healthier and more dignified lives.

Dimensions of Personal Hygiene

1. Hand Hygiene

Hand hygiene is the process of cleaning one's hands to prevent the spread of infectious diseases. Good hand hygiene means washing hands with soap and water or using alcohol-based rubs (hand sanitizer) to keep them germ-free.

2. Body Hygiene

Regular bathing or showering removes dirt, sweat, and dead skin cells. It helps prevent body odour and skin infections.

3. Oral Hygiene

Regular brushing and flossing of teeth prevents dental caries, gum disease, and bad breath. Lack of oral hygiene causes oral thrush and dental caries.

4. Nail Hygiene

Grooming nails properly prevents nail infections and the accumulation of dirt and germs under fingernails.

5. Facial Hygiene

Washing the face regularly prevents the spread of germs and maintains healthy skin.

6. Hair and Scalp Hygiene

A healthy scalp and proper hair care can prevent diseases and control conditions.

7. Menstrual Hygiene

Proper menstrual hygiene management is essential for the health and dignity of women and girls.

How Diseases Spread

Diseases spread through various routes:

1. Direct Contact

Touching an infected person or contaminated surfaces transmits germs.

2. Indirect Contact

Germs survive on surfaces and objects, transferring to hands and then to the body.

3. Respiratory Droplets

Coughing and sneezing release droplets that can be inhaled by others.

4. Faeco-Oral Route

Germs from faeces contaminate food, water, and surfaces, entering the body through the mouth.

Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviours. It encompasses the assessment and control of those environmental factors that can potentially affect health.

Key Components of Environmental Hygiene

1. Water Sanitation

- Access to safe and sufficient water for drinking, personal hygiene, food preparation, laundry, and cleaning
- Prevention of water-borne diseases

2. Waste Management

- Proper disposal of human and solid waste
- Safe disposal of hazardous waste

3. Vector Control

- Destroying breeding areas of mosquitoes, preventing the spread of diseases like malaria
- Control of mammals (such as rats) and arthropods (insects)

4. Pollution Control

- Controlling air, water, and soil pollution
- Reducing environmental health hazards

5. Food Safety

- Ensuring safe food handling and storage
- Preventing food contamination

Environmental Sanitation in Practice

Poor sanitation creates ideal conditions for disease to thrive. Effective environmental sanitation involves:

- Managing waste properly
- Ensuring access to safe water
- Controlling pollution
- Maintaining hygienic conditions in both urban and rural areas

WASH: Water, Sanitation, and Hygiene

The WASH Approach

WASH is a comprehensive approach that integrates water, sanitation, and hygiene interventions. Improving access to WASH infrastructure and practices, such as handwashing and environmental cleaning, is key to reducing the spread of diseases.

Key WASH Interventions

1. Access to Clean Water

Access to clean drinking water is a critical component of any disease prevention strategy.

2. Sanitation Facilities

Providing toilets for patients, staff, and caregivers

3. Hygiene Promotion

- Health education to promote practices that prevent water and sanitation-related diseases
- Inculcating healthy behaviours in future generations

Benefits of WASH

- Reduces diarrheal diseases
- Prevents respiratory infections
- Reduces soil-transmitted helminth infections
- Contributes to reducing malnutrition
- Prevents the spread of antimicrobial resistance

PERSONAL HYGIENE IN BALOCHISTAN: CHALLENGES AND OPPORTUNITIES

- B) Oral hygiene
- C) Financial hygiene
- D) Menstrual hygiene

Answer: C) Financial hygiene

3. According to CDC, personal hygiene includes all of the following EXCEPT:

- A) Regularly washing parts of the body and hair with soap and water
- B) Grooming nails
- C) Investing in stocks
- D) Covering coughs and sneezes

Answer: C) Investing in stocks

4. Hygiene is multi-faceted and comprises many behaviours, including:

- A) Only handwashing
- B) Hand- and face washing, menstrual hygiene, and food hygiene
- C) Only bathing
- D) Only oral care

Answer: B) Hand- and face washing, menstrual hygiene, and food hygiene

5. Lack of personal hygiene can lead to:

- A) Improved health
- B) Soil-transmitted helminth infections, respiratory diseases, and malnutrition
- C) Higher immunity
- D) Better social status

Answer: B) Soil-transmitted helminth infections, respiratory diseases, and malnutrition

6. Poor personal hygiene may cause:

- A) Only dental problems
- B) Oral thrush, dental caries, foul odour, and affect appearance
- C) Only skin problems
- D) Only hair problems

Answer: B) Oral thrush, dental caries, foul odour, and affect appearance

7. Which of the following is a dimension of personal hygiene?

- A) Financial hygiene
- B) Social hygiene
- C) Nail hygiene
- D) Political hygiene

Answer: C) Nail hygiene

8. Good hand hygiene means:

- A) Only using hand sanitizer
- B) Washing hands with soap and water or using

alcohol-based rubs to keep them germ-free

- C) Only rinsing hands with water
- D) Wearing gloves at all times

Answer: B) Washing hands with soap and water or using alcohol-based rubs to keep them germ-free

9. Proper nail hygiene helps prevent:

- A) Only aesthetic problems
- B) Nail infections and accumulation of dirt and germs under fingernails
- C) Only fungal infections
- D) Only bacterial infections

Answer: B) Nail infections and accumulation of dirt and germs under fingernails

10. Facial hygiene involves:

- A) Only using cosmetics
- B) Washing the face regularly to prevent the spread of germs and maintain healthy skin
- C) Only applying sunscreen
- D) Only moisturizing

Answer: B) Washing the face regularly to prevent the spread of germs and maintain healthy skin

11. A healthy scalp and proper hair care can:

- A) Only improve appearance
- B) Prevent diseases and control conditions
- C) Only reduce dandruff
- D) Only promote hair growth

Answer: B) Prevent diseases and control conditions

12. Lack of oral hygiene causes:

- A) Only bad breath
- B) Oral thrush and dental caries
- C) Only gum disease
- D) Only tooth discolouration

Answer: B) Oral thrush and dental caries

13. Personal hygiene enables individuals to:

- A) Only look better
- B) Live healthier and more dignified lives
- C) Only earn more money
- D) Only socialize better

Answer: B) Live healthier and more dignified lives

14. Which of the following is NOT a dimension of personal hygiene?

- A) Hand hygiene
- B) Body hygiene
- C) Environmental hygiene

Prohibition of Physical Touch in Islam and the Exception for Medical Emergencies

A **Mahram** is a person with whom marriage is permanently forbidden due to blood relationship, marriage, or fosterage (breastfeeding). These are unmarriageable kin with whom Islamic law permits a certain degree of interaction and relaxation of the rules of modesty.

Categories of Mahram:

- **Blood relations:** Father, grandfather, son, grandson, brother, paternal uncle, maternal uncle, and their descendants
- **Relations through marriage:** Husband, father-in-law, stepson, son-in-law
- **Foster relations:** Those established through breastfeeding under specific conditions

A Mahram is defined as a **non-marriageable male relative to the woman** - one whom she can never marry under any circumstances.

Definition of Non-Mahram

A **Non-Mahram** is any person of the opposite gender whom one is permitted to marry under Islamic law. A non-Mahram man is **every man who is lawful for a woman to marry**, even if a temporary hindrance to marriage exists.

Examples of Non-Mahram:

- Cousins (paternal and maternal)
- Brothers-in-law (sister's husband, wife's brother)
- Uncles by marriage
- Any unrelated man or woman
- Fiancé(e) - until the marriage contract (Nikah) is completed

Important Note: Even a sister's husband or a maternal/paternal aunt's husband is considered non-Mahram and subject to the same rules of interaction.

THE GENERAL RULE: PROHIBITION OF PHYSICAL TOUCH

The Core Principle

Islam establishes a clear and firm principle: **Intentional physical contact between non-Mahram men and women is not permissible.** This applies to any form of touch, whether handshake, hugging, kissing, or any other physical contact.

Evidence from the Quran

1. The Verse of Contact (Al-Ma'idah 5:6)

Allah says: *"If ye are in a state of ceremonial impurity, bathe your whole body. But if ye are ill, or on a journey, or one of you cometh from offices of nature, or ye have been in contact with women, and ye find no water, then take for yourselves clean sand or earth, and rub therewith your faces and hands."*

Scholars have interpreted "contact with women" (lams) as referring to physical touch, establishing a connection between physical contact and ritual purity.

2. The Verse of the Pledge (Al-Mumtahanah 60:12)

When women came to pledge allegiance to the Prophet Muhammad (peace be upon him), the verse was revealed, and the Prophet accepted their pledge **without any physical contact**—only through words.

Evidence from the Hadith

1. The Strongest Warning

The Prophet Muhammad (peace be upon him) said:

"For one of you to be stabbed in the head with an iron needle is better for him than that he should touch a woman who is not permissible for him."

This hadith, narrated by Ma'qil ibn Yassar and authenticated by Shaykh Al-Albani, demonstrates the severity of this prohibition in Islam.

2. The Prophet's Example

A'ishah (may Allah be pleased with her) reported:

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091



- Touching a female patient or checking her pulse does not break wudu
- If a female doctor is not available, a male doctor may treat a female patient

Shafi'i School

- A physician may look at the patient's body for treatment, but only as much as is needed
- It is a condition that there isn't a man capable of handling the treatment of a man (when a woman is treating a man)
- Wudu breaks by touching a dead body of a person of the opposite sex who is not a mahram

General Consensus

There is a consensus among Islamic jurists that, in cases of necessity, the principle of prohibition is suspended.

Scholarly Opinions

On Male Doctors Treating Female Patients

"One scenario in which it may be necessary for a man to look at a non-Mahram woman is illness. He may need to see certain body-parts of an ill woman for treatment, in fact, he may need to touch her e.g. touching her hand to check her pulse or touching her abdominal area if there is a doubt of internal swelling, or looking at an abscess are permissible in such situations."

On the Extent of Necessity

"The general rule is that looking at or touching private parts is prohibited unless there is a genuine necessity. In such cases, Islam permits looking and touching for the purpose of medical treatment, provided it does not exceed the limits of necessity, as the extent of necessity is determined by its urgency."

On Emergency First Aid

"According to this rule, first aid for the opposite sex is permitted in life-threatening emergency situations, if there are no other helpers around the victim except the opposite sex."

CONCLUSION

Key Principles to Remember

1. **The general rule** is that touching non-Mahram is prohibited
2. **The exception** is genuine medical necessity, including emergency situations
3. **Priority** should be given to same-gender practitioners
4. **Limit** exposure and contact to what is medically necessary
5. **Avoid** seclusion whenever possible
6. **Use barriers** such as gloves when touching patients
7. **Maintain** professional ethics and boundaries at all times
8. **Intention** should be solely for the pleasure of Allah and the benefit of the patient

MULTIPLE CHOICE QUESTIONS

1. What is a Mahram in Islamic terminology?

- A) Any Muslim person
- B) A person with whom marriage is permanently forbidden
- C) A person one is permitted to marry
- D) Any relative

Answer: B) A person with whom marriage is permanently forbidden

2. Which of the following is considered a Mahram?

- A) Paternal cousin
- B) Maternal cousin

C) Brother

D) Brother-in-law

Answer: C) Brother

3. A non-Mahram is defined as:

- A) A person with whom marriage is permanently forbidden
- B) Any person of the opposite gender whom one is permitted to marry
- C) Only strangers
- D) Only non-Muslims

Answer: B) Any person of the opposite gender whom one is permitted to marry



MATHAMETICS



Join Us For All Jobs Preparation



+92 333 2605045 , +92 342 4470091



<https://www.instagram.com/mkpreparations>



<https://youtube.com/@mkpreparations>



<https://www.facebook.com/MkPreparations>



<https://www.tiktok.com/@mkpreparations>



QUADRATIC EQUATIONS

A **Quadratic Equation** is a polynomial equation of the **second degree**. The general form is:

$$ax^2 + bx + c = 0$$

Where:

- a, b, c are constants (real or complex numbers).
- **Crucial Constraint:** $a \neq 0$ (if $a = 0$, the equation becomes linear $bx + c = 0$).
- x is the variable (unknown).

Historical Context: The word "Quadratic" comes from the Latin word "*quadratum*" meaning "square," referring to the x^2 term.

STANDARD FORM AND COMPONENTS

Every quadratic equation must be rearranged into the standard form $ax^2 + bx + c = 0$ before applying most solution techniques.

- a : The **quadratic coefficient** (determines the concavity of the parabola).
- b : The **linear coefficient**.
- c : The **constant term** (y-intercept of the parabola).

Example: $3x^2 - 5x + 2 = 0$ has $a = 3, b = -5, c = 2$.

METHODS OF SOLVING QUADRATIC EQUATIONS

There are **four primary methods** to find the roots (solutions) of a quadratic equation. Each has its specific use-case.

Method 1: Factorization (Splitting the Middle Term)

This is the fastest method but only works when the quadratic can be easily factored over integers.

Algorithm:

1. Multiply a and c to get the product ac .
2. Find two numbers p and q such that:
 - $p \times q = ac$
 - $p + q = b$
3. Rewrite the middle term: $ax^2 + px + qx + c = 0$.
4. Factor by grouping and solve for x .

Example: Solve $x^2 + 5x + 6 = 0$.

$a = 1, c = 6 \Rightarrow ac = 6$. We need $p + q = 5$ and $pq = 6$. The numbers are 2 and 3.

$$x^2 + 2x + 3x + 6 = 0 \Rightarrow x(x + 2) + 3(x + 2) = 0 \Rightarrow (x + 2)(x + 3) = 0.$$

Therefore, $x = -2$ or $x = -3$.

Method 2: Completing the Square

This method is fundamental and is used to derive the quadratic formula. It works for all quadratics.

Algorithm:

1. Ensure $a = 1$. If not, divide the entire equation by a :

$$x^2 + \frac{b}{a}x + \frac{c}{a} = 0.$$
2. Move the constant term to the RHS:

$$x^2 + \frac{b}{a}x = -\frac{c}{a}.$$
3. Add the square of half the coefficient of x to **both sides**:

$$x^2 + \frac{b}{a}x + \left(\frac{b}{2a}\right)^2 = -\frac{c}{a} + \left(\frac{b}{2a}\right)^2.$$
4. The LHS is now a perfect square trinomial:

$$\left(x + \frac{b}{2a}\right)^2 = \frac{b^2 - 4ac}{4a^2}.$$
5. Take the square root of both sides and solve for x .

Example: Solve $2x^2 - 8x - 10 = 0$.

Divide by 2: $x^2 - 4x - 5 = 0$.

Move constant: $x^2 - 4x = 5$.

Half of -4 is -2. Square is 4. Add 4:

Example 20 (Geometry): The length of a rectangle is 3 cm more than its width. If its area is 70 cm², find its dimensions.

Solution:

- Let width = x cm. Length = $x + 3$ cm.
- Area = $x(x + 3) = 70 \Rightarrow x^2 + 3x - 70 = 0$.
- Factor: $(x + 10)(x - 7) = 0 \Rightarrow x = -10$ or $x = 7$.
- Width cannot be negative, so $x = 7$. Length = $7 + 3 = 10$.
- Answer:** Width = 7 cm, Length = 10 cm.

Example 21: The sum of the squares of two consecutive positive even integers is 100. Find the integers.

Solution:

- Let integers be x and $x + 2$.
- Equation: $x^2 + (x + 2)^2 = 100 \Rightarrow x^2 + x^2 + 4x + 4 = 100$.
- $2x^2 + 4x - 96 = 0 \Rightarrow x^2 + 2x - 48 = 0$.
- Factor: $(x + 8)(x - 6) = 0 \Rightarrow x = -8$ or $x = 6$.
- Positive integers: $x = 6$, so $x + 2 = 8$.
- Answer:** 6 and 8.

Practice MCQs

#	Question & Options	Answer	Solution
1	What is the sum of the roots of $2x^2 - 8x + 5 = 0$? A) 4 B) -4 C) $\frac{5}{2}$ D) $-\frac{5}{2}$	A	For $ax^2 + bx + c = 0$, sum of roots = $-\frac{b}{a}$. Here $a = 2, b = -8$. Sum = $-\frac{-8}{2} = 4$.
2	For which k does $x^2 + kx + 16 = 0$ have equal roots? A) ± 4 B) ± 8 C) ± 16 D) ± 2	B	Equal roots $\rightarrow D = 0$. $k^2 - 4(1)(16) = 0 \Rightarrow k^2 = 64$. $k = \pm 8$.
3	The roots of $3x^2 - 5x + 2 = 0$ are: A) $1, \frac{2}{3}$ B) $-1, -\frac{2}{3}$ C) $2, \frac{1}{3}$ D) $-2, -\frac{1}{3}$	A	Factor: $3x^2 - 3x - 2x + 2 = 0$ $3x(x - 1) - 2(x - 1) = 0 \Rightarrow (x - 1)(3x - 2) = 0$. $x = 1$ or $x = \frac{2}{3}$.
4	What is the product of roots of $4x^2 + 3x - 7 = 0$? A) $\frac{3}{4}$ B) $-\frac{3}{4}$ C) $\frac{7}{4}$ D) $-\frac{7}{4}$	D	Product of roots = $\frac{c}{a}$. Here $a = 4, c = -7$. Product = $\frac{-7}{4}$.
5	Which equation has roots 3 and -2? A) $x^2 - x - 6 = 0$ B) $x^2 + x - 6 = 0$ C) $x^2 - x + 6 = 0$ D) $x^2 + x + 6 = 0$	A	Sum = $3 + (-2) = 1$, Product = -6 . Equation: $x^2 - (\text{Sum})x + (\text{Product}) = 0$ $\Rightarrow x^2 - 1x - 6 = 0$.

VARIATIONS

Variation describes the mathematical relationship between two or more variables, showing how a change in one variable affects the other(s).

- The relationship is expressed using a **constant of proportionality** or **constant of variation**, denoted by the letter k (or sometimes c , G , etc.).
- k is always a **non-zero constant** ($k \neq 0$).

TYPES OF VARIATION

Direct Variation

- Definition:** y varies directly as x if y increases when x increases, and decreases when x decreases, in the same ratio.
- Mathematical Form:**

$$y \propto x \Rightarrow y = kx$$

- Equivalent Form:**

$$\frac{y}{x} = k \text{ (The ratio is constant)}$$

- Graphical Property:** Straight line passing through the **origin** (0, 0).
- Sign of k :** If $k > 0$, positive slope; if $k < 0$, negative slope.

Inverse Variation

- Definition:** y varies inversely as x if y increases when x decreases, and vice versa (opposite behavior).
- Mathematical Form:**

$$y \propto \frac{1}{x} \Rightarrow y = \frac{k}{x} \text{ or } xy = k$$

- Equivalent Form:**

$$xy = k \text{ (The product is constant)}$$

- Graphical Property:** Rectangular hyperbola. The curve approaches but never touches the axes (asymptotes at $x = 0$ and $y = 0$).

Direct Variation with Powers (Square, Cube, Roots)

- Varies as the square of x :**

$$y = kx^2$$

- Varies as the cube of x :**

$$y = kx^3$$

- Varies as the square root of x :**

$$y = k\sqrt{x}$$

- Varies as the cube root of x :**

$$y = k\sqrt[3]{x}$$

Rule: Always identify the exact power or root mentioned in the problem statement. Missing a square/cube is a common error.

Joint Variation

- Definition:** A quantity varies **jointly** with two or more variables when it is directly proportional to the product of those variables (all varying directly together).

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 11 |

PARTIAL FRACTIONS

A **rational function** is a function of the form:

$$\frac{P(x)}{Q(x)}$$

where $P(x)$ and $Q(x)$ are polynomials, and $Q(x) \neq 0$.

Partial Fractions is the process of breaking down a single, complicated rational function into a sum of two or more simpler rational functions (called "partial fractions").

- It is the **reverse** process of adding or subtracting algebraic fractions.
- Example of reverse:**
 - Adding: $\frac{1}{x+1} + \frac{2}{x-3} = \frac{3x-1}{(x+1)(x-3)}$ (Going *to* a single fraction).
 - Partial Fractions: $\frac{3x-1}{(x+1)(x-3)} = \frac{1}{x+1} + \frac{2}{x-3}$ (Breaking *down*).

PRE-REQUISITE: PROPER vs. IMPROPER FRACTIONS

Before decomposing, you must classify the rational function.

Proper Fraction

- Definition:** The degree of the numerator $P(x)$ is **less than** the degree of the denominator $Q(x)$.
- Example:** $\frac{2x+1}{x^2+3x+2}$ (Degree 1 < Degree 2).
- Action:** You can directly decompose this into partial fractions.

Improper Fraction

- Definition:** The degree of the numerator $P(x)$ is **greater than or equal to** the degree of the denominator $Q(x)$.
- Example:** $\frac{x^3+2x}{x^2-1}$ (Degree 3 > Degree 2).
- Action:** You **MUST** perform polynomial long division first to express it as:

$$\frac{P(x)}{Q(x)} = \text{Quotient} + \frac{\text{Remainder}}{Q(x)}$$

Then, decompose only the new proper fraction (the remainder over the denominator).

FUNDAMENTAL THEOREM OF PARTIAL FRACTIONS

Any proper rational function $\frac{P(x)}{Q(x)}$ can be expressed as a sum of partial fractions, provided that $Q(x)$ can be factorized completely into linear and/or irreducible quadratic factors.

The **form** of the partial fractions depends entirely on the **factors** in the denominator $Q(x)$.

CASE 1: DISTINCT LINEAR FACTORS (Non-Repeating)

Condition:

The denominator $Q(x)$ factors into **distinct** (all different) linear factors.

General Form:

If

$$Q(x) = (a_1x + b_1)(a_2x + b_2) \dots (a_nx + b_n)$$

then:

$$\frac{P(x)}{Q(x)} = \frac{A_1}{a_1x + b_1} + \frac{A_2}{a_2x + b_2} + \dots + \frac{A_n}{a_nx + b_n}$$

where $A_1, A_2, \dots, A_n$ are constants to be determined.

Example Structure:

$$\frac{3x + 1}{(x + 2)(x - 3)} = \frac{A}{x + 2} + \frac{B}{x - 3}$$

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 21 |

$$x^2: A + B + 2C + D$$

$$x^1: A + C + 2D$$

$$\text{Constant: } A + B + D$$

- Equate with $2x^2 + 7x + 3$:
 - (1) $A + C = 0$
 - (2) $A + B + 2C + D = 2$
 - (3) $A + C + 2D = 7$
 - (4) $A + B + D = 3$
- From (1): $C = -A$.
 From (3): $A + (-A) + 2D = 7 \Rightarrow 2D = 7 \Rightarrow D = \frac{7}{2}$.
 From (4): $A + (-1) + \frac{7}{2} = 3 \Rightarrow A + \frac{5}{2} = 3 \Rightarrow A = \frac{1}{2}$.
 Then $C = -\frac{1}{2}$.
 Check (2): $\frac{1}{2} - 1 + 2(-\frac{1}{2}) + \frac{7}{2} = 0.5 - 1 - 1 + 3.5 = 2 \checkmark$.
- Answer:** $\frac{1}{2(x+1)} - \frac{1}{(x+1)^2} + \frac{-\frac{1}{2}x + \frac{7}{2}}{x^2 + 1}$
 OR $\frac{1}{2(x+1)} - \frac{1}{(x+1)^2} + \frac{7-x}{2(x^2+1)}$.

Practice MCQs

#	Question & Options	Answer	Solution
1	For $\frac{5x-1}{(x+2)(x-3)} = \frac{A}{x+2} + \frac{B}{x-3}$, find A. A) $-\frac{11}{5}$ B) $\frac{11}{5}$ C) 1 D) -1	B	$5x - 1 = A(x - 3) + B(x + 2)$. Put $x = -2$: $-11 = A(-5) \Rightarrow A = \frac{11}{5}$.
2	The correct partial fraction form for $\frac{2x+3}{(x-1)(x^2+4)}$ is: A) $\frac{A}{x-1} + \frac{B}{x^2+4}$ B) $\frac{A}{x-1} + \frac{Bx+C}{x^2+4}$ C) $\frac{Ax+B}{x-1} + \frac{C}{x^2+4}$ D) $\frac{A}{x-1} + \frac{B}{x+2} + \frac{C}{x-2}$	B	$x^2 + 4$ is an irreducible quadratic $\rightarrow$ linear numerator $Bx + C$. $x - 1$ is linear $\rightarrow$ constant numerator A .
3	If $\frac{4x+5}{(x-2)^2(x+1)} = \frac{A}{x-2} + \frac{B}{(x-2)^2} + \frac{C}{x+1}$, find B. A) $\frac{13}{3}$ B) $\frac{3}{13}$ C) $-\frac{13}{3}$ D) 13	A	$4x + 5 = A(x - 2)(x + 1) + B(x + 1) + C(x - 2)^2$. Put $x = 2$: $13 = B(3) \Rightarrow B = \frac{13}{3}$.
4	The partial fraction form for $\frac{x^2+1}{(x^2+x+1)^2}$ is: A) $\frac{A}{x^2+x+1} + \frac{B}{(x^2+x+1)^2}$	B	Repeated irreducible quadratic $\rightarrow$ each power gets a linear numerator.

SETS

A **Set** is a well-defined collection of distinct objects, considered as an object in its own right.

- The objects in a set are called **elements** or **members**.
- The term "**well-defined**" means that given any object, it must be possible to determine whether it belongs to the set or not (no ambiguity).

Examples:

- Set of all vowels in the English alphabet: $\{a, e, i, o, u\}$
- Set of prime numbers less than 10: $\{2, 3, 5, 7\}$

History: The modern theory of sets was developed by the German mathematician **Georg Cantor** in the late 19th century.

REPRESENTATION OF SETS

There are three common ways to represent a set:

Descriptive Form (Statement Form)

The set is described in words.

Example: A = Set of all even natural numbers.

Roster Form (Tabular or Listing Form)

All elements are listed within curly braces $\{ \}$, separated by commas.

Example: $A = \{2, 4, 6, 8, 10\}$

Rules for Roster Form:

- Elements are usually listed once (no repetition).
- Order of elements does not matter: $\{1, 2, 3\} = \{3, 2, 1\}$.
- An ellipsis ... is used to indicate a continuing pattern: $\{1, 2, 3, \dots, 100\}$.

Set-Builder Form (Rule Method)

A set is defined by a rule or condition that its elements must satisfy.

General Format:

$$A = \{x : \text{condition on } x\}$$

(Read as: "The set of all x such that the condition holds.")

Example: $A = \{x \mid x \in \mathbb{N}, 1 \leq x \leq 10\}$ represents $\{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$.

STANDARD NOTATIONS

Symbol	Meaning
$\in$	"Belongs to" (is an element of)
$\notin$	"Does not belong to"
$\{ \}$ or $\emptyset$	Empty set / Null set
$\mathbb{N}$	Set of all Natural numbers $\{1, 2, 3, \dots\}$
$\mathbb{W}$	Set of all Whole numbers $\{0, 1, 2, 3, \dots\}$
$\mathbb{Z}$ or $\mathbb{I}$	Set of all Integers $\{\dots, -2, -1, 0, 1, 2, \dots\}$
$\mathbb{Q}$	Set of all Rational numbers (fractions/decimals that terminate or repeat)
$\mathbb{R}$	Set of all Real numbers
$\mathbb{C}$	Set of all Complex numbers
$\mathbb{Z}^+ / \mathbb{Q}^+$	Positive integers / rationals
$ $ or $:$	"Such that" (used in set-builder notation)

TYPES OF SETS

Empty Set (Null Set / Void Set)

- A set that contains **no** elements.
- Denoted by $\emptyset$ or $\{ \}$.
- Example:** $A = \{x \mid x \text{ is a natural number less than } 1\} = \emptyset$.

Singleton Set (Unit Set)

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 33 |

#	Question & Options	Answer	Solution
1	Write the set of distinct letters in the word "MISSISSIPPI" in roster form. A) {M, I, S, P} B) {M, I, S, S, I, S, S, I, P, P, I} C) {M, I, S, P, I} D) {M, S, P}	A	The letters in "MISSISSIPPI" are M, I, S, S, I, S, S, I, P, P, I. Removing duplicates (distinct letters): M, I, S, P. Correct roster form: {M, I, S, P}.
2	The set-builder form of $A = \{2, 3, 5, 7\}$ is: A) $\{x \mid x \text{ is a prime number less than } 8\}$ B) $\{x \mid x \text{ is a composite number less than } 10\}$ C) $\{x \mid x \text{ is an even prime number}\}$ D) $\{x \mid x \text{ is a natural number less than } 8\}$	A	2, 3, 5, 7 are all prime numbers less than 8. (A) correctly describes the set. (D) would include 1, 4, 6 as well, so incorrect.
3	Which of the following is an empty set? A) $\{x \mid x \text{ is a vowel in the word "RYTHM"}\}$ B) $\{x \mid x \text{ is a natural number less than } 1\}$ C) $\{x \mid x \text{ is a prime number between } 1 \text{ and } 3\}$ D) Both A and B	D	(A) "RYTHM" has no vowels (A, E, I, O, U) $\rightarrow$ empty set. (B) Natural numbers start at 1, so numbers less than 1 $\rightarrow$ none $\rightarrow$ empty set. (C) Prime numbers between 1 and 3 is $\{2\} \rightarrow$ not empty. So both A and B are empty sets.
4	The set $A = \{x \mid x \in \mathbb{Z}, x^2 - 6x + 9 = 0\}$ is: A) Empty set B) Singleton set C) Infinite set D) Finite set with 2 elements	B	Solve $x^2 - 6x + 9 = 0 \Rightarrow (x - 3)^2 = 0 \Rightarrow x = 3$. The set is $\{3\}$, containing exactly one element $\rightarrow$ singleton set.
5	If $A = \{1, 2, 3, 4\}$ and $B = \{x \mid x \in \mathbb{N}, x^2 < 20\}$, then: A) $A = B$ B) $A \sim B$ C) $A \subset B$ D) $B \subset A$	A	$B = \{1, 2, 3, 4\}$ because squares of 1, 2, 3, 4 are < 20 . So $A = B$.
6	If $n(A) = 4$, the total number of subsets of A is: A) 4 B) 8 C) 16 D) 32	C	Total number of subsets $= 2^{n(A)} = 2^4 = 16$.
7	If $n(A) = 6$, the number of proper subsets of A is: A) 64 B) 63 C) 62 D) 32	B	Proper subsets = total subsets - 1 (excluding the set itself). $2^6 - 1 = 64 - 1 = 63$.
8	Given $A = \{1, 2, 3, 4\}$ and $B = \{3, 4, 5, 6\}$, find $A \cup B$ and $A \cap B$. A) $\{1, 2, 3, 4, 5, 6\}$ and $\{3, 4\}$ B) $\{1, 2, 5, 6\}$ and $\{3, 4\}$ C) $\{1, 2, 3, 4, 5, 6\}$ and $\{1, 2, 5, 6\}$ D) $\{3, 4\}$ and $\{1, 2, 3, 4, 5, 6\}$	A	Union = all elements in A or B = $\{1, 2, 3, 4, 5, 6\}$. Intersection = common elements = $\{3, 4\}$.



FUNCTIONS

A **function** is a special type of relation between two sets, where each element of the first set (input) is assigned to **exactly one** element of the second set (output).

- A function is often described as a **rule** or **mapping** that takes an input and produces a unique output.
- The key characteristic: **Every input has exactly one output.**
- If a relation violates this rule (e.g., one input maps to two different outputs), it is **not** a function.

Historical Context: The modern concept of a function was formalized by mathematicians like **Leibniz** and **Euler** in the 17th–18th centuries. The notation $f(x)$ was introduced by Euler.

STANDARD NOTATION

- A function is typically denoted by a letter such as f, g, h, F , etc.
- If f is a function from set A to set B , we write:

$$f: A \rightarrow B$$

(Read as: " f maps A into B " or " f is a function from A to B ").

- The value of f at a specific input x is written as:

$$f(x)$$

(Read as: " f of x ").

- **Example:** If $f(x) = 2x + 3$, then $f(2) = 2(2) + 3 = 7$.

KEY TERMINOLOGY

Domain (Input Set)

The set of all possible input values for which the function is defined.

- Denoted by $\text{Domain}(f)$ or simply D_f .
- For real-valued functions, the domain is often all real numbers $\mathbb{R}$, except values that cause division by zero, negative square roots, or logarithms of non-positive numbers.

Codomain (Potential Output Set)

The set that contains all possible output values that the function *could* produce.

- Denoted by $\text{Codomain}(f)$.
- It is the target set B in the notation $f: A \rightarrow B$.
- **Note:** The codomain is not necessarily equal to the actual set of outputs; it is the *intended* set.

Range (Actual Output Set)

The set of all actual output values that the function *does* produce.

- Denoted by $\text{Range}(f)$ or $f(A)$.
- The range is always a **subset** of the codomain ($\text{Range} \subseteq \text{Codomain}$).

Distinction:

- Codomain = "All possible y-values I declare"
- Range = "All actual y-values I get"

Example: For $f(x) = x^2$ with $f: \mathbb{R} \rightarrow \mathbb{R}$:

- Domain = $\mathbb{R}$ (all real numbers).
- Codomain = $\mathbb{R}$ (all real numbers, as declared).
- Range = $[0, \infty)$ (only non-negative numbers are produced).

REPRESENTATION OF FUNCTIONS

Functions can be represented in four primary ways:

Algebraically (Formula)

Using an equation like $f(x) = 3x - 5$.

Tabular Form (Table of Values)

Using a table of x and y values.

x	$y = f(x)$
-----	------------

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 43 |

	A) One-to-one B) Onto C) Both one-to-one and onto (bijective) D) Many-to-one		
14	Which function is even? A) $f(x) = x^3 + x$ B) $f(x) = x^4 + x^2$ C) $f(x) = x^2 + x$ D) $f(x) = x^3 - x$	B	$f(-x) = (-x)^4 + (-x)^2 = x^4 + x^2 = f(x)$. So $f(x) = x^4 + x^2$ is even. (A) and (D) are odd; (C) is neither.
15	Which function is odd? A) $f(x) = x^2$ B) $f(x) = x^3$ C) $f(x) = x^4$ D) $f(x) = x^2 + 1$	B	$f(-x) = (-x)^3 = -x^3 = -f(x)$. So $f(x) = x^3$ is odd.
16	Evaluate the piecewise function: $f(x) = \begin{cases} x^2 & \text{if } x < 1 \\ 2x + 1 & \text{if } x \geq 1 \end{cases}$ Find $f(0)$ and $f(3)$. A) 0 and 7 B) 0 and 1 C) 1 and 7 D) 0 and 6	A	For $x = 0 (< 1)$: $f(0) = 0^2 = 0$. For $x = 3 (\geq 1)$: $f(3) = 2(3) + 1 = 7$.
17	If $f(x) = x^2$ is shifted 4 units right and 2 units up, the new function is: A) $g(x) = (x + 4)^2 + 2$ B) $g(x) = (x - 4)^2 + 2$ C) $g(x) = (x + 4)^2 - 2$ D) $g(x) = (x - 4)^2 - 2$	B	Right shift: replace x with $(x - 4)$. Up shift: add 2. So $g(x) = (x - 4)^2 + 2$.
18	The graph of $y = -f(x)$ is a reflection of $y = f(x)$ across: A) The y-axis B) The x-axis C) The origin D) The line $y = x$	B	$y = -f(x)$ reflects the graph across the x-axis. $y = f(-x)$ reflects across the y-axis.
19	If $f(x) = \sqrt{x}$, what is the domain of f? A) All real numbers B) $[0, \infty)$ C) $(-\infty, 0]$ D) $\mathbb{R} \setminus \{0\}$	B	The square root is defined only for non-negative values. So $x \geq 0$. Domain = $[0, \infty)$.
20	The cost to produce x items is $C(x) = 30x + 100$. What is the cost to produce 8 items? A) 240 B) 340 C) 300 D) 400	B	$C(8) = 30(8) + 100 = 240 + 100 = 340$.

BASIC STATISTICS

Statistics is the branch of mathematics that deals with the **collection, organization, analysis, interpretation, and presentation** of data.

- The word "Statistics" comes from the Latin word "*status*" meaning "state" or "condition."
- Statistics helps us make sense of large amounts of numerical information.
- It is used extensively in economics, business, psychology, medicine, engineering, and social sciences.

Two Main Branches:

1. **Descriptive Statistics:** Methods for organizing, summarizing, and presenting data in an informative way (e.g., averages, graphs, tables).
2. **Inferential Statistics:** Methods for drawing conclusions or making predictions about a population based on a sample of data.

KEY TERMINOLOGY

Population

- The **entire** group of individuals, items, or data points that we are interested in studying.
- **Example:** All students in a country, all voters in an election, all light bulbs produced by a factory.

Sample

- A **subset** of the population that is selected for study.
- Sampling is done because studying the entire population is often impractical, time-consuming, or expensive.
- **Example:** 500 students selected from all students in a country.

Variable

- A characteristic or attribute that can take on different values.
- **Types of Variables:**
 - **Quantitative (Numerical):** Can be measured numerically (e.g., height, weight, age, income).
 - *Discrete:* Takes only specific values (e.g., number of children, shoe size).
 - *Continuous:* Can take any value within a range (e.g., height, temperature, time).
 - **Qualitative (Categorical):** Describes an attribute or category (e.g., gender, eye color, marital status, favorite subject).

Data

- The actual values or observations collected for a variable.
- **Raw Data:** Data in its original, unorganized form.
- **Array:** Data arranged in ascending or descending order.

Frequency

- The number of times a particular value or category occurs in a dataset.

FREQUENCY DISTRIBUTION

A **frequency distribution** is a table that organizes data by showing the frequency (count) of each value or class interval.

Ungrouped Frequency Distribution

- Used for discrete data with few distinct values.
- Lists each individual value and its frequency.

Example:

Value (x)	Frequency (f)
1	3
2	5
3	4
4	2

Grouped Frequency Distribution

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 52 |

- **Answer:** Bimodal – Mode = 3 and 5.

Example 12: Find the mode of the data: 4, 6, 8, 10, 12.

Solution:

- All values occur exactly once.
- **Answer:** No mode.

Example 13: Find the mode for the grouped data in Example 3.

Solution:

- Highest frequency is 12 in the class **30 – 33** (modal class).
- $L = 29.5$ (lower boundary of modal class).
- $f_1 = 12$ (frequency of modal class).
- $f_0 = 9$ (frequency of class before modal class).
- $f_2 = 5$ (frequency of class after modal class).
- $h = 4$.

$$\begin{aligned}\text{Mode} &= L + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h = 29.5 + \left(\frac{12 - 9}{24 - 9 - 5} \right) \times 4 \\ &= 29.5 + \left(\frac{3}{10} \right) \times 4 = 29.5 + 1.2 = 30.7.\end{aligned}$$

- **Answer:** 30.7 years.

Example 14: Find the range of the data: 15, 22, 18, 30, 25, 12, 28.

Solution:

- Maximum = 30, Minimum = 12.
- Range = 30 – 12 = 18.
- **Answer:** 18.

Example 15: Find the variance and standard deviation for the data: 2, 4, 6, 8, 10.

Solution:

- Mean $\bar{x} = \frac{2+4+6+8+10}{5} = \frac{30}{5} = 6$.
- Deviations from mean:

x	$x - \bar{x}$	$(x - \bar{x})^2$
2	-4	16
4	-2	4
6	0	0
8	2	4
10	4	16
Sum		$\Sigma(x - \bar{x})^2 = 40$

- Variance $\sigma^2 = \frac{40}{5} = 8$.
- Standard Deviation $\sigma = \sqrt{8} = 2.828$.
- **Answer:** Variance = 8, Standard Deviation = 2.828.

Example 16: Using the frequency distribution from Example 3, calculate the variance and standard deviation.

Solution:

- Mean $\bar{x} = 29.9$ (from Example 6).

Class Interval	f	x	$x - \bar{x}$	$(x - \bar{x})^2$	$f(x - \bar{x})^2$
22 – 25	4	23.5	-6.4	40.96	163.84
26 – 29	9	27.5	-2.4	5.76	51.84
30 – 33	12	31.5	1.6	2.56	30.72
34 – 37	5	35.5	5.6	31.36	156.80
Total	30				$\Sigma f(x - \bar{x})^2 = 403.20$

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 60 |

	C) Temperature in Celsius D) Number of children in a family		
2	For the class interval 20 – 29, the class mark (midpoint) is: A) 24.5 B) 25 C) 24 D) 20	A	Class Mark = (Lower Limit + Upper Limit) / 2 = (20 + 29) / 2 = 49 / 2 = 24.5.
3	Find the mean of the dataset: 4, 6, 8, 10, 12. A) 6 B) 8 C) 10 D) 9	B	Sum = 4 + 6 + 8 + 10 + 12 = 40. Number of values $n = 5$. Mean = 40 / 5 = 8.
4	In grouped data, the formula for the mean using the direct method is: A) $\frac{\sum fx}{\sum f}$ B) $\frac{\sum x}{n}$ C) $\frac{\sum fx}{\sum f}$ D) $\frac{\sum f}{\sum x}$	A	In grouped data, f = frequency, x = class mark. Mean = $\frac{\sum fx}{\sum f}$.
5	The mean of 6 numbers is 20. If one of the numbers is 30, what is the mean of the remaining 5 numbers? A) 18 B) 20 C) 22 D) 24	A	Sum of 6 numbers = 20 × 6 = 120. Sum of remaining 5 = 120 – 30 = 90. Mean of remaining 5 = 90 / 5 = 18.
6	Find the median of the dataset: 5, 7, 9, 11, 13. A) 7 B) 9 C) 10 D) 11	B	Data is already sorted. $n = 5$ (odd). Median position = (5 + 1)/2 = 3rd value. 3rd value = 9.
7	Find the median of the dataset: 2, 4, 6, 8, 10, 12. A) 6 B) 7 C) 8 D) 6.5	B	$n = 6$ (even). Median = average of 3rd and 4th values = (6 + 8) / 2 = 7.
8	In the grouped median formula $L + \left(\frac{\frac{n}{2} - cf}{f}\right) \times h$, what does cf represent? A) Frequency of the median class B) Cumulative frequency of the class preceding the median class C) Cumulative frequency of the median class D) Total frequency	B	cf is the cumulative frequency of the class before the median class. It is subtracted from $n/2$ to find the position within the median class.
9	Find the mode of the dataset: 1, 2, 3, 4, 5, 5, 6, 7. A) 5	A	The value 5 appears twice, while all other values appear only once. So the mode is 5.



INTRODUCTION TO TRIGONOMETRY

Trigonometry (from Greek: *trigonon* = triangle, *metron* = measure) is the branch of mathematics that deals with the relationships between the **angles** and **sides** of triangles, particularly right-angled triangles.

- It originated in ancient Greece and India for astronomical calculations.
- Today, it is fundamental in physics, engineering, architecture, navigation, computer graphics, and acoustics.

ANGLES AND THEIR MEASUREMENT

An **angle** is formed by the rotation of a ray from its initial position (initial side) to its final position (terminal side) about a fixed point (vertex).

Units of Angle Measurement

1. Degrees ($^{\circ}$)

- One full rotation around a circle = 360° .
- Subdivisions:
 - $1^{\circ} = 60$ minutes ($60'$)
 - $1' = 60$ seconds ($60''$)

2. Radians (rad)

- One radian is the angle subtended at the center of a circle by an arc whose length is equal to the radius of the circle.
- One full rotation = 2π radians ≈ 6.283 radians.

3. Relationship Between Degrees and Radians

$$360^{\circ} = 2\pi \text{ radians}$$

$$180^{\circ} = \pi \text{ radians}$$

Conversion Formulas:

- To convert degrees to radians: **Multiply by** $\frac{\pi}{180}$.
- To convert radians to degrees: **Multiply by** $\frac{180}{\pi}$.

Standard Conversions:

Degrees	Radians
0°	0
30°	$\frac{\pi}{6}$
45°	$\frac{\pi}{4}$
60°	$\frac{\pi}{3}$
90°	$\frac{\pi}{2}$
180°	π
270°	$\frac{3\pi}{2}$

- Formula: Multiply degrees by $\frac{\pi}{180^\circ}$.
- $75^\circ \times \frac{\pi}{180^\circ} = \frac{75\pi}{180} = \frac{5\pi}{12}$.
- **Answer:** $\frac{5\pi}{12}$ radians.

Example 2: Convert $\frac{5\pi}{6}$ radians to degrees.

Solution:

- Formula: Multiply radians by $\frac{180^\circ}{\pi}$.
- $\frac{5\pi}{6} \times \frac{180^\circ}{\pi} = \frac{5 \times 180}{6} = 150^\circ$.
- **Answer:** 150° .

Example 3: In a right triangle, the side opposite angle θ is 5 cm, and the hypotenuse is 13 cm. Find $\sin \theta$, $\cos \theta$, and $\tan \theta$.

Solution:

- Opposite = 5, Hypotenuse = 13.
- Using Pythagoras to find Adjacent: Adjacent = $\sqrt{13^2 - 5^2} = \sqrt{169 - 25} = \sqrt{144} = 12$.
- $\sin \theta = \frac{\text{Opposite}}{\text{Hypotenuse}} = \frac{5}{13}$.
- $\cos \theta = \frac{\text{Adjacent}}{\text{Hypotenuse}} = \frac{12}{13}$.
- $\tan \theta = \frac{\text{Opposite}}{\text{Adjacent}} = \frac{5}{12}$.
- **Answer:** $\sin \theta = \frac{5}{13}$, $\cos \theta = \frac{12}{13}$, $\tan \theta = \frac{5}{12}$.

Example 4: In a right triangle, $\sin \theta = \frac{3}{5}$. Find $\cos \theta$ and $\tan \theta$.

Solution:

- $\sin \theta = \frac{\text{Opposite}}{\text{Hypotenuse}} = \frac{3}{5}$. So Opposite = 3, Hypotenuse = 5.
- Adjacent = $\sqrt{5^2 - 3^2} = \sqrt{25 - 9} = \sqrt{16} = 4$.
- $\cos \theta = \frac{4}{5}$, $\tan \theta = \frac{3}{4}$.
- **Answer:** $\cos \theta = \frac{4}{5}$, $\tan \theta = \frac{3}{4}$.

Example 5: Evaluate $\sin 60^\circ \cos 30^\circ + \cos 60^\circ \sin 30^\circ$.

Solution:

- $\sin 60^\circ = \frac{\sqrt{3}}{2}$, $\cos 30^\circ = \frac{\sqrt{3}}{2}$, $\cos 60^\circ = \frac{1}{2}$, $\sin 30^\circ = \frac{1}{2}$.
- Expression = $\left(\frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2}\right) + \left(\frac{1}{2} \times \frac{1}{2}\right) = \frac{3}{4} + \frac{1}{4} = 1$.
- **Answer:** 1.

Example 6: Evaluate $\frac{\tan^2 60^\circ - \sin^2 45^\circ}{\cos^2 30^\circ}$.

Solution:

- $\tan 60^\circ = \sqrt{3} \Rightarrow \tan^2 60^\circ = 3$.
- $\sin 45^\circ = \frac{\sqrt{2}}{2} \Rightarrow \sin^2 45^\circ = \frac{2}{4} = \frac{1}{2}$.
- $\cos 30^\circ = \frac{\sqrt{3}}{2} \Rightarrow \cos^2 30^\circ = \frac{3}{4}$.
- Numerator = $3 - \frac{1}{2} = \frac{5}{2}$.
- Divide by denominator: $\frac{5/2}{3/4} = \frac{5}{2} \times \frac{4}{3} = \frac{10}{3}$.
- **Answer:** $\frac{10}{3}$.

Example 7: If $\sin \theta = \frac{3}{5}$, find $\cos \theta$ using the Pythagorean identity.

Solution:

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 69 |

- Let $y = \cos \theta$. Equation becomes $2y^2 - y - 1 = 0$.
- Factor: $(2y + 1)(y - 1) = 0 \Rightarrow y = -\frac{1}{2}$ or $y = 1$.
- Case 1: $\cos \theta = 1 \Rightarrow \theta = 0^\circ$.
- Case 2: $\cos \theta = -\frac{1}{2} \Rightarrow \theta = 120^\circ$ (Quadrant II).
- Answer:** 0° and 120° .

Practice MCQs

#	Question & Options	Answer	Solution
1	Convert 120° to radians. A) $\frac{\pi}{3}$ B) $\frac{2\pi}{3}$ C) $\frac{4\pi}{3}$ D) $\frac{5\pi}{6}$	B	Multiply by $\frac{\pi}{180}$: $120^\circ \times \frac{\pi}{180} = \frac{120\pi}{180} = \frac{2\pi}{3}$.
2	Convert $\frac{3\pi}{4}$ radians to degrees. A) 45° B) 90° C) 135° D) 150°	C	Multiply by $\frac{180^\circ}{\pi}$: $\frac{3\pi}{4} \times \frac{180^\circ}{\pi} = \frac{3 \times 180}{4} = 135^\circ$.
3	In a right triangle, if $\sin \theta = \frac{4}{5}$, find $\cos \theta$. A) $\frac{3}{4}$ B) $\frac{3}{5}$ C) $\frac{4}{3}$ D) $\frac{5}{3}$	B	Opposite = 4, Hypotenuse = 5. Adjacent = $\sqrt{25 - 16} = \sqrt{9} = 3$. $\cos \theta = \frac{3}{5}$.
4	If $\tan \theta = \frac{5}{12}$, find $\sin \theta$ (where θ is acute). A) $\frac{5}{13}$ B) $\frac{12}{13}$ C) $\frac{13}{12}$ D) $\frac{12}{5}$	A	Opposite = 5, Adjacent = 12. Hypotenuse = $\sqrt{5^2 + 12^2} = \sqrt{25 + 144} = \sqrt{169} = 13$. $\sin \theta = \frac{5}{13}$.
5	Evaluate $\sin 30^\circ + \cos 60^\circ$. A) 0 B) $\frac{1}{2}$ C) 1 D) $\frac{3}{2}$	C	$\sin 30^\circ = \frac{1}{2}$, $\cos 60^\circ = \frac{1}{2}$. Sum = $\frac{1}{2} + \frac{1}{2} = 1$.
6	Evaluate $\tan^2 45^\circ + \cos^2 60^\circ$. A) $\frac{5}{4}$ B) $\frac{3}{4}$	A	$\tan 45^\circ = 1 \Rightarrow \tan^2 45^\circ = 1$. $\cos 60^\circ = \frac{1}{2} \Rightarrow \cos^2 60^\circ = \frac{1}{4}$. Sum = $1 + \frac{1}{4} = \frac{5}{4}$.

TANGENTS & ANGLES IN SEGMENTS OF A CIRCLE

A **circle** is a set of all points in a plane that are at a fixed distance (the **radius**) from a fixed point (the **center**). Before diving into tangents and segment angles, let's review the essential parts of a circle:

Term	Definition
Radius	A line segment from the center to any point on the circumference.
Chord	A line segment joining any two points on the circumference.
Diameter	A chord that passes through the center (the longest chord).
Secant	A line that intersects the circle at two distinct points.
Tangent	A line that touches the circle at exactly one point.
Point of Contact	The single point where the tangent touches the circle.
Arc	Any part of the circumference.
Segment	The region bounded by an arc and its corresponding chord.
Major Segment	The larger region bounded by an arc and a chord (contains the center).
Minor Segment	The smaller region bounded by an arc and a chord.
Sector	The region bounded by two radii and an arc.

THE TANGENT TO A CIRCLE

Definition

A **tangent** to a circle is a straight line that intersects (touches) the circle at **exactly one point**, called the **point of contact** (or point of tangency).

Note: A tangent never enters the interior of the circle; it only skims the boundary.

Theorem 1: Tangent-Radius Perpendicularity Theorem

Statement: The tangent at any point of a circle is **perpendicular** to the radius through the point of contact.

Mathematical Form:

If O is the center of the circle, A is the point of contact, and l is the tangent at A , then:

$$OA \perp l$$

Diagrammatic Meaning: The radius to the point of contact and the tangent line form a right angle (90°).

Corollary: At a given point on a circle, only **one** tangent can be drawn.

Theorem 2: Equal Tangents from an External Point

Statement: The lengths of the two tangents drawn from an **external point** to a circle are **equal**.

Mathematical Form:

If P is an external point, and PA and PB are tangents to the circle touching at A and B respectively, then:

$$PA = PB$$

Additional Properties:

- The line joining the external point P to the center O **bisects** the angle between the two tangents ($\angle APO = \angle OPB$).
- The line OP also bisects the angle between the two radii ($\angle AOP = \angle POB$).

ANGLES IN A SEGMENT OF A CIRCLE

Definition of a Segment

A **segment** is the region enclosed by a chord and its corresponding arc.

- Minor Segment:** Formed by the minor arc (smaller part).
- Major Segment:** Formed by the major arc (larger part).

An **angle in a segment** is the angle subtended by a chord at any point on the circumference of that segment.

Theorem 3: Angle in a Semicircle

Statement: The angle subtended by a **diameter** at any point on the circumference is a **right angle** (90°).

MK PREPARATIONS: Let's Make It Happen

+92 333 2605045, +92 342 4470091

Page 75 |

Glossary of Mathematical Definitions

QUADRATIC EQUATIONS

Term	Definition
Quadratic Equation	A polynomial equation of the second degree. General form: $ax^2 + bx + c = 0$, where $a \neq 0$.
Quadratic Coefficient (a)	The coefficient of x^2 in a quadratic equation; determines the concavity of the parabola.
Linear Coefficient (b)	The coefficient of x in a quadratic equation.
Constant Term (c)	The term in a quadratic equation without a variable; represents the y-intercept of the parabola.
Discriminant (D or Δ)	The expression $b^2 - 4ac$ inside the square root of the quadratic formula; determines the nature of roots.
Vertex (Turning Point)	The minimum (if $a > 0$) or maximum (if $a < 0$) point of a parabola.
Axis of Symmetry	A vertical line passing through the vertex of a parabola: $x = -\frac{b}{2a}$.
Roots (Solutions)	The values of x that satisfy the quadratic equation; also called zeros or x-intercepts.
Sum of Roots	For α and β as roots: $\alpha + \beta = -\frac{b}{a}$ (Vieta's formula).
Product of Roots	For α and β as roots: $\alpha \cdot \beta = \frac{c}{a}$ (Vieta's formula).

VARIATIONS

Term	Definition
Variation	A mathematical relationship between two or more variables showing how a change in one variable affects the other(s).
Constant of Variation (k)	A non-zero constant that relates variables in a variation equation.
Direct Variation	y varies directly as x if y increases when x increases, and decreases when x decreases, in the same ratio. Formula: $y = kx$.
Inverse Variation	y varies inversely as x if y increases when x decreases, and vice versa. Formula: $y = \frac{k}{x}$ or $xy = k$.
Joint Variation	A quantity varies jointly with two or more variables when it is directly proportional to the product of those variables. Formula: $y = kxz$.
Combined Variation	A combination of direct, inverse, and/or joint variations in a single equation. Formula: $y = \frac{k \cdot (\text{Direct variables})}{(\text{Inverse variables})}$.
Partial Variation	A quantity consists of two parts: a fixed (constant) part and a varying part. Formula: $y = mx + c$.

PARTIAL FRACTIONS

Term	Definition
Rational Function	A function of the form $\frac{P(x)}{Q(x)}$ where $P(x)$ and $Q(x)$ are polynomials and $Q(x) \neq 0$.
Partial Fractions	The process of breaking down a single, complicated rational function into a sum of two or more simpler rational functions.
Proper Fraction	A rational function where the degree of the numerator $P(x)$ is less than the degree of the denominator $Q(x)$.
Improper Fraction	A rational function where the degree of the numerator $P(x)$ is greater than or equal to the degree of the denominator $Q(x)$.

Self-Assessment Test 1

#	Question & Options	Answer	Explanation
1	What is the sum of the roots of the equation $3x^2 - 12x + 7 = 0$? A) -4 B) 4 C) $7/3$ D) $-7/3$	B	For $ax^2 + bx + c = 0$, sum of roots = $-b/a$. Here $a = 3$, $b = -12$, so sum = $-(-12)/3 = 4$.
2	The discriminant of $4x^2 - 4x + 1 = 0$ is: A) 0 B) 16 C) 32 D) -16	A	$D = b^2 - 4ac = (-4)^2 - 4(4)(1) = 16 - 16 = 0$. This means the roots are real and equal.
3	Which quadratic has complex conjugate roots? A) $x^2 - 4x + 4 = 0$ B) $x^2 - 2x + 5 = 0$ C) $x^2 - 3x + 2 = 0$ D) $2x^2 - 5x + 2 = 0$	B	For $x^2 - 2x + 5 = 0$, $D = 4 - 20 = -16 < 0$, so roots are complex conjugates.
4	If one root of $x^2 - 8x + k = 0$ is 3, find k: A) 5 B) 15 C) 24 D) 11	B	Substitute $x = 3$: $9 - 24 + k = 0 \Rightarrow k = 15$.
5	The vertex of $y = 2x^2 - 8x + 5$ is: A) (2, -3) B) (-2, 13) C) (2, 5) D) (4, -11)	A	$h = -b/(2a) = 8/4 = 2$. $k = f(2) = 8 - 16 + 5 = -3$.
6	For what value of k does $x^2 + kx + 25 = 0$ have equal roots? A) ± 5 B) ± 10 C) ± 25 D) ± 50	B	Equal roots $\Rightarrow D = 0 \Rightarrow k^2 - 100 = 0 \Rightarrow k = \pm 10$.
7	The roots of $2x^2 - 7x + 3 = 0$ are: A) 3, $1/2$ B) -3, $-1/2$ C) 1, $3/2$ D) -1, $-3/2$	A	Factor: $(2x-1)(x-3) = 0 \Rightarrow x = 1/2, 3$.
8	If α and β are roots of $x^2 - 5x + 3 = 0$, find $\alpha^2 + \beta^2$: A) 19 B) 25 C) 31 D) 13	A	$\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta = 25 - 6 = 19$.
9	What is the product of roots of $3x^2 + 2x - 5 = 0$? A) $5/3$ B) $-5/3$ C) $2/3$ D) $-2/3$	B	Product = $c/a = -5/3$.

10	Form a quadratic equation with roots -3 and 2: A) $x^2 - x - 6 = 0$ B) $x^2 + x - 6 = 0$ C) $x^2 - x + 6 = 0$ D) $x^2 + x + 6 = 0$	B	Sum = -1, Product = -6 $\Rightarrow x^2 - (-1)x + (-6) = x^2 + x - 6 = 0$.
11	Solve: $2x^2 - 5x - 3 \leq 0$ A) $-1/2 \leq x \leq 3$ B) $-3 \leq x \leq 1/2$ C) $x \leq -1/2$ or $x \geq 3$ D) $x \leq -3$ or $x \geq 1/2$	A	Roots: $(2x+1)(x-3) = 0 \Rightarrow x = -1/2, 3$. $a > 0$, ≤ 0 between roots $\Rightarrow -1/2 \leq x \leq 3$.
12	If y varies inversely as the square root of x, and y = 6 when x = 4, find y when x = 16: A) 3 B) 6 C) 12 D) 24	A	$y = k/\sqrt{x} \Rightarrow 6 = k/2 \Rightarrow k = 12$. $y = 12/4 = 3$.
13	Which graph represents an inverse variation? A) Straight line through origin B) Straight line not through origin C) Rectangular hyperbola D) Parabola	C	Inverse variation $y = k/x$ produces a rectangular hyperbola.
14	If y varies directly as x^2 and inversely as z, and y = 12 when x = 2, z = 3, find y when x = 4, z = 6: A) 12 B) 16 C) 24 D) 32	C	$y = kx^2/z \Rightarrow 12 = k(4)/3 \Rightarrow k = 9$. $y = 9(16)/6 = 24$.
15	In partial variation $y = mx + c$, the constant part is: A) m B) x C) c D) mx	C	c is the fixed/constant part; mx is the varying part.
16	The partial fraction decomposition of $(3x+5)/(x+1)(x-2)$ gives: A) $A = 2/3$, $B = 11/3$ B) $A = 2/3$, $B = -7/3$ C) $A = -2/3$, $B = 7/3$ D) $A = -2/3$, $B = -7/3$	A	$3x+5 = A(x-2) + B(x+1)$. $x=-1$: $2 = A(-3) \Rightarrow A = -2/3$. $x=2$: $11 = B(3) \Rightarrow B = 11/3$.
17	For repeated factor $(x+1)^3$, the partial fraction form includes: A) 1 term B) 2 terms C) 3 terms D) 4 terms	C	For $(ax+b)^n$, include n terms: $A/(x+1) + B/(x+1)^2 + C/(x+1)^3$.
18	For an irreducible quadratic factor, the numerator must be: A) Constant B) Linear	B	Irreducible quadratic ax^2+bx+c requires linear numerator $Ax+B$.

18	When decomposing an improper rational function, the first step is: A) Factorization B) Long division C) Setting up partial fractions D) Substitution	B	Improper means numerator degree $\geq$ denominator degree $\Rightarrow$ long division first.
19	If $A = \{1,2,3,4,5\}$ and $B = \{2,4,6,8\}$, find $A - B$: A) $\{1,3,5\}$ B) $\{2,4\}$ C) $\{6,8\}$ D) $\{1,2,3,4,5,6,8\}$	A	$A - B$ = elements in A not in B = $\{1,3,5\}$.
20	If $n(A) = 18$, $n(B) = 14$, and $n(A \cap B) = 6$, find $n(A \cup B)$: A) 20 B) 26 C) 32 D) 38	B	$n(A \cup B) = 18 + 14 - 6 = 26$.
21	The number of subsets of a set with 4 elements that contain the element 1 is: A) 4 B) 8 C) 16 D) 2	B	Fix 1 in subset, remaining 3 elements can be included or not: $2^3 = 8$.
22	If $A = \{x x \text{ is a vowel}\}$ and $B = \{x x \text{ is a letter in 'APPLE'}\}$, then $A \cap B =$: A) $\{A\}$ B) $\{A, E\}$ C) $\{A, P, L, E\}$ D) $\{A, P, L, E\}$	B	Vowels = $\{A, E, I, O, U\}$. Letters in APPLE = $\{A, P, L, E\}$. Intersection = $\{A, E\}$.
23	If $n(A \times B) = 20$ and $n(A) = 4$, find $n(B)$: A) 4 B) 5 C) 16 D) 80	B	$n(A \times B) = n(A) \times n(B) \Rightarrow 20 = 4 \times n(B) \Rightarrow n(B) = 5$.
24	The power set of $\{1,2,3\}$ has how many elements? A) 3 B) 6 C) 8 D) 9	C	Power set has $2^3 = 8$ elements.
25	Which relation is a function from $\{a,b,c\}$ to $\{1,2\}$? A) $\{(a,1),(b,2),(c,1)\}$ B) $\{(a,1),(a,2),(b,1)\}$ C) $\{(a,1),(b,1),(b,2)\}$ D) $\{(a,1),(b,2),(c,1),(c,2)\}$	A	Each input maps to exactly one output.
26	The range of $f(x) = -x^2 + 4$ is: A) $(-\infty, 4]$ B) $(-\infty, -4]$ C) $[4, \infty)$ D) $[-4, \infty)$	A	Maximum value is 4 (at $x=0$), range = $(-\infty, 4]$.