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EDITION!**

# FPSC



# LECTURER CHEMISTRY

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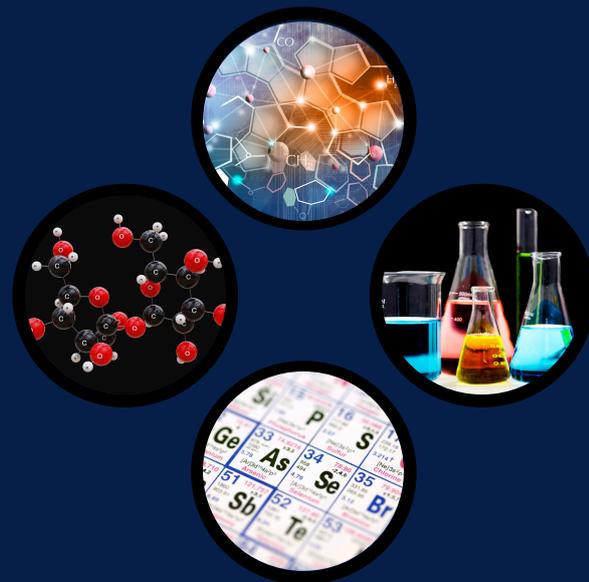
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- Electronic Structure
- Chemical Kinetics & Radioactivity
- Reaction, Mechanism (electrophilic & nucleophilic substitution & addition reaction)
- Inorganic Chemistry
- Thermodynamics
- Synthetic & Polymer Chemistry
- Chemical Bonding
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- Organic Chemistry by Jerry M.
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## Table Of Content

### Part 1: CHEMISTRY

- States of Matter (Gases)
- States of Matter (Liquids and Solids)
- Atomic Structure
- Chemical Bonding
- Chemical Kinetics
- Electrochemistry
- Thermochemistry
- Radio and Nuclear Chemistry
- Biochemistry
- Aromatic Compounds (Benzene)
- Carbonyl Compounds
- Haloalkanes & SN Reaction
- Industrial Chemistry and Synthetic Polymer
- Periodic classification of elements and Atomic Structure
- s & p- Block Elements
- Transition Elements and Coordination Chemistry

### Part 2: ENGLISH

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

### Part 3: PEDAGOGY

- Teaching Techniques and Methodologies
- Classroom Management and Discipline
- Testing, Measurement, Assessment and Evaluation
- Taxonomies of Education



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# **PART I: CHEMISTRY**

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## Chapter 1

# The Gaseous State

## Introduction to States of Matter

Matter exists primarily in four states: **Solid, Liquid, Gas, and Plasma.**

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**Solids:** Have a definite shape and volume. Particles are tightly packed in a fixed, orderly arrangement and can only vibrate.

**Liquids:** Have a definite volume but no definite shape; they take the shape of their container. Particles are close together but can move past one another (flow).

**Gases:** Have no definite shape or volume. They expand spontaneously to fill their container. Particles are far apart, move rapidly and randomly, and have high kinetic energy.

**Plasma:** A fourth state of matter consisting of an ionized gas with positive ions and free electrons. It is macroscopically neutral and responds strongly to electromagnetic fields

### Example of plasma

(Stars, neon signs).

The gaseous state is the simplest to study and model mathematically due to the minimal intermolecular forces and large separations between molecules.

## General Properties and Characteristics of Gases

Gases exhibit unique properties due to the large spaces between their molecules and their high kinetic energy.

**Expansibility:** Gases expand indefinitely to fill the entire volume of their container.

**Compressibility:** Gases can be easily compressed into a smaller volume by applying pressure due to the large amount of space between molecules (e.g., LPG, CNG).

**Diffusibility:** Gases mix spontaneously and rapidly with each other to form a homogeneous mixture.

**Diffusion:** The spontaneous intermingling and mixing of gas molecules (e.g., the smell of perfume spreading in a room).

1. The Gaseous State



**Effusion:** The process by which gas molecules escape from a container through a tiny hole or porous plug into a vacuum or region of lower pressure without collisions.

**Exertion of Pressure:** Gas molecules constantly collide with the walls of their container, exerting pressure. This pressure is due to the force of these numerous collisions per unit area and is exerted uniformly in all directions.

**Low Density:** Densities are much lower than those of liquids and solids because molecules are widely spaced.

### Parameters (State Variables) of a Gas

A gas sample is completely described by four measurable properties:

#### Pressure (P):

The force exerted by gas molecules per unit area of the container wall.

**SI Unit:** Pascal (Pa).

**Common Units:** atmosphere (atm), millimeter of mercury (mm Hg), torr, bar.

**Relations:**  $1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr} = 1.013 \times 10^5 \text{ Pa} = 1.013 \text{ bar}$ .

**Measurement:** **Manometer** (for gas samples), **Barometer** (for atmospheric pressure).

#### Volume (V)

The volume of the gas is the volume of its container.

**SI Unit:** Cubic meter ( $\text{m}^3$ ).

**Common Units:** Liter (L), milliliter (mL), cubic decimeter ( $\text{dm}^3$ ).

**Relation:**  $1 \text{ L} = 1 \text{ dm}^3 = 1000 \text{ mL} = 10^{-3} \text{ m}^3$ .

**Temperature (T):** A measure of the average kinetic energy of the gas molecules.

**SI Unit:** Kelvin (K). **Always used in gas law calculations.**

**Common Unit:** Degrees Celsius ( $^{\circ}\text{C}$ ).

**Conversion:**  $\text{K} = ^{\circ}\text{C} + 273.15$

**Amount (n):** The quantity of gas, expressed in moles.

**Calculation:**  $n = \text{mass of gas (m)} / \text{Molar mass (M)}$

### The Gas Laws

These are experimental relationships between the parameters of a fixed mass of gas.

#### Boyle's Law (Pressure-Volume Relationship)

**Statement:** For a fixed amount of gas at constant temperature, the volume of the gas is inversely proportional to its pressure.

**Mathematical Expression:**  $V \propto 1/P$  (constant n, T) or  $PV = k$  or  $P_1V_1 = P_2V_2$

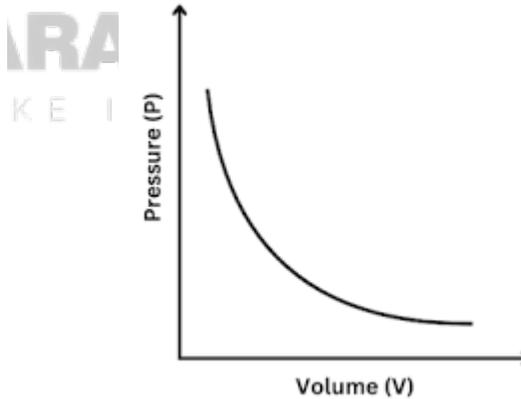
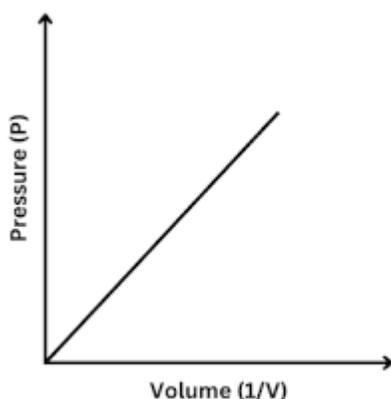
**Explanation (KMT):** At constant temperature, the average kinetic energy is constant. Increasing pressure (by decreasing volume) means molecules hit the walls more frequently, thus pressure increases.

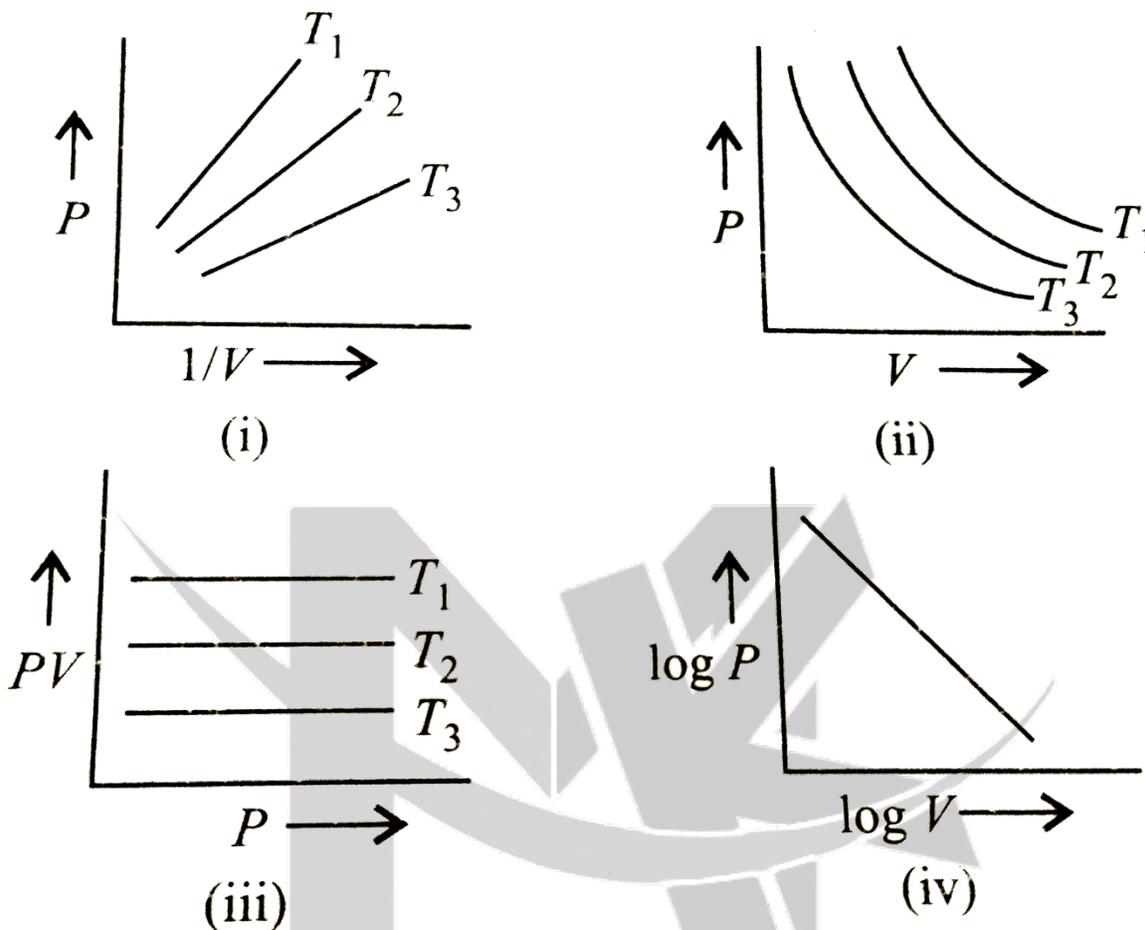
#### Graphical Representation:

A plot of **P vs. V** is a hyperbola called an **isotherm**.

A plot of **P vs. 1/V** is a straight line through the origin.

A plot of **PV vs. P** is a straight line parallel to the P-axis.





### Charles's Law (Volume-Temperature Relationship)

**Statement:** For a fixed amount of gas at constant pressure, the volume of the gas is directly proportional to its absolute temperature (Kelvin).

**Mathematical Expression:**  $V \propto T$  (constant n, P) or  $V/T = k$  or  $V_1/T_1 = V_2/T_2$

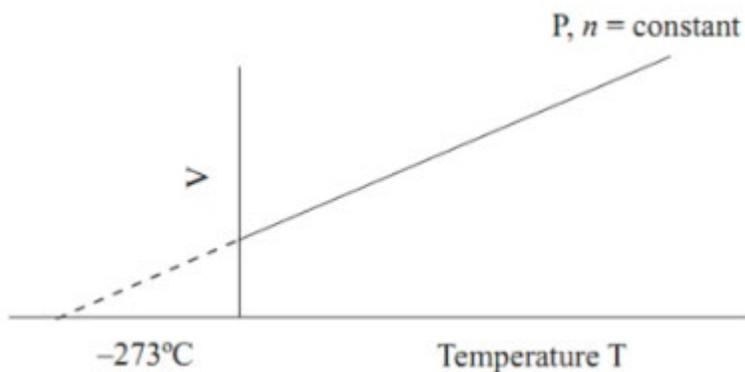
**Explanation (KMT):** Increasing temperature increases molecular speed. Molecules hit the walls more frequently and with greater force. To keep pressure constant, the volume must increase.

**Absolute Zero:** By extrapolating the volume-temperature graph to zero volume, a temperature of  $-273.15^\circ\text{C}$  is obtained. This is **absolute zero (0 K)**, the theoretical point which is

- Unattainable

- Contrary to the Law of conservation of mass
- Here all molecular motion cease.

Graphical Representation:



A plot of V vs. T (in K) is a straight line through the origin

### Gay-Lussac's Law (Pressure-Temperature Relationship)

**Statement:** For a fixed amount of gas at constant volume, the pressure of the gas is directly proportional to its absolute temperature.

**Mathematical Expression:**  $P \propto T$  (constant n, V) or  $P/T = k$  or  $P_1/T_1 = P_2/T_2$

**Explanation (KMT):** In a fixed volume, increasing temperature raises molecular speed, leading to more frequent and forceful collisions with the walls, thus increasing pressure.

### Avogadro's Law (Volume-Amount Relationship)

**Statement:** Equal volumes of all ideal gases at the same temperature and pressure contain the same number of molecules.

**Mathematical Expression:**  $V \propto n$  (constant P, T) or  $V/n = k$

**Molar Volume:** At Standard Temperature and Pressure (STP: 0°C and 1 atm), one mole of any ideal gas occupies 22.414 L or 22.4 dm<sup>3</sup>.

### The Combined Gas Law

**Derivation:** This law combines Boyle's, Charles's, and Gay-Lussac's laws.



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**Statement:** For a fixed mass of gas, the ratio PV/T is constant.

**Mathematical Expression:**  $P_1V_1/T_1 = P_2V_2/T_2$

### The Ideal Gas Equation

**Derivation:** Combining the simple gas laws:  $V \propto nT/P$ . introducing the proportionality constant R gives the Ideal Gas Equation.

**Equation:**  $PV = nRT$

Where R is the Universal Gas Constant.

**Significance:** This is an **Equation of State** as it relates all four variables (P, V, T, n) that define the state of a gas.

### The Gas Constant (R)

**Values:** The numerical value of R depends on the units of P and V.

$R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$  (Most common)

$R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$  (SI units)

$R = 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$

$R = 62.364 \text{ L torr K}^{-1} \text{ mol}^{-1}$

**Calculation:** Using molar volume at STP:  $R = (1 \text{ atm} \times 22.414 \text{ L}) / (1 \text{ mol} \times 273.15 \text{ K}) \approx 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$

**Physical Significance:** R represents the work done per mole per degree Kelvin.

### Applications of the Ideal Gas Equation

#### Calculation of Density (d):

From  $n = m/M$  and  $PV = nRT$ , we get  $PV = (m/M) RT$ .

Rearranging:  $PM = (m/V) RT$ .

Since density  $d = m/V$ , we get:  $d = PM / RT$



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Density is directly proportional to Molar Mass (M) and Pressure (P), and inversely proportional to Temperature (T).

### Calculation of Molar Mass (M):

From  $PV = (m/M)RT$ , we get  $M = mRT / PV$

### Dalton's Law of Partial Pressures

**Statement:** The total pressure exerted by a mixture of non-reacting gases is equal to the sum of the partial pressures of the individual gases.

**Mathematical Expression:**  $P_{total} = P_1 + P_2 + P_3 + \dots$

**Partial Pressure:** The pressure a gas would exert if it alone occupied the entire volume of the mixture at the same temperature.

**Relation to Mole Fraction:** The partial pressure of a gas in a mixture is given by its mole fraction (X) multiplied by the total pressure.

$$P_i = X_i \times P_{total}$$

where mole fraction  $X_i = n_i / n_{total}$

### Applications:

**Collection of Gases over Water:** When a gas is collected over water, it is moist and contains water vapor.

$$P_{dry\ gas} = P_{total} - P_{water\ vapor} \text{ (Aqueous Tension)}$$

**Respiration & Deep-Sea Diving:** These processes depend on the partial pressures of oxygen, nitrogen, and carbon dioxide.

### Graham's Law of Diffusion and Effusion

**Diffusion:** The spontaneous mixing of gases by random molecular motion.

**Effusion:** The escape of gas molecules through a tiny pin-hole into a region of lower pressure.

**Statement:** The rate of diffusion or effusion of a gas is inversely proportional to the square root of its density or molar mass at constant temperature and pressure.



### Mathematical Expression:

$$r_1 / r_2 = \sqrt{(d_2 / d_1)} = \sqrt{(M_2 / M_1)}$$

Where r, d, and M are the rate, density, and molar mass, respectively.

**Experimental Verification:** In a long tube, ammonia (NH<sub>3</sub>, M=17) and hydrogen chloride (HCl, M=36.5) are released from opposite ends. The white ring of ammonium chloride (NH<sub>4</sub>Cl) forms closer to the HCl end. The ratio of distances traveled ( $r_{\text{NH}_3} / r_{\text{HCl}}$ ) is approximately 1.46, which matches  $\sqrt{(36.5/17)}$ .

### Kinetic Molecular Theory (KMT) of Gases

This theory explains the behavior of ideal gases based on the motion of their particles.

#### Postulates:

1. A gas consists of a large number of tiny particles in constant, random, straight-line motion.
2. The volume of the individual gas molecules is negligible compared to the total volume of the gas.
3. Intermolecular forces of attraction or repulsion between gas molecules are negligible.
4. Collisions between gas molecules and with the container walls are perfectly elastic (no net loss of kinetic energy).
5. The average kinetic energy of the gas molecules is directly proportional to the absolute temperature.

$$\text{K.E.}_{\text{avg}} \propto T$$

6. At the same temperature, molecules of different gases have the same average kinetic energy.

### Explanation of Gas Laws from KMT

**Boyle's Law:** At constant T, KE is constant. Reducing volume increases the frequency of collisions with the walls, increasing pressure.

**Charles's Law:** Increasing T increases KE. Molecules move faster and push harder against the container walls. To maintain constant pressure, the volume must increase.



**Avogadro's Law:** More molecules ( $n$ ) mean more collisions. To maintain constant  $P$  and  $T$ , the volume must increase proportionally.

**Graham's Law:**

At the same  $T$ , gases have the same average KE:  $\frac{1}{2}m_1v_1^2 = \frac{1}{2}m_2v_2^2$ . Rearranging gives  $v_1/v_2 = \sqrt{(m_2/m_1)} = \sqrt{(M_2/M_1)}$ . Since rate is proportional to speed, Graham's law follows.

### M Kinetic Interpretation of Temperature

K From KMT, the pressure exerted by a gas is derived as:  $PV = (1/3) mNC^2$ , where  $C$  is the root mean square (RMS) velocity.

P For 1 mole of gas ( $N = N_a$ ),  $PV = RT$ . Equating, we get the average kinetic energy per mole:  $E = (3/2) RT$ .

R The average kinetic energy per molecule is:  $e = (3/2) kT$ , where  $k = R/N_a$  is **Boltzmann's constant** ( $1.38 \times 10^{-23} \text{ J/K}$ ).

P **Conclusion:** The absolute temperature is a measure of the average translational kinetic energy of the molecules.

### A Molecular Velocities and Distribution

R Gas molecules have a distribution of velocities described by the **Maxwell-Boltzmann Distribution**.

T At higher temperatures, the curve flattens and shifts to the right.

### I Types of Velocities:

- O 1. **Root Mean Square Velocity ( $V_{rms}$ ):**  $V_{rms} = \sqrt{(3RT / M)}$  ( $M$  must be in kg/mol)
- N 2. **Average Velocity ( $v_{avg}$ ):**  $v_{avg} = \sqrt{(8RT / \pi M)}$
- S 3. **Most Probable Velocity ( $v_{mp}$ ):**  $v_{mp} = \sqrt{(2RT / M)}$

**Relationship:**  $v_{mp} : v_{avg} : V_{rms} = 1 : 1.128 : 1.224$

### Collision Properties



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**Mean Free Path ( $\lambda$ ):** The average distance a molecule travels between two successive collisions.  $\lambda$  **decreases with increasing pressure** and **increases with increasing temperature**.

**Collision Frequency ( $Z$ ):** The number of collisions per unit volume per second.  $Z$  **increases with pressure and temperature**

### Real Gases:

#### Deviation from Ideal Behavior

Ideal gases obey  $PV = nRT$  under all conditions. Real gases deviate, especially at **high pressure** and **low temperature**.

#### Causes of Deviation

**Intermolecular Forces:** Attractive forces between molecules reduce the force of their collisions with the walls, leading to a lower observed pressure than the ideal pressure.

**Finite Molecular Volume:** The volume of the molecules themselves is not negligible compared to the container volume, reducing the actual free space available for movement.

#### Compressibility Factor ( $Z$ )

**Definition:**  $Z = PV / nRT$ . For an ideal gas,  $Z = 1$  at all conditions.

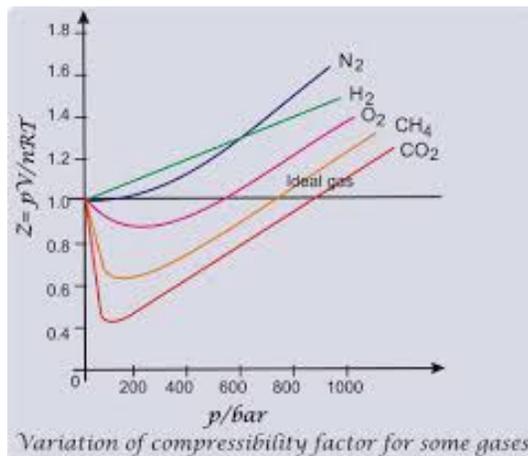
#### For Real Gases:

At **low to moderate pressures**,  $Z < 1$  due to the dominance of attractive forces.

At **very high pressures**,  $Z > 1$  due to the dominance of repulsive forces from the finite molecular volume.

At **high temperatures**, deviations are smaller, and gases behave more ideally.

**Boyle Temperature ( $T_B$ ):** The temperature at which a real gas obeys Boyle's law over a wide range of pressure. At  $T_B$ ,  $Z \approx 1$ .



### Van der Waals Equation

This equation modifies the ideal gas equation to account for real gas behavior.

For n moles:  $[P + a(n^2/V^2)] (V - nb) = nRT$

For 1 mole:  $[P + a/V^2] (V - b) = RT$

#### Significance of Constants:

'a': Corrects for intermolecular attractive forces. Units:  $\text{atm L}^2 \text{mol}^{-2}$ . Larger 'a' means stronger attractions.

'b': Corrects for the finite volume of gas molecules (excluded volume). Units:  $\text{L mol}^{-1}$ . Larger 'b' means larger molecular size.

### Liquefaction of Gases & Critical Phenomena

Gases can be liquefied by applying high pressure and cooling below a specific temperature.

#### Critical Constants:

**Critical Temperature ( $T_c$ ):** The highest temperature at which a gas can be liquefied by pressure alone.

**Critical Pressure ( $P_c$ ):** The minimum pressure required to liquefy a gas at its critical temperature.

**Critical Volume ( $V_c$ ):** The volume occupied by one mole of the gas at its  $T_c$  and  $P_c$ .



## Relation with van der Waals Constants:

$$V_c = 3b$$

$$P_c = a / 27b^2$$

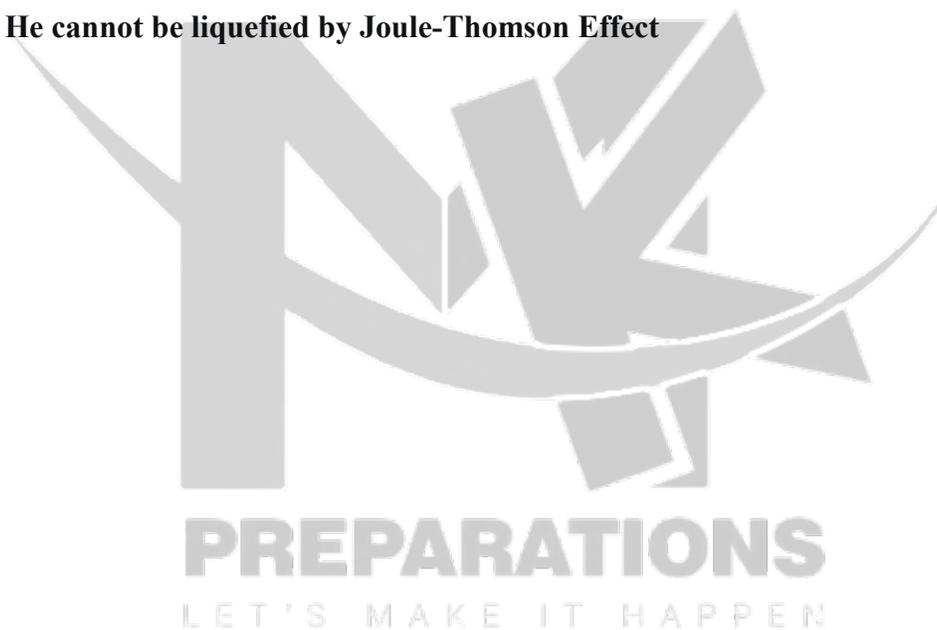
$$T_c = 8a / (27Rb)$$

## M Joule-Thomson Effect:

K • When a compressed gas is allowed to expand adiabatically through a porous plug or nozzle into a region of lower pressure, it cools down. This cooling is used in gas liquefaction processes like **Linde's Method** for liquefying air.

P • **H<sub>2</sub> and He cannot be liquefied by Joule-Thomson Effect**

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## One-Liners: The Gaseous State

### 1. Introduction to States of Matter

1. Matter primarily exists in four states: **Solid, Liquid, Gas, and Plasma**.
2. **Solids** have a definite shape and volume with particles in a fixed, orderly arrangement.
3. **Liquids** have a definite volume but no definite shape, taking the shape of their container.
4. **Gases** have no definite shape or volume, expanding spontaneously to fill their container.
5. **Plasma** is an ionized gas consisting of positive ions and free electrons, found in stars and neon signs.
6. The **gaseous state** is the simplest to study mathematically due to minimal intermolecular forces.

### 2. General Properties of Gases

7. **Expansibility** is the property of gases to expand indefinitely and fill the entire volume of their container.
8. **Compressibility** allows gases to be easily reduced in volume by applying pressure (e.g., LPG, CNG).
9. **Diffusibility** is the spontaneous and rapid mixing of gases to form a homogeneous mixture.
10. **Diffusion** is the intermingling of gas molecules (e.g., perfume smell spreading in a room).
11. **Effusion** is the escape of gas molecules through a tiny hole into a vacuum without collisions.
12. Gases exert **pressure** due to constant collisions of molecules with the container walls.
13. Gases have **low density** because their molecules are widely spaced.

### 3. Parameters (State Variables) of a Gas

14. A gas sample is described by four parameters: **Pressure (P), Volume (V), Temperature(T), and Amount (n)**.
15. The **SI unit of pressure** is Pascal (Pa); common units include atm, mm Hg, torr, and bar.
16. **Standard conversions:**  $1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr} = 1.013 \times 10^5 \text{ Pa} = 1.013 \text{ bar}$ .
17. Pressure is measured by a **manometer** for gas samples and a **barometer** for atmospheric pressure.
18. The **SI unit of volume** is cubic metre ( $\text{m}^3$ ); common units are litre (L) and millilitre (mL).
19. The **SI unit of temperature** for gas laws is **Kelvin (K)**, where  $K = ^\circ\text{C} + 273.15$ .



20. The **amount of gas (n)** is expressed in moles, calculated as  $n = \text{mass (m)} / \text{Molar mass (M)}$ .

#### 4. The Gas Laws

21. **Boyle's Law:** For a fixed mass of gas at constant temperature, volume is inversely proportional to pressure ( $V \propto 1/P$  or  $P_1V_1 = P_2V_2$ ).

22. A plot of **P vs. V** at constant temperature is a hyperbola called an **isotherm**.

23. **Charles's Law:** For a fixed mass of gas at constant pressure, volume is directly proportional to its absolute temperature ( $V \propto T$  or  $V_1/T_1 = V_2/T_2$ ).

24. **Absolute Zero (0 K or -273.15 °C)** is the temperature where the volume of an ideal gas becomes zero.

25. **Gay-Lussac's Law:** For a fixed mass of gas at constant volume, pressure is directly proportional to its absolute temperature ( $P \propto T$  or  $P_1/T_1 = P_2/T_2$ ).

26. **Avogadro's Law:** Equal volumes of all ideal gases at the same T and P contain the same number of molecules ( $V \propto n$ ).

27. At **STP (0°C and 1 atm)**, one mole of any ideal gas occupies **22.4 litres or 22.4 dm<sup>3</sup>**.

28. The **Combined Gas Law** states:  $P_1V_1/T_1 = P_2V_2/T_2$  for a fixed mass of gas.

#### 5. The Ideal Gas Equation

29. The **Ideal Gas Equation** is  $PV = nRT$ , where R is the Universal Gas Constant.

30. This is an **Equation of State** as it relates all four variables (P, V, T, n) that define the state of a gas.

31. Common values of **R** include  $0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$ ,  $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ , and  $1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$ .

32. The value of R is calculated using molar volume at STP:  $R = (1 \text{ atm} \times 22.414 \text{ L}) / (1 \text{ mol} \times 273.15 \text{ K})$ .

33. **Density (d)** of a gas can be calculated from the ideal gas equation:  $d = PM / RT$ .

34. **Molar Mass (M)** can be calculated as  $M = mRT / PV$ .

#### Dalton's Law of Partial Pressures

35. **Dalton's Law:** The total pressure of a mixture of non-reacting gases is equal to the sum of their partial pressures ( $P_{\text{total}} = P_1 + P_2 + P_3 + \dots$ ).

36. The **partial pressure** of a gas is the pressure it would exert if it alone occupied the entire volume.

37. Partial pressure is given by  $P_i = X_i \times P_{\text{total}}$ , where  $X_i$  is the mole fraction ( $X_i = n_i / n_t$ ).

38. When a gas is collected over water,  $P_{\text{dry gas}} = P_{\text{total}} - P_{\text{water vapor}}$  (aqueous tension).



## 7. Graham's Law of Diffusion and Effusion

39. **Graham's Law:** The rate of diffusion/effusion of a gas is inversely proportional to the square root of its density or molar mass ( $r_1 / r_2 = \sqrt{d_2 / d_1} = \sqrt{M_2 / M_1}$ ).

40. In the  $\text{NH}_3$  and  $\text{HCl}$  diffusion experiment, the white ring of  $\text{NH}_4\text{Cl}$  forms closer to the  $\text{HCl}$  end.

## 8. Kinetic Molecular Theory (KMT) of Gases

41. **Postulate 1:** A gas consists of tiny particles in constant, random, straight-line motion.

42. **Postulate 2:** The volume of individual gas molecules is negligible compared to the total gas volume.

43. **Postulate 3:** Intermolecular forces are negligible.

44. **Postulate 4:** Collisions are perfectly elastic (no net loss of kinetic energy).

45. **Postulate 5:** The average kinetic energy is directly proportional to the absolute temperature ( $K_{\text{avg}} \propto T$ ).

46. **Postulate 6:** At the same temperature, different gases have the same average kinetic energy.

47. The **pressure** exerted by a gas is derived as  $PV = (1/3) mNC^2$ , where  $\mu$  is the RMS velocity.

48. The **average kinetic energy per mole** is  $E = (3/2) RT$ .

49. The **average kinetic energy per molecule** is  $e = (3/2) kT$ , where  $k$  is Boltzmann's constant ( $1.38 \times 10^{-23} \text{ J/K}$ ).

50. The **Maxwell-Boltzmann Distribution** describes the distribution of molecular velocities in a gas.

51. **Most Probable Velocity ( $v_{\text{mp}}$ )** is the velocity possessed by the largest fraction of molecules.

52. **Root Mean Square Velocity ( $V_{\text{rms}}$ )** =  $\sqrt{3RT / M}$ ;  $M$  must be in  $\text{kg/mol}$ .

53. **Average Velocity ( $v_{\text{avg}}$ )** =  $\sqrt{8RT / \pi M}$ .

54. **Most Probable Velocity ( $v_{\text{mp}}$ )** =  $\sqrt{2RT / M}$ .

55. The relationship is  $v_{\text{mp}} : v_{\text{avg}} : v_{\text{rms}} = 1 : 1.128 : 1.224$ .

56. **Mean Free Path ( $\lambda$ )** is the average distance a molecule travels between two successive collisions.

57. Mean free path **decreases with increasing pressure** and **increases with increasing temperature**.

58. **Collision Frequency ( $Z$ )** is the number of collisions per unit volume per second and increases with  $P$  and  $T$ .

## 9. Real Gases: Deviation from Ideal Behavior



59. Real gases deviate from ideal behavior especially at **high pressure** and **low temperature**.
60. Causes of deviation: **Intermolecular attractive forces** and **finite molecular volume**.
61. The **Compressibility Factor**,  $Z = PV / nRT$ ; for an ideal gas,  $Z = 1$  at all conditions.
62. At low pressures,  $Z < 1$  due to dominant attractive forces.
63. At very high pressures,  $Z > 1$  due to dominant repulsive forces from finite molecular volume.
64. The **Boyle Temperature ( $T_B$ )** is the temperature at which a real gas obeys Boyle's law over a wide pressure range ( $Z \approx 1$ ).
65. The **van der Waals equation** for  $n$  moles is:  $[P + a (n^2/V^2)] (V - nb) = nRT$ .
66. Constant '**a**' corrects for intermolecular attractive forces (Units:  $\text{atm L}^2 \text{mol}^{-2}$ ).
67. Constant '**b**' corrects for the finite volume of gas molecules (excluded volume) (Units:  $\text{L mol}^{-1}$ ).
68. The **excluded volume** is four times the actual volume of the gas molecules.
- 10. Liquefaction of Gases & Critical Phenomena**
69. Gases can be liquefied by applying high pressure and cooling below a specific temperature.
70. **Critical Temperature ( $T_c$ )** is the highest temperature at which a gas can be liquefied by pressure alone.
71. **Critical Pressure ( $P_c$ )** is the minimum pressure required to liquefy a gas at its critical temperature.
72. **Critical Volume ( $V_c$ )** is the volume occupied by one mole of the gas at its  $T_c$  and  $P_c$ .
73. Relations with van der Waals constants:  $V_c = 3b$ ,  $P_c = a / 27b^2$ ,  $T_c = 8a / (27Rb)$ .
74. The **Joule-Thomson effect** is the cooling of a gas when it expands adiabatically from high to low pressure.
75. **Linde's method** for liquefying air uses the Joule-Thomson effect.



## Practice MCQs: The Gaseous State

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1. According to Boyle's law, for a fixed amount of gas at constant temperature, the volume is:

- A) directly proportional to its pressure
- B) inversely proportional to its pressure
- C) directly proportional to the square of its pressure
- D) independent of its pressure

**Answer: inversely proportional to its pressure**

2. Mathematically, Charles's law can be represented as:

- A)  $V \propto P$
- B)  $V \propto 1/T$
- C)  $V \propto T$
- D)  $P \propto T$

**Answer:  $V \propto T$**

3. The value of the universal gas constant R in litre-atm  $K^{-1} mol^{-1}$  is:

- A) 8.314
- B) 0.0821
- C) 1.987
- D) 62.364

**Answer: 0.0821**

4. At Standard Temperature and Pressure (STP), one mole of any ideal gas occupies a volume of:

- A) 20.0 L
- B) 22.4 L
- C) 24.8 L
- D) 25.0 L

**Answer: 22.4 L**

5. Dalton's law of partial pressures states that the total pressure of a mixture of non-reacting gases is equal to the:

- A) average of the partial pressures
- B) product of the partial pressures
- C) sum of the partial pressures
- D) difference of the partial pressures

**Answer: sum of the partial pressures**

6. Graham's law of diffusion states that the rate of diffusion of a gas is inversely proportional to the:

- A) square of its density
- B) square root of its molar mass
- C) square of its molar mass
- D) square root of its density

**Answer: square root of its molar mass**

7. According to the kinetic molecular theory, the average kinetic energy of gas molecules is directly proportional to the:

- A) square of the absolute temperature
- B) square root of the absolute temperature
- C) absolute temperature
- D) pressure of the gas

**Answer: absolute temperature**

8. The root mean square velocity of a gas molecule is given by:

- A)  $\sqrt{(2RT/M)}$
- B)  $\sqrt{(3RT/M)}$
- C)  $\sqrt{(8RT/\pi M)}$
- D)  $\sqrt{(RT/M)}$

**Answer:  $\sqrt{(3RT/M)}$**

1. The Gaseous State



9. The compressibility factor (Z) for an ideal gas is always:

- A) 0
- B) 1
- C) less than 1
- D) greater than 1

Answer: 1

10. The van der Waals constant 'a' accounts for:

- A) the finite volume of gas molecules
- B) the universal gas constant
- C) intermolecular attractive forces
- D) the temperature of the gas

Answer: intermolecular attractive forces

11. The critical temperature of a gas is defined as the temperature:

- A) at which it solidifies
- B) above which it cannot be liquefied
- C) at which it becomes ideal
- D) below which it cannot exist as a liquid

Answer: above which it cannot be liquefied

12. The plasma state of matter is characterized by the presence of:

- A) only neutral atoms
- B) positive ions and free electrons
- C) molecules in fixed positions
- D) only negative ions

Answer: positive ions and free electrons

13. The SI unit for the viscosity of a liquid is:

- A) Poise

B) Pascal Second (Pa.s)

C) Dyne

D) Newton

Answer: Pascal Second (Pa.s)

14. Surface tension is defined as the force acting:

- A) per unit volume
- B) per unit area
- C) at right angles to a unit length of the liquid surface
- D) parallel to the liquid surface

Answer: at right angles to a unit length of the liquid surface

15. The molar heat of vaporization for water is approximately:

- A) 6.02 kJ/mole
- B) 40.7 kJ/mole
- C) 80.0 kJ/mole
- D) 100.0 kJ/mole

Answer: 40.7 kJ/mole

16. Liquid crystals are an intermediate phase between:

- A) solid and gas
- B) liquid and gas
- C) solid crystal and clear liquid
- D) amorphous and crystalline solid

Answer: solid crystal and clear liquid

17. Which of the following has the highest surface tension at room temperature?

- A) Methanol
- B) Ethanol
- C) Water
- D) Hexane

Answer: Water



18. The phenomenon where a liquid turns into vapour at its surface at any temperature is called:

- A) boiling
- B) condensation
- C) evaporation
- D) sublimation

Answer: evaporation

19. The boiling point of a liquid is the temperature at which its vapour pressure becomes equal to the:

- A) critical pressure
- B) atmospheric pressure
- C) vapor pressure of water
- D) internal pressure of the container

Answer: atmospheric pressure

20. The property of a liquid that measures its resistance to flow is called:

- A) surface tension
- B) viscosity
- C) compressibility
- D) diffusibility

Answer: viscosity

21. Hydrogen bonding in water is responsible for its:

- A) low boiling point
- B) high vapour pressure
- C) high surface tension
- D) low density

Answer: high surface tension

22. The amount of heat required to convert one mole of solid into liquid at its melting point is called:

- A) molar heat of vaporization

B) molar heat of fusion

C) specific heat

D) latent heat of condensation

Answer: molar heat of fusion

23. Crystalline solids have:

- A) irregular shapes
- B) no sharp melting points
- C) a definite geometric shape
- D) randomly arranged particles

Answer: a definite geometric shape

24. Amorphous solids, like glass:

- A) have a sharp melting point
- B) soften over a range of temperatures
- C) have a well-defined crystal lattice
- D) are good conductors of electricity

Answer: soften over a range of temperatures

25. The rate of diffusion in solids is:

- A) very fast
- B) moderate
- C) negligible
- D) similar to gases

Answer: negligible

26. For a gas, a plot of P versus  $1/V$  at constant temperature gives a:

- A) curve
- B) straight line through the origin
- C) parabola
- D) hyperbola

Answer: straight line through the origin

27. The partial pressure of a gas in a mixture is equal to its mole fraction multiplied by the:



- A) volume of the container
- B) total number of moles
- C) universal gas constant
- D) total pressure

**Answer: total pressure**

**28. In the kinetic theory of gases, the pressure exerted by the gas is due to the:**

- A) weight of the gas molecules
- B) collisions of molecules with the container walls
- C) intermolecular attractions
- D) volume of the molecules

**Answer: collisions of molecules with the container walls**

**29. The mean free path of gas molecules increases with:**

- A) increase in pressure
- B) decrease in temperature
- C) increase in temperature
- D) increase in molecular size

**Answer: increase in temperature**

**30. At very high pressures, the compressibility factor (Z) for a real gas is generally:**

- A) less than 1
- B) equal to 1
- C) greater than 1
- D) zero

**Answer: greater than 1**

**31. The van der Waals equation for one mole of a gas is:**

- A)  $(P + a/V)(V - b) = RT$
- B)  $(P + a/V^2)(V - b) = RT$
- C)  $P(V - b) = RT$

- D)  $PV = RT$

**Answer:  $(P + a/V^2)(V - b) = RT$**

**32. The Joule-Thomson effect is used in which method for gas liquefaction?**

- A) Faraday's method
- B) Linde's method
- C) Claude's method
- D) Distillation method

**Answer: Linde's method**

**33. Which of the following is NOT a postulate of the kinetic molecular theory for ideal gases?**

- A) Gas molecules are in constant random motion.
- B) The volume of gas molecules is negligible.
- C) Intermolecular forces are strong.
- D) Collisions are perfectly elastic.

**Answer: Intermolecular forces are strong.**

**34. The most probable velocity of gas molecules is given by:**

- A)  $\sqrt{(2RT/M)}$
- B)  $\sqrt{(3RT/M)}$
- C)  $\sqrt{(8RT/\pi M)}$
- D)  $\sqrt{(RT/M)}$

**Answer:  $\sqrt{(2RT/M)}$**

**35. The relationship between the three molecular velocities is:**

- A)  $v_{mp} > v_{avg} > u_{rms}$
- B)  $u_{rms} > v_{avg} > v_{mp}$
- C)  $v_{avg} > u_{rms} > v_{mp}$
- D)  $v_{mp} = v_{avg} = u_{rms}$

**Answer:  $C_{rms} > C_{avg} > C_{mp}$**



36. The critical constants  $V_c$ ,  $P_c$ , and  $T_c$  are related to van der Waals constants by:

- A)  $V_c = b$ ,  $P_c = a/27b^2$ ,  $T_c = 8a/27Rb$
- B)  $V_c = 3b$ ,  $P_c = a/27b$ ,  $T_c = 8a/27Rb$
- C)  $V_c = 3b$ ,  $P_c = a/27b^2$ ,  $T_c = 8a/27Rb$
- D)  $V_c = b$ ,  $P_c = a/b^2$ ,  $T_c = a/Rb$

Answer:  $V_c = 3b$ ,  $P_c = a/27b^2$ ,  $T_c = 8a/27Rb$

37. The law of corresponding states is derived from the:

- A) Ideal gas equation
- B) Combined gas law
- C) van der Waals equation
- D) Graham's law

Answer: van der Waals equation

38. Which gas shows an initial decrease in the compressibility factor ( $Z$ ) with increasing pressure at moderate pressures?

- A) Hydrogen
- B) Helium
- C) Nitrogen
- D) all ideal gases

answer: Nitrogen

39. The distillation process carried out under reduced pressure is called:

- A) Simple distillation
- B) Fractional distillation
- C) Vacuum distillation
- D) Steam distillation

Answer: Vacuum distillation

40. The unit of surface tension in the SI system is:

- A) Joule per square meter ( $J/m^2$ )

B) Newton per meter ( $N/m$ )

C) Both A and B

D) Pascal (Pa)

Answer: Newton per meter ( $N/m$ )

41. The constant 'b' in the van der Waals equation represents:

- A) Attraction between molecules
- B) The excluded volume per mole
- C) The gas constant
- D) The critical volume

Answer: The excluded volume per mole

42. The average kinetic energy of a gas molecule depends only on the:

- A) Pressure of the gas
- B) Volume of the gas
- C) Temperature of the gas
- D) Nature of the gas

Answer: Absolute Temperature of the gas

43. If the temperature of a gas is doubled (in Kelvin), its root mean square velocity becomes:

- A) Half
- B) Doubled
- C)  $\sqrt{2}$  times
- D) Four times

Answer:  $\sqrt{2}$  times

44. The vapour pressure of a liquid increases with an increase in:

- A) Intermolecular forces
- B) Molecular weight
- C) Temperature
- D) Surface area

Answer: Temperature



**45. The boiling point of water on top of Mount Everest is:**

- A) 100°C
- B) Greater than 100°C
- C) Less than 100°C
- D) 0°C

**Answer: Less than 100°C**

**46. Which of the following liquids has the highest viscosity at room temperature?**

- A) Water
- B) Acetone
- C) Honey
- D) Methanol

**Answer: Honey**

**47. The forces of attraction between an instantaneous dipole and an induced dipole are called:**

- A) Dipole-dipole forces
- B) London dispersion forces
- C) Hydrogen bonding
- D) Ion-dipole forces

**Answer: London dispersion forces**

**48. The study of glaciers and polar ice caps relies on the understanding of:**

- A) Heat of vaporization
- B) Heat of fusion
- C) Surface tension
- D) Vapour pressure

**Answer: Heat of fusion**

**49. Liquid crystals are used in:**

- A) Making ordinary glass
- B) LCD screens of calculators and watches
- C) As refrigerants
- D) As rocket fuels

**Answer: LCD screens of calculators and watches**

**50. Which of the following is a crystalline solid?**

- A) Glass
- B) Plastic
- C) Rubber
- D) Sodium Chloride (NaCl)

**Answer: Sodium Chloride (NaCl)**



## Chapter 2

# States of Matter - Liquids and Solids

## Kinetic Molecular Theory of Liquids and Solids

### Postulates for Liquids

- M**• **Composition and Proximity:** A liquid consists of atoms, ions, or molecules that are in close contact with one another, resulting in negligible space between them.
- K**• **Motion:** The particles are in constant, random motion. However, this motion is restricted by the close packing; they cannot move freely but can slide past one another, which is why liquids can flow.
- P**• **Intermolecular Forces:** The attractive forces between liquid molecules are stronger than those in gases but significantly weaker than those in solids. These forces are insufficient to hold the particles in fixed positions.
- R**• **Kinetic Energy:** The average kinetic energy of the liquid molecules is directly proportional to the absolute temperature. At a given temperature, the average kinetic energy of the liquid molecules is equal to that of its vapour molecules.

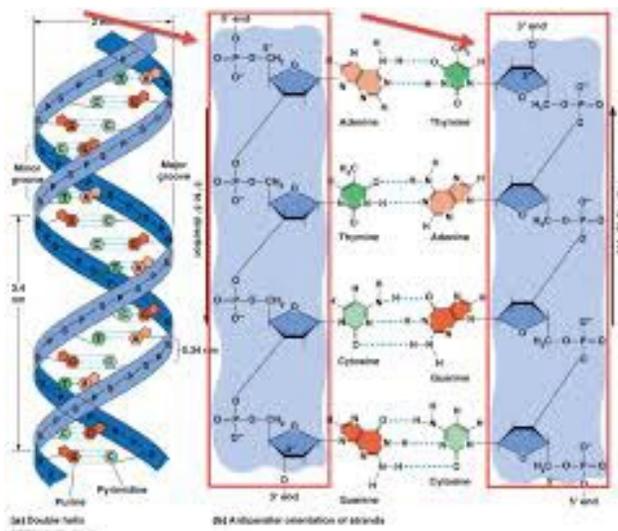
### Postulates for Solids

- A**• **Composition and Packing:** Solids are composed of atoms, ions, or molecules that are closely packed together in a fixed, orderly arrangement.
- R**• **Intermolecular Forces:** The particles are held together by very strong intermolecular (or ionic/covalent/metallic) forces of attraction.
- A**• **Rigidity and Motion:** Solids are rigid and possess a definite shape because their particles are locked in place and cannot translate or rotate. They can only vibrate about their mean positions.
- T**• **Order and Arrangement:** The particles in solids exhibit a high degree of long-range order, arranged in regular, three-dimensional patterns called a crystal lattice (for crystalline solids).
- I**• **Compressibility and Density:** There is very little empty space between particles, making solids virtually incompressible. This close packing results in high density.

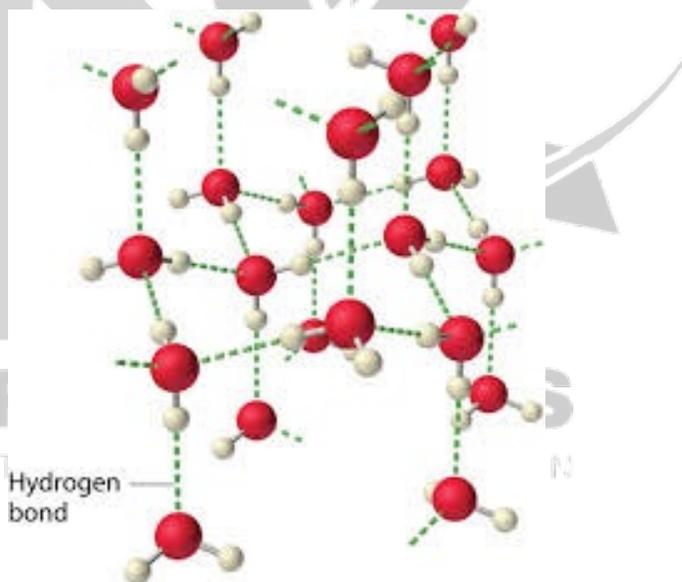
### Intermolecular Forces

Intermolecular forces are the attractive forces *between* molecules. They are much weaker than intramolecular forces (covalent, ionic bonds) that hold atoms together *within* a molecule. Collectively, these weak forces are known as **Van der Waals forces**.

### Types of Intermolecular Forces



**Structure of Ice:** In ice, water molecules form an open, tetrahedral, cage-like structure due to extensive hydrogen bonding, creating empty spaces. This makes ice less dense than liquid water, causing it to float.



### Structure of ice

**Other Applications:** Cleaning action of soaps and detergents (by reducing surface tension), adhesive action of paints and dyes, and the viscous, sticky nature of substances like glue and honey.

### Physical Properties of Liquids



## One-Liners: Solid & Liquid State

### PART 1: SOLID STATE

#### 1. Types of Solids

1. **Solids** have a definite volume and shape and are rigid due to the inability of their particles to translate.
2. **Crystalline solids** have a regular, repeating three-dimensional arrangement of particles called a crystal lattice.
3. Examples of crystalline solids are sugar, salt, diamond, and metals.
4. **Amorphous solids** have a random, disordered arrangement of particles and lack a well-defined crystal lattice.
5. Examples of amorphous solids are glass, rubber, and plastics.
6. Amorphous solids are considered **super-cooled liquids** due to their disordered structure, evident in the flow of old glass panes.

#### 2. Isotropy and Anisotropy

7. **Isotropy** is the property of having identical values of physical properties in all directions, characteristic of amorphous solids.
8. **Anisotropy** is the property where the magnitude of a physical property varies with direction, characteristic of crystalline solids.
9. Anisotropy in crystals arises from the different arrangement of particles in different directions.

#### 3. Crystal Habit and Symmetry

10. The external shape of a crystal is called its **habit**.
11. The plane surfaces of a crystal are called **faces**, and the angles between them are **interfacial angles**.
12. The constancy of interfacial angles is a fundamental characteristic of a given crystalline substance.
13. A **plane of symmetry** divides a crystal into two halves that are mirror images of each other.
14. An **axis of symmetry** is an imaginary line about which rotating the crystal brings it into an equivalent position more than once in a  $360^\circ$  rotation.
15. A **centre of symmetry** is a point in the crystal such that any line drawn through it meets the surface at equal distances on opposite sides.

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2. States of Matter: Liquids and Solids



## Practice MCQs – States of Matter

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1. Which of the following is an amorphous solid?

- A) Diamond
- B) Sodium Chloride
- C) Graphite
- D) Glass

Answer: D) Glass

2. The property of a crystal having different values of a physical property in different directions is called:

- A) Isotropy
- B) Anisotropy
- C) Polymorphism
- D) Isomorphism

Answer: B) Anisotropy

3. The external shape of a crystal is known as its:

- A) Symmetry
- B) Lattice
- C) Habit
- D) Face

Answer: C) Habit

4. An imaginary plane that divides a crystal into two mirror images is a:

- A) Axis of Symmetry
- B) Plane of Symmetry
- C) Centre of Symmetry
- D) Bragg's Plane

Answer: B) Plane of Symmetry

5. In a face-centered cubic (FCC) unit cell, the number of atoms per unit cell is:

- A) 1
- B) 2

C) 4

D) 6

Answer: C) 4

6. The coordination number in a body-centered cubic (BCC) lattice is:

- A) 6
- B) 8
- C) 12
- D) 4

Answer: B) 8

7. Bragg's equation for X-ray diffraction is:

- A)  $n\lambda = d \sin\theta$
- B)  $n\lambda = 2d \sin\theta$
- C)  $\lambda = 2d \sin\theta$
- D)  $n\lambda = 2d/\sin\theta$

Answer: B)  $n\lambda = 2d \sin\theta$

8. Which of the following is an ionic crystal?

- A) Ice
- B) Iodine
- C) Sodium Chloride
- D) Diamond

Answer: C) Sodium Chloride

9. In a sodium chloride (NaCl) crystal, each ion is surrounded by \_\_\_\_\_ ions of the opposite charge.

- A) Four
- B) Six
- C) Eight
- D) Twelve

Answer: B) Six



## Chapter 3

# Atomic Structure

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## Historical Development of the Atomic Theory

### Early Greek Philosophers and the Concept of the Atom

**Leucippus (500 B.C):** First proposed that matter is composed of indivisible particles. He is known as the father of atomic philosophy.

**Democritus (430 B.C):** A student of Leucippus, he named these fundamental particles "atomos," meaning "uncuttable" or "indivisible."

- He theorized that different properties of matter (e.g., sour taste, white color) arose from the different shapes and sizes of these atoms.
- He believed changes in matter were due to the combination and separation of atoms.

### Dalton's Atomic Theory (1808)

John Dalton converted the philosophical idea of the atom into a scientific theory based on experimental evidence.

#### Main Postulates:

- Matter is composed of indivisible atoms.
- Atoms of the same element are identical in mass and properties.
- Compounds are formed by the combination of atoms of different elements in simple whole-number ratios.
- Chemical reactions involve the rearrangement of atoms.
- **Significance:** This theory laid the experimental foundation for modern chemistry.

## Discovery of Subatomic Particles

The indivisibility of the atom was challenged by the discovery of subatomic particles.

### Discovery of the Electron (Cathode Rays)



## One-Liners - Atomic Structure

### Historical Development & Subatomic Particles

1. **Democritus** named the fundamental, indivisible particle of matter "**atomos**".
2. **John Dalton** established the first scientific atomic theory based on experimental evidence.
3. **J.J. Thomson** discovered the **electron** through his cathode ray tube experiment.
4. The **charge-to-mass ratio (e/m)** of electrons is constant, proving they are a universal constituent of all atoms.
5. **R.A. Millikan**, via his oil-drop experiment, determined the **charge of a single electron**.
6. **E. Goldstein** discovered the **proton** by observing positive rays or canal rays.
7. The **e/m ratio for positive rays** depends on the nature of the gas in the discharge tube.
8. **James Chadwick** discovered the **neutron** by bombarding beryllium with alpha particles.
9. A **proton** is approximately **1836 times heavier** than an electron.
10. The absolute charge of an electron is  $-1.602 \times 10^{-19}$  **Coulomb**.

### 2. Atomic Models

11. **J.J. Thomson's "Plum Pudding Model"** described the atom as a sphere of positive charge with electrons embedded in it.
12. **Rutherford's alpha-particle scattering experiment** led to the proposal of the **nuclear model** of the atom.
13. Rutherford's model concluded that the atom is mostly **empty space** with a small, dense, positively charged **nucleus**.
14. A major defect of Rutherford's model was its inability to explain the **stability of the atom**.
15. **Niels Bohr** combined Rutherford's model with **Planck's quantum theory** to explain the hydrogen spectrum.
16. Bohr's first postulate states that electrons revolve in certain **stationary orbits** without radiating energy.
17. Bohr's model introduced the **quantization of angular momentum:  $mvr = nh/2\pi$**
18. The radius of the nth orbit in a hydrogen atom is given by  **$r = 0.529 n^2 / z$**
19. The energy of an electron in the nth orbit is given by  **$E_n = -13.6 Z^2/n^2$  eV/atom**.
20. The total energy of an electron in a Bohr orbit is **negative**, indicating it is bound to the nucleus.
21. Bohr's model successfully derived the **Rydberg formula** for the hydrogen spectrum.
22. Bohr's model could not explain the **Zeeman effect** (splitting of spectral lines in a magnetic field).
23. Bohr's model violated the **Heisenberg Uncertainty Principle**.

### 3. Quantum Theory & Spectra



## Practice MCQs

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1. The  $e/m$  value for positive rays is minimum for:

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

Answer: C) Oxygen

2. An orbital can have a maximum of two electrons with opposite spins according to:

- A) Heisenberg's Principle
- B) Aufbau Principle
- C) Hund's rule
- D) Pauli's Exclusion Principle

Answer: D) Pauli's Exclusion Principle

3. Cathode rays can drive a small paddle wheel, verifying they possess:

- A) Wavelength
- B) Velocity
- C) Frequency
- D) Momentum

Answer: D) Momentum

4. The mass of a proton is 1837 times more than that of a/an:

- A) Positron
- B) Electron
- C) Neutron
- D)  $\alpha$ -Particle

Answer: B) Electron

5. According to Planck's Quantum Theory, greater the energy of

radiation, greater will be its:

- A) Wavelength
- B) Frequency
- C) Wave number
- D) Both B and C

Answer: D) Both B and C

6. The magnetic quantum number is related to the:

- A) Size of orbit
- B) Shape of orbital
- C) Orientation of orbital
- D) Spin of electron

Answer: C) Orientation of orbital

7. Which atomic orbital has the highest energy?

- A) 4d
- B) 4f
- C) 5s
- D) 5p

Answer: B) 4f

8. The value of four quantum numbers for the valence electron of an element are  $n=3$ ,  $l=0$ ,  $m=0$ ,  $s=+1/2$ .

The element is:

- A) Li
- B) K
- C) Na
- D) Sc

Answer: C) Na

9. The atomic number of an element is 35. How many s, p, and d-electrons does it possess in its ground state?

# Chemical Bonding and Molecular Structure

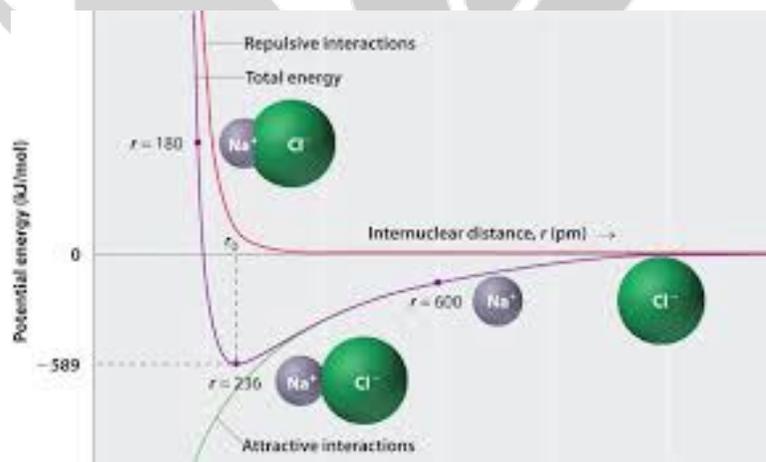
## Introduction to Chemical Bonds

### Definition:

A **chemical bond** is defined as the attractive force that holds two or more atoms together in a stable molecule or ion. This force results from the electrostatic interactions between the electrons and nuclei of the combining atoms.

### Fundamental Goal of Bond Formation:

Atoms form chemical bonds to achieve a lower energy state, thereby increasing their stability compared to their isolated forms. A stable chemical bond is formed only when the total energy of the system decreases as the atoms approach each other.



## Primary Types of Chemical Bonds:

### Ionic (Electrovalent) Bond

### Covalent Bond

- Non-polar Covalent Bond
- Polar Covalent Bond

### Coordinate Covalent (Dative) Bond

### Metallic Bond



## Chemical Bonding: Topic-Wise One-Liners

### 1. Introduction to Chemical Bonds

1. A **chemical bond** is the attractive force that holds atoms together in a molecule or compound.
2. The primary cause of bond formation is to achieve a **lower energy state** and greater stability.
3. The main types of chemical bonds are **Ionic, Covalent, and Metallic bonds**.
4. A **coordinate covalent bond** is a special type where both shared electrons are donated by a single atom.

### 2. Atomic Properties & Periodic Trends

5. **Atomic radius** is the distance from the nucleus to the outermost shell of electrons.
6. Across a period, atomic radius **decreases** due to an increase in effective nuclear charge.
7. Down a group, atomic radius **increases** due to the addition of new electron shells.
8. A **cation** is always smaller than its parent atom due to greater effective nuclear charge and reduced shielding.
9. An **anion** is always larger than its parent atom due to increased electron-electron repulsion.
10. For **isoelectronic species**, size decreases with increasing nuclear charge (e.g.,  $\text{Al}^{3+} < \text{Mg}^{2+} < \text{Na}^+ < \text{Ne} < \text{F}^- < \text{O}^{2-}$ ).
11. **Ionization Energy (IE)** is the minimum energy required to remove the most loosely bound electron from a gaseous atom.
12. Ionization energy generally **increases** across a period and **decreases** down a group.
13. **Exceptions** in IE trends: Group IIA ( $ns^2$ ) has higher IE than Group IIIA ( $ns^2np^1$ ), and Group VA ( $ns^2np^3$ ) has higher IE than Group VIA ( $ns^2np^4$ ).
14. **Electron Affinity (EA)** is the energy released when an electron is added to a neutral gaseous atom.
15. Electron affinity generally **increases** across a period and **decreases** down a group.
16. An exception to EA trend: **Chlorine has a higher electron affinity than Fluorine**.
17. **Electronegativity (EN)** is the ability of an atom to attract shared electrons in a covalent bond.
18. Electronegativity **increases** across a period and **decreases** down a group.
19. **Fluorine** is the most electronegative element on the Pauling scale.

### 3. Ionic Bond

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

4. Chemical Bonding and Molecular Structure

## Practice MCQs on Chemical Bonding

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

1. Which overlapping may not lead to sigma bond formation?

- A) p-p in fluorine
- B) s-p in hydrogen fluoride
- C)  $sp^2-sp^2$  in benzene
- D) p-p in ethene

Answer: D) p-p in ethene

2. Ionic bond with greater ionic character is mostly formed between elements of?

- A) IA and IIA
- B) IA and VIIA
- C) IA and VIA
- D) IIA and VIIA

Answer: B) IA and VIIA

3. Bonds in calcium carbide between carbon atoms are?

- A) Two pi
- B) One sigma and one pi
- C) One sigma and two pi
- D) Ionic (no sigma, no pi)

Answer: C) One sigma and two pi

4. Indicate the parameter which affects atomic radii in a period?

- A) Number of shells
- B) Nuclear charge
- C) Shielding effect
- D) Number of orbitals

Answer: B) Nuclear charge

5. A cation is smaller in size than the parent atom because of?

- A) Greater effective nuclear charge and

lesser shielding effect

- B) Greater effective nuclear charge and greater shielding effect
- C) Lesser effective nuclear charge and lesser shielding effect
- D) Lesser effective nuclear charge and greater shielding effect

Answer: A) Greater effective nuclear charge and lesser shielding effect

6. Indicate the incorrect order of atomic/ionic radii?

- A)  $Na > Na^+$
- B)  $O^{2-} < O^-$
- C)  $Cl^- > Cl$
- D)  $Mg^{2+} < Mg$

Answer: B)  $O^{2-} < O^-$

7. Ionization energy of an element in a period increases due to?

- A) Successive addition of electron shell
- B) Successive increase of nuclear charge
- C) Successive increase of effective nuclear charge
- D) Both b and c

Answer: D) Both b and c

8. In the formation of a compound AB, an electron is transferred from atom A to atom B, then?

- A) A is divalent
- B) B is oxidized and A is reduced
- C) The compound AB is covalent
- D) The compound AB is electrovalent

Answer: D) The compound AB is electrovalent

## Chapter 5

# Chemical Kinetics

Chemical Kinetics is the branch of chemistry that deals with the rates (or speeds) of chemical reactions, the factors affecting these rates, and the mechanisms by which reactions occur.

### Rate of a Chemical Reaction

The rate of a reaction is defined as the change in the concentration of any reactant or product per unit time.

#### Mathematical Expression:

For a general reaction:  $aA + bB \rightarrow cC + dD$

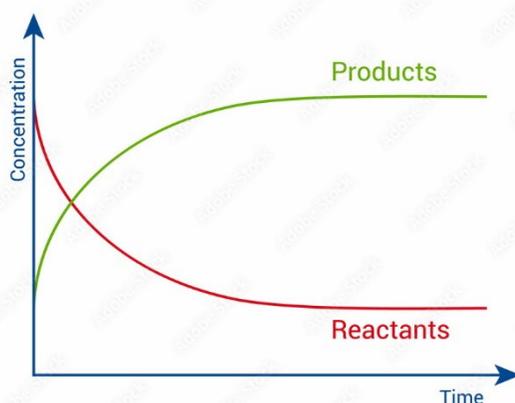
$$\text{Rate} = - (1/a) \Delta[A]/\Delta t = - (1/b) \Delta[B]/\Delta t = + (1/c) \Delta[C]/\Delta t = + (1/d) \Delta[D]/\Delta t$$

The negative sign for reactants indicates a decrease in concentration, while the positive sign for products indicates an increase.

**Units:** The unit of reaction rate is typically moles per cubic decimeter per second ( $\text{mol dm}^{-3} \text{s}^{-1}$ ).

#### Graphical Representation:

A plot of concentration vs. time shows that the rate is not constant



The concentration of reactants decreases rapidly initially and then slowly.

## One-Liners - Chemical Kinetics

### 1. Introduction to Chemical Kinetics

- Chemical Kinetics** is the branch of chemistry that deals with the study of reaction rates and their mechanisms.
- The **rate of a reaction** is defined as the change in concentration of a reactant or product per unit time.
- For a reaction,  $aA + bB \rightarrow cC + dD$ , the rate is expressed as:  $\text{Rate} = - (1/a) \Delta [A]/\Delta t = - (1/b) \Delta [B]/\Delta t = + (1/c) \Delta [C]/\Delta t = + (1/d) \Delta [D]/\Delta t$ .
- The unit of reaction rate is typically  $\text{mol dm}^{-3} \text{s}^{-1}$ .
- The **average rate** is the change in concentration over a finite time interval.
- The **instantaneous rate** is the rate at a specific moment, given by the slope of the tangent on a concentration-time graph.
- The instantaneous rate is highest at the start of the reaction and decreases over time.

### 2. Rate Law and Rate Constant

- The **Rate Law** is an experimentally determined expression relating the reaction rate to the concentrations of reactants.
- For a reaction  $aA + bB \rightarrow \text{products}$ , the rate law is **Rate = k [A]<sup>m</sup> [B]<sup>n</sup>**.
- The exponent's **m** and **n** are the **orders of the reaction** with respect to A and B, respectively.
- The **overall order** of a reaction is the sum of the powers (m + n).
- The **rate constant (k)** is the proportionality constant in the rate law.
- The value of **k** is constant for a given reaction at a specific temperature.
- The units of the rate constant **k** depend on the overall order of the reaction.

### 3. Order of Reaction

- A **zero-order reaction** has a rate independent of reactant concentration (Rate = k).
- The half-life ( $t_{1/2}$ ) for a zero-order reaction is directly proportional to the initial concentration ( $t_{1/2} = [A]$ ).
- A **first-order reaction** has a rate directly proportional to the concentration of a single reactant (Rate = k [A]).
- The half-life for a first-order reaction is constant and independent of the initial concentration ( $t_{1/2} = 0.693/k$ ).
- A **second-order reaction** has a rate proportional to the square of a single reactant's concentration or to the product of two reactant concentrations.
- The half-life for a second-order reaction (with  $2A \rightarrow \text{products}$ ) is inversely proportional to the initial concentration ( $t_{1/2} = 1 / (k [A]_0)$ ).

## Practice MCQs

1. The slope of a concentration versus time graph is called?

- A) Intercept
- B) Rate constant
- C) Rate of reaction
- D) Order of reaction

**Answer: Rate of reaction**

2. The presence of a catalyst affects which of the following?

- A) Temperature
- B) Kinetic Energy
- C) pH
- D) Activation Energy

**Answer: Activation Energy**

3. For a reaction where  $A + A + 2A \rightarrow$  Product, the order of reaction is?

- A) Zero or 1
- B) 1 or 2
- C) 2 or 3
- D) Data unpredictable

**Answer: Data unpredictable**

4. A graph between  $\log K$  on the Y-axis and  $1/T$  on the X-axis is a?

- A) Hyperbolic curve
- B) Parabolic curve
- C) Straight line
- D) Peaks

**Answer: Straight line**

5. From the equation  $\log k = -E_a/2.303RT$ , which of the following is incorrect?

- A)  $K \propto T$
- B)  $K \propto 1/E_a$

C)  $K \propto E_a$

D) A is independent of the reactant

**Answer:  $K \propto E_a$**

6. The unit of reaction rate is?

- A)  $\text{mol dm}^{-3} \text{S}^{-1}$
- B)  $\text{mol}^{-1} \text{dm}^{-3} \text{S}$
- C)  $\text{mol}^{-2} \text{dm}^{-3} \text{S}^{-1}$
- D)  $\text{mol dm}^{-3} \text{S}^{-2}$

**Answer:  $\text{mol dm}^{-3} \text{S}^{-1}$**

7. When NaOH solution reacts with Aluminum in different physical states, the most rapid reaction occurs with?

- A) Al foil
- B) Cubes of Al
- C) Al powder
- D) Al alloy

**Answer: Al powder**

8. The units of the rate constant are the same as the rate of reaction for which order?

- A) First order reaction
- B) Second order reaction
- C) Third order reaction
- D) Zero order reaction

**Answer: Zero order reaction**

9. With an increase of  $10^\circ\text{C}$  temperature, the rate of reaction doubles primarily due to?

- A) An increase in the activation energy of reactants
- B) A decrease in the activation energy of the reaction
- C) A decrease in the number of



# Electrochemistry

## Introduction to Electrochemistry

Electrochemistry is the branch of chemistry that deals with the interconversion of chemical energy and electrical energy. This involves two main types of processes:

**Production of Electricity from Chemical Reactions:** This occurs in **Galvanic or Voltaic Cells** (like batteries), where a spontaneous redox reaction generates an electric current.

**Use of Electricity to Drive Chemical Reactions:** This occurs in **Electrolytic Cells**, where an external electric current is used to force a non-spontaneous chemical reaction to occur, a process known as **electrolysis**.

A fundamental requirement for these processes is the presence of an **electrolyte**—a substance that in solution or molten state conducts electricity by the movement of ions.

## Oxidation and Reduction (Redox Reactions)

### Basic Concepts

**Oxidation:** Addition of oxygen or removal of hydrogen.

e.g.  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$  (Oxidation of  $\text{SO}_2$ )

**Reduction:** Removal of oxygen or addition of hydrogen.

e.g.,  $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$  (Reduction of  $\text{Cl}_2$ )

**Electron Transfer Concept (Modern Concept):**

**Redox Reaction:** A reaction in which oxidation and reduction occur simultaneously.

**Oxidation State (Oxidation Number)**

The oxidation number is the **apparent charge** (positive or negative) that an atom would have if all its bonds in a compound were completely ionic.

**Rules for Assigning Oxidation Numbers:**

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



### One-Liner Statements - Electrochemistry

#### 1. Introduction to Electrochemistry

1. **Electrochemistry** is the branch of chemistry dealing with the interconversion of electrical energy and chemical energy.
2. An **electrolytic cell** uses electrical energy to drive a non-spontaneous chemical reaction (electrolysis).
3. A **galvanic** or **voltaic cell** converts chemical energy from a spontaneous reaction into electrical energy.

#### 2. Oxidation and Reduction (Redox)

4. **Oxidation** is defined as the loss of electrons or an increase in oxidation number.
5. **Reduction** is defined as the gain of electrons or a decrease in oxidation number.
6. An **oxidizing agent** accepts electrons and gets reduced during a reaction.
7. A **reducing agent** donates electrons and gets oxidized during a reaction.
8. In the classical concept, oxidation is the addition of oxygen or removal of hydrogen.
9. In the classical concept, reduction is the removal of oxygen or addition of hydrogen.

#### 3. Oxidation State (Oxidation Number)

10. The **oxidation number** is the apparent charge an atom would have if all bonds were 100% ionic.
11. The oxidation number of a free element (e.g., Na, O<sub>2</sub>, Cl<sub>2</sub>) is always zero.
12. The oxidation number of hydrogen is +1, except in metal hydrides (e.g., NaH, CaH<sub>2</sub>) where it is -1.
13. The oxidation number of oxygen is -2, except in peroxides (e.g., H<sub>2</sub>O<sub>2</sub>) where it is -1, and in OF<sub>2</sub> where it is +2.
14. The algebraic sum of oxidation numbers of all atoms in a neutral molecule is zero.
15. The algebraic sum of oxidation numbers of all atoms in a polyatomic ion is equal to the charge on the ion.
16. In K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, the oxidation number of Cr is +6.
17. In H<sub>2</sub>SO<sub>4</sub>, the oxidation number of S is +6.

#### 4. Balancing Redox Reactions

18. The **Oxidation Number Method** balances redox reactions by equating the total increase and decrease in oxidation numbers.
19. The **Ion-Electron (Half-Reaction) Method** splits the reaction into oxidation and reduction half-reactions, which are balanced separately before combining.
20. In the half-reaction method for acidic medium, O atoms are balanced by adding H<sub>2</sub>O and H

M  
K

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

### Practice MCQs

1. Weak electrolyte in solution is:

- A) completely ionized
- B) slightly ionized
- C) never ionized
- D) destroyed

Answer: slightly ionized

2. Which one of the following is a strong electrolyte in solution?

- A) Ammonium hydroxide
- B) Carbonic acid
- C) Potassium iodide
- D) Acetic acid

Answer: Potassium iodide

3. In an electrolytic cell, the cathode has a charge:

- A) Positive
- B) Negative
- C) Neutral
- D) Zero

Answer: Negative

4. The oxidation number of Cl in  $\text{HClO}_3$  is:

- A) -1
- B) +1
- C) +3
- D) +5

Answer: +5

5. The oxidation number of magnesium in  $\text{MgCO}_3$  is:

- A) +3
- B) +2
- C) +1

D) -1

Answer: +2

6. Which one of the following is a reduction reaction?

- A)  $\text{Br}_2 \rightarrow 2\text{Br}^-$
- B)  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$
- C)  $\text{Zn} \rightarrow \text{Zn}^{2+}$
- D)  $\text{Sn}^{2+} \rightarrow \text{Sn}^{4+}$

Answer:  $\text{Br}_2 \rightarrow 2\text{Br}^-$

7. A cell in which a non-spontaneous redox reaction is carried out by passing an electric current is a/an:

- A) Galvanic cell
- B) Voltaic cell
- C) Daniell cell
- D) Electrolytic cell

Answer: Electrolytic cell

8. Zinc rod acts as anode in the Daniell cell but acts as cathode when coupled with aluminum electrode, this is because the standard reduction potential of:

- A)  $\text{Zn} > \text{Al}$
- B)  $\text{Zn} < \text{Al}$
- C)  $\text{Zn} = \text{Al}$
- D) None of these

Answer:  $\text{Zn} > \text{Al}$

9. Electrolysis is a process in which the 'cations' and 'anions' liberated from electrolyte are:

- A) hydrated
- B) hydrolyzed
- C) discharged

# Thermochemistry

## Introduction to Thermochemistry

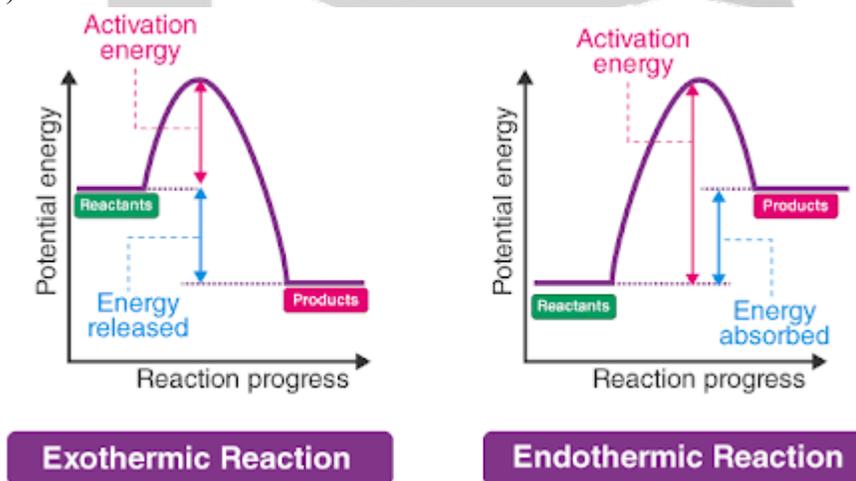
**Thermochemistry** is the branch of physical chemistry that deals with the thermal energy changes (heat changes) that accompany chemical reactions and physical transformations. It is a specific application of the first law of thermodynamics to chemical processes, focusing on the energy stored in substances (internal energy) and the energy transferred as heat during reactions.

**Energy Changes in Reactions:** During a chemical reaction, bonds in the reactants are broken (requiring energy) and new bonds in the products are formed (releasing energy). The net heat change of the reaction is the difference between these two energy values.

**Sign Convention:** The heat change of a reaction is denoted by  $\Delta H$  (enthalpy change). By convention:

$\Delta H = \text{Negative (-ve): Exothermic Reaction.}$  Heat is released to the surroundings (e.g., combustion).

$\Delta H = \text{Positive (+ve): Endothermic Reaction.}$  Heat is absorbed from the surroundings (e.g., photosynthesis).



## Key Thermodynamic Concepts

**System:** The specific part of the universe under study (e.g., reactants in a beaker).

**Surroundings:** Everything else in the universe outside the system.



## One-Liners - Thermochemistry

### Introduction to Thermochemistry

1. **Thermochemistry** is the study of heat energy changes accompanying chemical reactions and physical transformations.
2. An **exothermic** reaction releases heat to the surroundings, indicated by a **negative  $\Delta H$** .
3. An **endothermic** reaction absorbs heat from the surroundings, indicated by a **positive  $\Delta H$** .
4. **Energy** is defined as the capacity to do work.
5. The **Electron Volt (eV)** is the smallest unit of energy, used for sub-atomic particles.
6. The SI unit of energy is the **Joule (J)**.
7. One calorie is equal to **4.184 Joules**.
8. The biggest practical unit of energy is the **Kilowatt-hour (KWH)**, which equals 3.6 million Joules.

### Systems and Surroundings

9. A **system** is the specific part of the universe under observation.
10. The **surroundings** comprise everything else in the universe outside the system.
11. The **boundary** is the real or imaginary surface separating the system from its surroundings.
12. An **open system** can exchange both matter and energy with its surroundings.
13. A **closed system** can exchange energy but not matter with its surroundings.
14. An **isolated system** can exchange neither matter nor energy with its surroundings.
15. The human body is an example of an **open system**.

### State Functions and Path Functions

16. A **state function** is a property whose value depends only on the current state of the system, not the path taken to reach that state.
17. Examples of state functions are **Internal Energy (E), Enthalpy (H), Pressure (P), Volume (V), and Temperature (T)**.
18. **Heat (q)** and **Work (w)** are path functions, as their values depend on the path taken.
19. **Intensive properties** do not depend on the quantity of matter (e.g., Temperature, Density).
20. **Extensive properties** depend on the quantity of matter (e.g., Mass, Volume, Internal Energy).

### First Law of Thermodynamics

21. The **First Law of Thermodynamics** states that energy cannot be created or destroyed, only converted from one form to another (Law of Conservation of Energy).

## Practice MCQs

1. Which of the following is always true for an exothermic reaction?

- A)  $\Delta H$  is positive
- B)  $\Delta H$  is negative
- C)  $\Delta S$  is positive
- D)  $\Delta G$  is negative

Answer:  $\Delta H$  is negative

2. The branch of chemistry that deals with the energy changes in chemical reactions is called:

- A) Electrochemistry
- B) Thermochemistry
- C) Chemical Kinetics
- D) Stoichiometry

Answer: Thermochemistry

3. Which one of the following is an extensive property?

- A) Temperature
- B) Density
- C) Internal Energy
- D) Specific Heat

Answer: Internal Energy

4. In an isolated system, what can be exchanged with the surroundings?

- A) Matter only
- B) Energy only
- C) Both matter and energy
- D) Neither matter nor energy

Answer: Neither matter nor energy

5. A state function is:

- A) Heat (q)
- B) Work (w)
- C) Enthalpy (H)

D) Both q and w

Answer: Enthalpy (H)

6. According to the first law of thermodynamics, the equation for the change in internal energy ( $\Delta E$ ) is:

- A)  $\Delta E = q - w$
- B)  $\Delta E = q / w$
- C)  $\Delta E = q + w$
- D)  $\Delta E = w - q$

Answer:  $\Delta E = q + w$

7. For a system that absorbs heat and does work on the surroundings, the signs of q and w are respectively:

- A) Negative, Negative
- B) Positive, Positive
- C) Positive, Negative
- D) Negative, Positive

Answer: Positive, Negative

8. The work done by a system during an expansion against a constant external pressure is given by:

- A)  $w = P\Delta V$
- B)  $w = -P\Delta V$
- C)  $w = \Delta V/P$
- D)  $w = -\Delta V/P$

Answer:  $w = -P\Delta V$

9. Enthalpy (H) is defined as:

- A)  $E - PV$
- B)  $E / PV$
- C)  $E + PV$
- D)  $PV - E$

Answer:  $E + PV$



# Radio and Nuclear Chemistry

### Introduction to Radioactivity

#### Definition:

**Radioactivity** is the spontaneous disintegration of unstable atomic nuclei, accompanied by the emission of penetrating radiation such as alpha particles, beta particles, and gamma rays. This process is independent of external factors like temperature, pressure, or chemical combination and depends solely on the internal instability of the nucleus.

#### Radioactive Elements:

These are elements whose nuclei are unstable and undergo spontaneous decay to achieve a more stable configuration. Examples include Uranium (U), Radium (Ra), Polonium (Po), and Thorium (Th).

#### Historical Background & Discovery

- **1895 (Wilhelm Roentgen):** Discovered X-rays, which are high-energy electromagnetic radiation. This discovery sparked interest in "invisible rays."
- **1896 (Henri Becquerel):** Accidentally discovered that uranium salts emitted invisible, penetrating rays that could darken a photographic plate without any external energy source. This was the first observation of natural radioactivity.
- **1898 (Marie & Pierre Curie):** Coined the term "radioactivity." They discovered two new, highly radioactive elements: **Polonium** and **Radium**.
- **1899 (Ernest Rutherford):** Identified and named the different types of radiation based on their penetrating power and charge: **Alpha ( $\alpha$ )**, **Beta ( $\beta$ )**, and **Gamma ( $\gamma$ )**.

This series of discoveries fundamentally changed the understanding of the atom, revealing that it was not indivisible and that the nucleus could undergo transformations.

### Types and Properties of Radiations

Rutherford's experiment of passing radiation through an electric field classified the three types based on their deflection.

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



## One-Liners - Radio and Nuclear Chemistry

### 1. Introduction to Radioactivity

1. **Radioactivity** is the spontaneous disintegration of unstable atomic nuclei, emitting radiation.
2. This process is independent of external factors like temperature and pressure.
3. **Radioactive elements**, like Uranium and Radium, have unstable nuclei that decay to achieve stability.

### 2. Historical Background

4. **Wilhelm Roentgen** discovered X-rays in 1895.
5. **Henri Becquerel** discovered natural radioactivity from uranium salts in 1896.
6. **Marie and Pierre Curie** coined the term "radioactivity" and discovered Polonium and Radium.
7. **Ernest Rutherford** identified and named Alpha, Beta, and Gamma radiations in 1899.

### 3. Types and Properties of Radiations

8. **Alpha particles** are helium nuclei with a charge of +2 and mass of 4 amu.
9. **Beta particles** are fast-moving electrons with a charge of -1 and negligible mass.
10. **Gamma rays** are high-energy, neutral, massless electromagnetic radiation.
11. The order of **penetrating power** is: Alpha < Beta < Gamma.
12. The order of **ionizing power** is: Alpha > Beta > Gamma.
13. Alpha rays are deflected towards the negative plate, and Beta rays towards the positive plate in an electric field.
14. Gamma rays are not deflected by electric or magnetic fields.

### 4. Detection and Measurement

15. A **Cloud Chamber** makes the path of ionizing radiation visible as a trail of droplets.
16. An **Ionization Chamber** measures radiation by detecting the electric current from gas ionization.
17. A **Geiger-Muller Counter** uses gas amplification to produce a countable pulse for each radiation event.
18. A **Scintillation Counter** uses a crystal and photomultiplier tube to convert radiation into light and then an electrical pulse.
19. **Film Badges** are used for personnel monitoring by measuring the exposure that darkens photographic film.

### 5. Theory of Radioactive Disintegration

20. Radioactive decay is a spontaneous, random process that follows first-order kinetics.

## Practice MCQs

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

**1. What is the defining characteristic of radioactivity?**

- A) It requires high temperature to initiate
- B) It involves the spontaneous disintegration of unstable nuclei
- C) It only occurs in man-made elements
- D) It is highly dependent on chemical bonding

**Answer: Spontaneous disintegration of unstable nuclei**

**2. Who accidentally discovered natural radioactivity?**

- A) Marie Curie
- B) Wilhelm Roentgen
- C) Henri Becquerel
- D) Ernest Rutherford

**Answer: Henri Becquerel**

**3. Which scientist coined the term "radioactivity"?**

- A) Marie and Pierre Curie
- B) Henri Becquerel
- C) Ernest Rutherford
- D) Wilhelm Roentgen

**Answer: Marie and Pierre Curie**

**4. What is the identity of an alpha particle?**

- A) A high-energy electron
- B) A helium nucleus
- C) A high-energy photon
- D) A proton

**Answer: A helium nucleus**

**5. Which type of radiation has the highest penetrating power?**

- A) Alpha rays
- B) Beta rays
- C) Gamma rays
- D) X-rays

**Answer: Gamma rays**

**6. Which type of radiation has the highest ionizing power?**

- A) Alpha rays
- B) Beta rays
- C) Gamma rays
- D) Neutrons

**Answer: Alpha rays**

**7. In an electric field, towards which plate are beta particles deflected?**

- A) Negative plate
- B) Positive plate
- C) They are not deflected
- D) Perpendicular to the field

**Answer: Positive plate**

**8. Which instrument uses a supersaturated vapor to make radiation paths visible?**

- A) Geiger-Muller Counter
- B) Scintillation Counter
- C) Cloud Chamber
- D) Ionisation Chamber

**Answer: Cloud Chamber**

**9. What is the principle behind a Film Badge used for radiation monitoring?**

- A) Gas ionization
- B) Light scintillation
- C) Film darkening



## Chapter 9

# Biochemistry

## 9. Biochemistry

### Introduction to Biomolecules

**Definition:** Biomolecules are the organic molecules that form the basis of life, produced by living organisms. They are essential for cellular structure, function, and metabolism.

**Major Classes:** The four major classes of organic biomolecules are:

- Carbohydrates
- Lipids
- Proteins
- Nucleic Acids

### Composition of a Cell

The following table illustrates the approximate chemical composition of a typical mammalian cell, highlighting the significance of these biomolecules:

Chemical Component	Percentage in Mammalian Cell
Water	70%
Proteins	18%
Carbohydrates	4%
Lipids	3%
DNA	0.25%
RNA	1.1%
Other Organics & Ions	3.65%

M  
K  
  
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### One-Liners - Biochemistry

#### 1. Introduction to Biomolecules

1. **Biomolecules** are organic molecules essential for cellular structure, function, and metabolism.
2. The four major classes of organic biomolecules are **Carbohydrates, Lipids, Proteins, and Nucleic Acids**.
3. A typical mammalian cell is composed of approximately **70% water**.
4. After water, **proteins** are the most abundant chemical component in a mammalian cell (18%).
5. **Nucleic Acids (DNA & RNA)** together constitute about 1.35% of a mammalian cell's chemical composition.

#### 2. Carbohydrates

6. **Carbohydrates** are defined as polyhydroxy aldehydes or ketones, or substances that yield them upon hydrolysis.
7. The general empirical formula for carbohydrates is  **$C_x(H_2O)_y$** .
8. The primary function of carbohydrates is to serve as a **primary energy source**, with glucose being the main fuel.
9. Carbohydrates are classified into **monosaccharides, oligosaccharides, and polysaccharides** based on the number of monosaccharide units.
10. **Monosaccharides** are the simplest sugars that cannot be hydrolyzed into smaller units.
11. Monosaccharides are classified based on the number of carbon atoms as **trioses, tetroses, pentoses, and hexoses**.
12. **Glucose** is an aldohexose with the molecular formula  $C_6H_{12}O_6$  and is also known as dextrose or blood sugar.
13. In an aqueous solution, glucose predominantly exists in a cyclic form called **glucopyranose**.
14. The  $\alpha$  and  $\beta$  forms of a sugar are called **anomers**, differing at the anomeric carbon.
15. **Mutarotation** is the spontaneous change in optical rotation of a sugar in solution due to interconversion between  $\alpha$  and  $\beta$  anomers.
16. **Epimers** are monosaccharides that differ in configuration around a single carbon atom, other than the anomeric carbon (e.g., Glucose and Galactose at C4).
17. **Oligosaccharides** yield 2 to 10 monosaccharide units upon hydrolysis, with disaccharides being the most common.
18. Disaccharide units are joined by a **glycosidic bond**.
19. **Maltose** is a reducing sugar composed of two glucose units with an  $\alpha$ -1,4 glycosidic

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**1. Which of the following is a polymerization process?**

- A) The cracking of petroleum
- B) Fractional distillation of crude oil
- C) Formation of polyethene
- D) Hydrolysis of proteins

**Answer: Formation of polyethene**

**2. Which one is an addition polymer?**

- A) Nylon-6
- B) Polystyrene
- C) Terylene
- D) Epoxy resin

**Answer: Polystyrene**

**3. Which is a synthetically prepared polymer?**

- A) Animal fat
- B) Starch
- C) Cellulose
- D) PVC

**Answer: PVC**

**4. Vegetable oils are:**

- A) Unsaturated fatty acids
- B) Glycerides of unsaturated fatty acids
- C) Glycerides of saturated fatty acids
- D) Essential oils obtained from plants

**Answer: Glycerides of unsaturated fatty acids**

**5. The water-soluble vitamin is:**

- A) A
- B) D
- C) K
- D) C

**Answer: C**

**6. Which of the following element is not present in all proteins?**

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

**Answer: Sulphur**

**7. Hydrolysis of fats is catalysed by:**

- A) Urease
- B) Maltase
- C) Zymase
- D) Lipases

**Answer: Lipases**

**8. Which of the following statement is incorrect for glucose and sucrose?**

- A) Both are soluble in water
- B) Both are naturally occurring
- C) Both are carbohydrates
- D) Both are disaccharides

**Answer: Both are disaccharides**

**9. Starch is a polymer of:**

- A) Beta-D glucose
- B) Alpha-D glucose
- C) Gamma-D glucose
- D) Alpha-beta-D glucose

**Answer: Alpha-D glucose**

**10. The most abundant proteins present in the connective tissues are:**

- A) Legumin
- B) Collagen
- C) Albumin
- D) Globulin

**Answer: Collagen**



# Aromatic Compounds (Benzene)

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### Introduction to Aromatic Compounds

**Definition:** Aromatic compounds are a class of cyclic, planar, and conjugated organic compounds that exhibit exceptional stability due to the delocalization of  $\pi$ -electrons. The term "aromatic" originally referred to their pleasant fragrances but now is based on their specific chemical structure and stability.

**Parent Molecule:** Benzene ( $C_6H_6$ ) is the fundamental and simplest aromatic hydrocarbon. All compounds that resemble benzene in chemical behavior, particularly their unusual stability, are classified as aromatic.

#### Historical Context:

**Michael Faraday** first isolated benzene in 1825 from the oily residue of London's illuminating gas.

**Eilhardt Mitscherlich** synthesized it in 1834 by heating benzoic acid with lime.

The name "**benzene**" is derived from "gum benzoin," a fragrant resin from which benzoic acid was obtained.

**Health Warning:** Benzene is a known carcinogen (causes leukemia) and should be handled with extreme care.

### Nomenclature of Benzene Derivatives

The systematic process of naming benzene derivatives follows IUPAC rules, though many common names are retained.

**Monosubstituted Benzenes:** Compounds with one substituent on the benzene ring.

**IUPAC System:** Named by adding the substituent name as a prefix to "benzene."

Example:  $C_6H_5-Br$  is **Bromobenzene**;  $C_6H_5-NO_2$  is **Nitrobenzene**.

**Common Names:** Some derivatives have widely accepted common names that are used in preference to systematic names.



## One Liner - Aromatic Compounds

1. Aromatic compounds are cyclic, planar, conjugated, and obey Hückel's  $(4n+2)$   $\pi$ -electron rule.
2. Benzene ( $C_6H_6$ ) is the parent aromatic hydrocarbon with a delocalized  $\pi$ -cloud of 6 electrons.
3. The resonance energy of benzene is **152 kJ/mol**, explaining its exceptional stability.
4. Benzene primarily undergoes **Electrophilic Aromatic Substitution (EAS)** reactions to preserve its aromaticity.
5. The EAS mechanism involves the formation of a resonance-stabilized **arenium ion** intermediate.
6. Substituents on the ring are classified as **Activating/Deactivating** and **Ortho-Para/Meta Directing**.
7. **Ortho/Para directors** are generally electron-donating groups (except halogens).
8. **Meta directors** are strong electron-withdrawing groups.
9. The benzene ring is resistant to addition and oxidation, but alkyl side-chains can be oxidized to  $-COOH$ .

### Aromatic Compounds & Electrophilic Aromatic Substitution: Detailed One-Liners

#### 1. Introduction & History

1. **Aromatic compounds** are a class of cyclic, planar, and conjugated organic compounds that exhibit exceptional stability due to the delocalization of  $\pi$ -electrons.
2. **Benzene ( $C_6H_6$ )** is the simplest and parent aromatic hydrocarbon.
3. **Michael Faraday** first isolated benzene in 1825 from the oily residue of coal gas.
4. **Eilhardt Mitscherlich** synthesized benzene by heating benzoic acid with lime in 1834.
5. The name "benzene" is derived from "gum benzoin," a fragrant resin from which benzoic acid was obtained.
6. Benzene is a known **carcinogen** and can cause leukemia (leukopenia).

#### 2. Nomenclature of Benzene Derivatives

7. **Monosubstituted benzenes** are named by adding the substituent as a prefix to "benzene" (e.g.,  $C_6H_5-Br$  is Bromobenzene).
8. Common names for monosubstituted benzenes include **Toluene** ( $C_6H_5-CH_3$ ), **Phenol** ( $C_6H_5-OH$ ), **Aniline** ( $C_6H_5-NH_2$ ), **Benzaldehyde** ( $C_6H_5-CHO$ ), and **Benzoic acid** ( $C_6H_5-COOH$ ).
9. For **disubstituted benzenes**, **ortho (o-)** denotes a 1,2 relationship, **meta (m-)** denotes a 1,3 relationship, and **para (p-)** denotes a 1,4 relationship.
10. If one substituent gives a special name (like  $-OH$  in phenol), the compound is named as a derivative of that parent, with the special group at position 1 (e.g.,  $NO_2-C_6H_4-OH$  is \*o\*-Nitrophenol).



3. Phenanthrene contains \_\_\_\_\_ benzene rings.

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

Answer: Three

4. Aniline is a derivative of benzene which contains \_\_\_\_\_.

- A) Hydroxyl group
- B) Amino group
- C) Amido group
- D) Imido group

Answer: Amino group

5. How many  $\pi$  electrons are there in benzene?

- A) 3
- B) 4
- C) 6
- D) 8

Answer: 6

6. When two or more different substituents are attached to a benzene ring, the number 1 position is given to the highest priority group. Which one has the highest priority?

- A)  $\text{-NH}_2$
- B)  $\text{-CHO}$
- C)  $\text{-COOH}$
- D)  $\text{-CN}$

Answer:  $\text{-COOH}$

7. Which one of the following is NOT a meta-directing group?

- A)  $\text{-CN}$
- B)  $\text{-OH}$

C)  $\text{-COOH}$

D)  $\text{-CHO}$

Answer:  $\text{-OH}$

8. Which pair of groups contains both ortho- and para-directors?

- A)  $\text{-OH}$ ,  $\text{-RCO}$
- B)  $\text{-NR}_3$ ,  $\text{-CN}$
- C)  $\text{-OCH}_3$ ,  $\text{-CHO}$
- D)  $\text{-N(CH}_3)_2$ ,  $\text{-NH}_2$

Answer:  $\text{-N(CH}_3)_2$ ,  $\text{-NH}_2$

9. Michael Faraday discovered benzene in the gas produced by destructive distillation of vegetable oil done in \_\_\_\_\_.

- A) The presence of oxygen
- B) The presence of hydrogen
- C) The absence of oxygen
- D) The presence of excessive oxygen

Answer: The absence of oxygen

10. How many moles of  $\text{H}_2$  are added when benzene is hydrogenated to cyclohexane?

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

Answer: Three

11. The heat of hydrogenation of cyclohexene is \_\_\_\_\_.

- A)  $-219.5$  kJ/mole
- B)  $219.5$  calories/mole
- C)  $-119$  kJ/mole
- D)  $-119$  Cal/mole

Answer:  $-119$  kJ/mole



## Carbonyl Compounds – Aldehydes, Ketones, and Carboxylic Acid Derivatives

### Introduction to Carbonyl Compounds

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**Definition:** Carbonyl compounds are a major class of organic molecules characterized by the presence of a **carbonyl functional group**, which consists of a carbon atom doubly bonded to an oxygen atom ( $>C=O$ ).

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**Significance:** This group is highly reactive and is a key structural feature in many biological molecules (like sugars and metabolic intermediates) and industrial chemicals (like solvents, pharmaceuticals, and polymers).

#### Major Classes:

The nature of the atoms or groups attached to the carbonyl carbon determines the class of the compound and its reactivity.

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- **Aldehydes (R-CHO):** The carbonyl carbon is bonded to at least one hydrogen atom.
- **Ketones (R-CO-R')**: The carbonyl carbon is bonded to two alkyl or aryl groups.
- **Carboxylic Acids (R-COOH):** The carbonyl carbon is bonded to a hydroxyl group (-OH).
- **Carboxylic Acid Derivatives:**
- **Esters (R-COO-R')**
- **Amides (R-CONH<sub>2</sub>, R-CONHR, R-CONR<sub>2</sub>)**
- **Acyl Chlorides (R-COCl)**
- **Acid Anhydrides (R-CO-O-CO-R')**

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#### Important;

**Ketonic group is present in camphor and menthone.**

Aldehyde group is present in most sugars (Any sugar where this group is present is known as reducing sugar). It is the principal constituent of number of essential oils used as fragrances and flavours.



### One Liner - Carbonyl Compounds

#### 1. Introduction to Carbonyl Compounds

1. Organic compounds containing the **carbonyl functional group** ( $>C=O$ ) are called carbonyl compounds.
2. The carbonyl group consists of a carbon atom doubly bonded to an oxygen atom.
3. Major classes include **aldehydes, ketones, carboxylic acids**, and their **derivatives** (esters, amides, acyl chlorides, acid anhydrides).
4. In **aldehydes**, the carbonyl carbon is bonded to at least one hydrogen atom ( $R-CHO$ ).
5. In **ketones**, the carbonyl carbon is bonded to two alkyl or aryl groups ( $R-CO-R'$ ).
6. Aldehydes are terminal functional groups and have no position isomerism.

#### 2. Nomenclature

7. The IUPAC suffix for aldehydes is **-al**.
8. In IUPAC naming of aldehydes, the carbonyl carbon is always assigned number **1**.
9. For cyclic aldehydes where  $-CHO$  is attached to a ring, the suffix **-carbaldehyde** is used.
10. The IUPAC suffix for ketones is **-one**.
11. In ketones, the chain is numbered to give the carbonyl carbon the **lowest possible number**.
12. Common names for ketones are derived by naming the two alkyl groups followed by the word "**ketone**".

#### 3. Structure and Physical Properties

13. The carbonyl carbon is  **$sp^2$ -hybridized**, resulting in a **trigonal planar** geometry with bond angles of  $\sim 120^\circ$ .
14. The  $C=O$  bond is **polar** due to the electronegativity difference between carbon and oxygen.
15. Carbonyl compounds have **higher boiling points** than alkanes of similar molecular weight due to **dipole-dipole interactions**.
16. They have **lower boiling points** than comparable alcohols because they **cannot form intermolecular hydrogen bonds** with each other.
17. Lower members (up to  $C_4$ ) are **soluble in water** as the carbonyl oxygen can hydrogen bond with water.

#### 4. Preparation of Aldehydes and Ketones

18. **Primary alcohols** undergo controlled oxidation to form **aldehydes** using reagents like **PCC** or **Dess-Martin Periodinane**.
19. **Secondary alcohols** are oxidized to **ketones** by common oxidizing agents like

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1. Which of the following is the IUPAC name for  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ ?

- A) Propanal
- B) Butanal
- C) Pentanal
- D) Butanone

Answer: Butanal

2. The carbonyl carbon in both aldehydes and ketones is:

- A)  $\text{sp}$ -hybridized
- B)  $\text{sp}^2$ -hybridized
- C)  $\text{sp}^3$ -hybridized
- D) None of these

Answer:  $\text{sp}^2$ -hybridized

3. Which reagent is used to oxidize a primary alcohol to an aldehyde without further oxidation to an acid?

- A)  $\text{KMnO}_4$
- B)  $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}_2\text{SO}_4$
- C) PCC
- D)  $\text{LiAlH}_4$

Answer: PCC

4. The product of the Friedel-Crafts acylation of benzene with  $\text{CH}_3\text{COCl}$  is:

- A) Acetophenone
- B) Toluene
- C) Benzoic acid
- D) Benzaldehyde

Answer: Acetophenone

5. Which compound will react with  $\text{NaHSO}_3$  to form a crystalline addition product?

- A)  $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$

- B)  $\text{HCHO}$
- C)  $(\text{CH}_3)_3\text{CCHO}$
- D)  $\text{C}_6\text{H}_5\text{COCH}_3$

Answer:  $\text{HCHO}$

6. The reaction of an aldehyde with  $\text{HCN}$  is an example of:

- A) Electrophilic substitution
- B) Nucleophilic substitution
- C) Electrophilic addition
- D) Nucleophilic addition

Answer: Nucleophilic addition

7. A positive iodoform test is given by:

- A)  $\text{CH}_3\text{CH}_2\text{OH}$
- B)  $\text{CH}_3\text{OH}$
- C)  $(\text{CH}_3)_3\text{CCHO}$
- D)  $\text{CH}_3\text{CH}_2\text{CHO}$

Answer:  $\text{CH}_3\text{CH}_2\text{OH}$

8. Which of the following will not undergo aldol condensation?

- A)  $\text{CH}_3\text{CHO}$
- B)  $\text{HCHO}$
- C)  $\text{CH}_3\text{COCH}_3$
- D)  $\text{CH}_3\text{CH}_2\text{CHO}$

Answer:  $\text{HCHO}$

9. In the Cannizzaro reaction, two molecules of an aldehyde react to yield:

- A) An alcohol and a ketone
- B) An alcohol and a carboxylic acid salt
- C) Two alcohols
- D) A ketone and a carboxylic acid

Answer: An alcohol and a carboxylic acid salt



## Halogenoalkanes (Alkyl Halides) & SN Reactions

### Introduction to Halogenoalkanes

**Definition:** Halogenoalkanes, also known as alkyl halides, are organic compounds in which one or more hydrogen atoms of an alkane have been replaced by halogen atoms (F, Cl, Br, I). Their general formula is **R-X**.

Or

**Monohalo alkanes** (R-X) are called alkyl halides.

It is a class of compounds where a **halogen atom is bound to an  $sp^3$  orbital** of an alkyl group

**Halogenoarenes:** These are compounds where a halogen is attached directly to an aromatic ring. Their general formula is **Ar-X** (where Ar is an aryl group, e.g.,  $C_6H_5-$ ).

### Classification of Alkyl Halides

Alkyl halides are classified based on the carbon atom to which the halogen is bonded.

**Primary ( $1^\circ$ ) Alkyl Halide:** The halogen atom is attached to a carbon atom that is itself attached to only one other carbon atom.

**Examples:**  $CH_3-Cl$  (Chloromethane),  $CH_3-CH_2-Br$  (Bromoethane).

**Secondary ( $2^\circ$ ) Alkyl Halide:** The halogen atom is attached to a carbon atom that is attached to two other carbon atoms.

**Example:**  $(CH_3)_2CH-Cl$  (2-Chloropropane or Isopropyl chloride).

**Tertiary ( $3^\circ$ ) Alkyl Halide:** The halogen atom is attached to a carbon atom that is attached to three other carbon atoms.

**Example:**  $(CH_3)_3C-Cl$  (2-Chloro-2-methylpropane or tert-Butyl chloride)

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1. The carbon atom in an alkyl halide is:

- A)  $sp$  hybridized
- B)  $sp^2$  hybridized
- C)  $sp^3$  hybridized
- D) unhybridized

**Answer: C)  $sp^3$  hybridized**

2. Which of the following is a tertiary alkyl halide?

- A)  $CH_3CH_2Br$
- B)  $(CH_3)_2CHCl$
- C)  $CH_3Cl$
- D)  $(CH_3)_3CBr$

**Answer: D)  $(CH_3)_3CBr$**

3. The correct order of boiling points for alkyl chlorides is:

- A)  $CH_3Cl > C_2H_5Cl > CH_3Br$
- B)  $C_2H_5Cl > CH_3Cl > C_2H_5Br$
- C)  $CH_3Cl < C_2H_5Cl < C_3H_7Cl$
- D)  $C_3H_7Cl < C_2H_5Cl < CH_3Cl$

**Answer: C)  $CH_3Cl < C_2H_5Cl < C_3H_7Cl$**

4. Which reagent is best for converting ethanol to chloroethane?

- A)  $Cl_2/UV$  light
- B)  $NaCl$
- C)  $SOCl_2$
- D)  $HCl$  in water

**Answer: C)  $SOCl_2$**

5. The most reactive alkyl halide towards  $SN_2$  reaction is:

- A)  $(CH_3)_3C-Br$
- B)  $CH_3-CH_2-Br$
- C)  $CH_3-Br$
- D)  $(CH_3)_2CH-Br$

**Answer: C)  $CH_3-Br$**

6. In an  $SN_1$  reaction, the rate-determining step involves the formation of a:

- A) Free radical

- B) Carbanion
- C) Carbocation
- D) Carbene

**Answer: C) Carbocation**

7. Which factor favors the  $SN_1$  mechanism over  $SN_2$ ?

- A) A primary substrate
- B) A strong nucleophile
- C) A polar protic solvent
- D) A polar aprotic solvent

**Answer: C) A polar protic solvent**

8. The major product of the  $E_2$  elimination of 2-bromobutane with ethoxide is:

- A) 1-Butene
- B) 2-Butene (cis and trans)
- C) Butane
- D) 1-Bromobutane

**Answer: B) 2-Butene (cis and trans)**

9. Which of the following is the best leaving group?

- A)  $F^-$
- B)  $Cl^-$
- C)  $Br^-$
- D)  $I^-$

**Answer: D)  $I^-$**

10. Racemization occurs in which type of reaction?

- A)  $SN_2$
- B)  $E_2$
- C)  $SN_1$
- D)  $E_1$

**Answer: C)  $SN_1$**

11. The general formula of a Grignard reagent is:

- A)  $R-Mg-OH$
- B)  $R-Mg-X$
- C)  $R-Mg-OR$



## Chapter 13

# Industrial Chemistry & Synthetic Polymers

## Introduction to Industrial Chemistry

**Definition:** Industrial chemistry is the branch of chemistry concerned with the chemical processing of raw materials into usable and profitable products. These products can be final consumer goods or intermediate chemicals used to manufacture other items.

### Scope and Importance:

- It is a highly diverse manufacturing sector that produces thousands of chemicals, which the public encounters as end-use products.
- These products are valued for the specific effects or properties they provide, such as non-stick coatings or weed killers.
- Chemical processing involves both chemical conversion (e.g., manufacturing sulphuric acid from sulphur) and physical operations (e.g., heat transfer, temperature control) to achieve high yields required by a competitive industry.

### Importance of Chemical Industry in Pakistan's Economy

The chemical industry is a cornerstone of Pakistan's economic development and international trade.

**Economic Contribution:** It accounts for approximately **4.5% of total exports** and **12% of total imports**.

**Industrial Role:** It is a key enabler for **forward-oriented industries** (e.g., automobiles, textiles, leather goods, food and beverages) and **backward-oriented industries** (e.g., supplying surfactants to oil refineries).

**Growth Factors:** The sector has experienced rapid growth due to:

- Rising domestic demand
- Improved availability of raw materials
- Supportive government policies
- Increased foreign investment
- Technological advancements
- Enhanced regional integration



## One Liners - Polymers

### 1. Introduction to Polymers

1. A **polymer** is a high molecular mass substance consisting of a large number of repeating units.
2. The simpler molecules from which polymers are made are called **monomers**.
3. The process of converting monomers into polymers is called **polymerization**.
4. A polymer formed from only one type of monomer is called a **homopolymer** (e.g., PVC).
5. A polymer formed from two or more different types of monomers is called a **copolymer** (e.g., Bakelite).

### 2. Classification Based on Origin and Availability

6. **Natural polymers** occur naturally in plants and animals (e.g., proteins, starch, cellulose, rubber).
7. **Biopolymers** are a category of naturally occurring, biodegradable polymers.
8. **Semi-synthetic polymers** are derived from natural polymers but are chemically modified (e.g., Rayon, Vulcanized Rubber).
9. **Synthetic polymers** are human-made (e.g., Nylon, Polyethylene, Polypropylene).

### 3. Classification Based on Structure

10. **Linear polymers** have long, straight chains and are flexible (e.g., HDPE, Nylon).
11. **Branched-chain polymers** have branches extending from the main chain, making them less dense (e.g., LDPE).
12. **Cross-linked polymers** have chains linked by a 3D network, making them rigid and insoluble (e.g., Bakelite, Vulcanized Rubber).

### 4. Classification Based on Molecular Forces & Properties

13. **Thermoplastics** soften on heating and harden on cooling due to moderate intermolecular forces (e.g., PE, PP, PVC).
14. **Thermosetting polymers** permanently harden upon heating due to strong covalent cross-links (e.g., Bakelite, Epoxy resins).
15. **Elastomers** are rubber-like and elastic due to weak van der Waals forces (e.g., Natural rubber, Neoprene).
16. **Fibers** possess high tensile strength due to strong intermolecular forces like hydrogen bonding (e.g., Nylon, Polyester).
17. **Van der Waals forces** are weak attractive forces between molecules.
18. **Dipole-dipole interactions** are attractive forces between the positive end of one polar molecule and the negative end of another.

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1. What are the simpler molecules that give rise to polymers called?

- A) Polymers
- B) Copolymers
- C) Monomers
- D) Cross-linkers

**Answer: Monomers**

2. Which type of polymer consists of only one type of monomer molecule?

- A) Copolymer
- B) Synthetic Polymer
- C) Thermoplastic
- D) Homopolymer

**Answer: Homopolymer**

3. Which type of synthetic polymer can be melted and reshaped upon heating?

- A) Thermoplastic
- B) Thermosetting
- C) Elastomer
- D) Fibers

**Answer: Thermoplastic**

4. What is the primary characteristic of cross-linked polymers?

- A) High solubility
- B) Low flexibility
- C) Three-dimensional network
- D) Linear chains

**Answer: Three-dimensional network**

5. What is the monomer of Polyvinyl Chloride (PVC)?

- A) Vinyl acetate
- B) Styrene
- C) Vinyl chloride

D) Acrylonitrile

**Answer: Vinyl chloride**

6. What is a common use of Nylon-6,6?

- A) Non-stick cookware
- B) Carpet fibers
- C) Food packaging
- D) Disposable cups

**Answer: Carpet fibers**

7. Which of the following rubber is not a polydiene?

- A) Nitrile rubber
- B) Polyisoprene
- C) Polychloroprene
- D) Thiol rubber

**Answer: Nitrile rubber**

8. Nylon is made up of:

- A) Polyvinyl
- B) Polyamide
- C) Polyester
- D) Polyethylene

**Answer: Polyamide**

9. Which one of the following is a chain growth polymer?

- A) Teflon
- B) Nylon-6,6
- C) Nylon-6
- D) Bakelite

**Answer: Teflon**

10. Orlon is a polymer of:

- A) Styrene
- B) Tetrafluoroethene
- C) Acrylonitrile

# Periodic Classification of Elements and Atomic Structure

## Historical Development Of The Periodic Table

### M Early Attempts at Classification

**K Al-Razi:** Classified substances based on their physical and chemical properties.

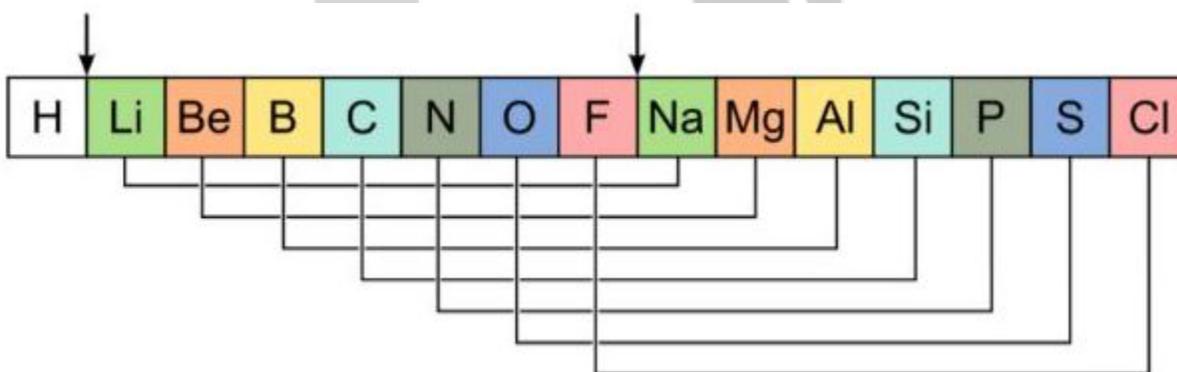
**Dobereiner's Triads (1829):** Grouped elements into triads (groups of three) with similar properties. The atomic mass of the middle element was roughly the average of the other two.

Element	Atomic weight (amu)	Element	Atomic weight (amu)	Element	Atomic weight (amu)
<i>Li</i>	7	<i>Ca</i>	40	<i>Cl</i>	35.5
<i>Na</i>	23	<i>Sr</i>	88	<i>Br</i>	80
<i>K</i>	39	<i>Ba</i>	137	<i>I</i>	127

Table: Dobereiner's triads

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**Newlands' Law of Octaves (1864):** Noted that when elements were arranged by increasing atomic mass, every eighth element had similar properties, like the octaves in music.



### Mendeleev's Periodic Table (1871)

**Basis:** Arranged elements in ascending order of their **atomic masses**.

**Structure:** Presented a regular table with vertical columns called **Groups** and horizontal rows called **Periods**.



## One-Liner - Classification of Elements & Atomic Structure

### 1. Historical Development of the Periodic Table

1. **Al-Razi** classified substances based on their physical and chemical properties.
2. **Dobereiner** grouped elements into **triads** where the atomic mass of the middle element was approximately the average of the other two.
3. **Newlands** proposed the **Law of Octaves**, stating that every eighth element had similar properties when arranged by atomic mass.
4. **Mendeleev** created the first successful periodic table based on **atomic masses**.
5. Mendeleev's **Periodic Law** states that the properties of elements are a periodic function of their atomic masses.
6. A major achievement of Mendeleev's table was the correct **prediction of the properties of undiscovered elements** like Gallium and Germanium.
7. The modern periodic table is based on **atomic number**, as established by **Henry Moseley**.
8. The **Modern Periodic Law** states that the properties of elements are a periodic function of their atomic numbers.
9. The modern table rectifies the position of **isotopes** as they have the same atomic number.
10. The **noble gases** (Group 18) were a new addition to the modern periodic table.

### 2. Structure of the Modern Periodic Table

11. **Groups** are the vertical columns in the periodic table, and elements in the same group have the same number of **valence electrons**.
12. **Periods** are the horizontal rows, and the period number signifies the **highest principal quantum number (n)**.
13. Based on the subshell being filled, elements are classified into **s, p, d, and f blocks**.
14. **s-block elements** have valence electrons in the s-orbital and include **Groups 1 and 2** (Alkali and Alkaline Earth Metals).
15. **p-block elements** have valence electrons in the p-orbital and include **Groups 13 to 18**.
16. **d-block elements** have valence electrons in the d-orbital and include **Groups 3 to 12**, known as **Transition Elements**.
17. **f-block elements** have valence electrons in the f-orbital and are called **Inner Transition Elements** (Lanthanides and Actinides).
18. **Group 1** elements are called **Alkali Metals**.
19. **Group 2** elements are called **Alkaline Earth Metals**.
20. **Group 17** elements are called **Halogens**.
21. **Group 18** elements are called **Noble Gases**.

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## Practice MCQs

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1. Which of the following pairs are chemically dissimilar?

- A) Na and K
- B) Ba and Sr
- C) Zr and Hf
- D) Ca and Zn

Answer: D) Ca and Zn

2. The total number of inner transition elements is:

- A) 10
- B) 14
- C) 28
- D) 30

Answer: C) 28

3. The alkali metal which is liquid at 15°C is:

- A) K
- B) Cs
- C) Na
- D) None

Answer: D) None

4. Which of the following ion will form most water soluble hydroxide?

- A) K<sup>+</sup>
- B) Ni<sup>2+</sup>
- C) Zn<sup>2+</sup>
- D) Al<sup>3+</sup>

Answer: A) K<sup>+</sup>

5. Which of the following has greatest tendency to lose electron?

- A) F
- B) Fr
- C) S

D) Be

Answer: B) Fr

6. The oxide of which of the following elements will be acidic in character:

- A) Mg
- B) Rb
- C) Li
- D) Cl

Answer: D) Cl

7. Which of the following is isoelectronic with carbon atom?

- A) Na<sup>+</sup>
- B) Al<sup>3+</sup>
- C) O<sup>-</sup>
- D) N<sup>+</sup>

Answer: B) Al<sup>3+</sup>

8. Which of the following ions are paramagnetic in character?

- A) Zn<sup>2+</sup>
- B) Cu<sup>+</sup>
- C) Ni<sup>2+</sup>
- D) Ag<sup>+</sup>

Answer: C) Ni<sup>2+</sup>

9. Ca<sup>2+</sup> ion is isoelectronic with:

- A) Mg<sup>2+</sup>
- B) Na<sup>+</sup>
- C) Ar
- D) Kr

Answer: C) Ar

10. Gradual addition of electronic shells in the noble gases causes a decrease in their:

- A) Ionization energy



### S and P-Block Elements

Elements are classified into blocks based on the type of atomic orbital in which the valence electrons reside.

Block	Valence Orbital	General Electronic Configuration	Groups Included
s-Block	s-orbital	$ns^{1-2}$	IA (Alkali metals), IIA (Alkaline earth metals), and Helium
p-Block	p-orbital	$ns^2 np^{1-6}$	IIIA to VIIIA (Noble gases), except Helium
d-Block	d-orbital	$(n-1)d^{1-10} ns^2$	Transition elements (Group IIIB to VIIIB, IB, IIB)
f-Block	f-orbital	$(n-2)f^{1-14} (n-1) d^{0-1} ns^2$	Lanthanides and Actinides

#### General Properties of S-Block Elements

##### Physical Properties

**Appearance:** Soft, silvery-white, lustrous metals (except Lithium turns grey in air).

**Density & Melting/Boiling Points:** Low density, low melting, and boiling points (Alkali metals are softer than Alkaline Earth metals).

**Conductivity:** Excellent conductors of heat and electricity.

**Flame Colors:** Impart characteristic colors to flames (e.g., **Li: Red, Na: Yellow, K: Violet**).

##### Chemical Properties

**Valence Electrons:** Have 1 (Group 1) or 2 (Group 2) electrons in their outermost *s*-orbital, with general configuration  $ns^1$  or  $ns^2$ .

**Ionization Energy:** Very low ionization enthalpies, making them highly electropositive.

**Reactivity:** Highly reactive; reactivity increases down the group, typically stored in oil (except Be, Mg).

**Ion Formation:** Easily lose valence electrons to form +1 (Group 1) or +2 (Group 2) ions (cations).

**Compound Nature:** Form predominantly ionic compounds (except,  $BeCl_2$ ).

**Oxides:** Form basic oxides and hydroxides (e.g.,  $M_2O$ ,  $MO$ ), which react with water to form strong bases (alkalies).

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## One-Liners - s and p-Block Elements

### 1. The Periodic Table and Periodicity

1. The **Modern Periodic Table** is arranged based on increasing **atomic number**.
2. For s- and p-block elements, the **group number** equals the number of **valence electrons**.
3. The **period number** indicates the total number of **electron shells** in an atom.
4. **Valence electrons** are the electrons in the outermost shell and determine an element's chemical properties.
5. **Metals** typically have 1-3 valence electrons and tend to lose electrons to form **cations**.
6. **Non-metals** typically have 4-7 valence electrons and tend to gain electrons to form **anions**.
7. **Metalloids** (e.g., B, Si, Ge) exhibit properties of both metals and non-metals.
8. **Noble gases** have a completely filled valence shell and are chemically very unreactive.
9. Elements are classified into **s, p, d, and f blocks** based on the orbital where the valence electrons reside.
10. The general electronic configuration for the **s-block** is  $ns^{1-2}$ .
11. The general electronic configuration for the **p-block** is  $ns^2 np^{1-6}$ .

### 2. Periodic Trends in Physical Properties

#### Trends Down a Group:

12. **Atomic/Ionic radius increases** down a group due to an increase in the number of electron shells.
13. **Ionization Energy (IE) decreases** down a group due to increased atomic size and the shielding effect.
14. **Electron Affinity (EA) decreases** down a group due to increased atomic size and shielding.
15. An exception to the EA trend is that **Chlorine has a higher electron affinity than Fluorine**.
16. **Electronegativity (EN) decreases** down a group.
17. **Metallic character increases** down a group.
18. **Electropositive character increases** down a group.

#### Trends Across a Period:

19. **Atomic radius decreases** across a period due to an increase in effective nuclear charge.
20. **Ionization Energy (IE) increases** across a period due to decreasing atomic radius.
21. An exception to the IE trend is that **Nitrogen has a higher IE than Oxygen** due to its



- B)  $\text{NO}_2$
- C)  $\text{N}_2\text{O}$
- D)  $\text{NO}$

Answer:  $\text{N}_2\text{O}$

3. The basicity of orthophosphoric acid ( $\text{H}_3\text{PO}_4$ ) is:

- A) 1
- B) 2
- C) 3
- D) 4

Answer: 3

4. Bone ash contains calcium phosphate approximately:

- A) 40%
- B) 50%
- C) 70%
- D) 80%

Answer: 80%

5. In the Contact Process, arsenic impurities are removed:

- A) by prolong heating the gases
- B) by treating with  $\text{Fe}(\text{OH})_3$
- C) in the scrubbing tower
- D) in the absorption tower

Answer: by treating with  $\text{Fe}(\text{OH})_3$

6. Which of the following acids possesses oxidizing and reducing properties?

- A)  $\text{HCl}$
- B)  $\text{HNO}_2$
- C)  $\text{HNO}_3$
- D)  $\text{H}_2\text{SO}_4$

Answer:  $\text{HNO}_2$

7. Sugar becomes black when concentrated  $\text{H}_2\text{SO}_4$  is added due to:

- A) Hydrolysis
- B) Hydration
- C) Dehydration
- D) Decolourization

Answer: Dehydration

8.  $\text{SO}_3$  is not absorbed directly in water to form  $\text{H}_2\text{SO}_4$  because:

- A) The reaction does not go to completion
- B) The reaction is quite slow
- C) The reaction is highly exothermic
- D)  $\text{SO}_3$  is insoluble in water

Answer: The reaction is highly exothermic

9. Nitric acid behaves as an oxidizing agent in its reaction with:

- A) Ammonia
- B) Sodium hydroxide
- C) Copper
- D) Sodium carbonate

Answer: Copper

10. Which of the following oxyacids has reducing power?

- A)  $\text{H}_3\text{PO}_3$
- B)  $\text{H}_3\text{PO}_4$
- C)  $\text{H}_4\text{P}_2\text{O}_7$
- D) All of these

Answer:  $\text{H}_3\text{PO}_3$

11. Fuming nitric acid contains an excess of:

- A)  $\text{N}_2\text{O}_5$
- B)  $\text{NO}_2$
- C)  $\text{NO}$
- D) All these oxides

Answer:  $\text{NO}_2$

# Transition Elements (d-Block) & Coordination Chemistry

## Introduction to Transition Elements

### Definition:

Transition elements are defined as those elements which have incompletely filled **d-orbitals** in their ground state or in any of their common oxidation states. The f-block elements (Lanthanides and Actinides) are often called **Inner Transition Elements** and have incompletely filled f-orbitals.

d- block elements										
3d series →	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
4d series →	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd
5d series →	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg

### Location in the Periodic Table:

They are located in the central part of the periodic table, spanning **Groups 3 to 12**, positioned between the electropositive s-block metals and the electronegative p-block elements.

### Electronic Configuration

#### General Valence Shell Configuration:

The general electronic configuration for d-block elements is  $(n-1) d^{1-10} ns^{1-2}$ .

- **First Transition Series (3d):** Scandium (Sc, 21) to Zinc (Zn, 30)
- **Second Transition Series (4d):** Yttrium (Y, 39) to Cadmium (Cd, 48)
- **Third Transition Series (5d):** Lanthanum (La, 57), Hafnium (Hf, 72) to Mercury (Hg, 80)
- **Fourth Transition Series (6d):** Actinium (Ac, 89), Rutherfordium (Rf, 104) onwards (incomplete and radioactive).

#### Exceptions to the Aufbau Principle:



## One Liners - Transition elements and Coordination Chemistry:

1. **Transition elements** are defined as those elements which have incompletely filled **d-orbitals** in their ground state or in any of their common oxidation states.
2. The general electronic configuration of transition elements is  $(n-1)d^{1-10} ns^{1-2}$ .
3. Zinc (Zn), Cadmium (Cd), and Mercury (Hg) are not considered typical transition elements as their d-subshell is completely filled.
4. Transition elements are characterized by **variable oxidation states, complex formation, and colored ions**.
5. Not all ions of transition elements are colored; for example,  $Sc^{3+}$  and  $Zn^{2+}$  are colorless due to empty and fully filled d-orbitals, respectively.
6. Transition elements can form **interstitial compounds** when small non-metal atoms like H, B, C, or N occupy the empty spaces in their crystal lattices.
7. The formation of interstitial compounds makes the parent metal **more brittle and harder**.
8. **Non-stoichiometric compounds** are those that do not obey the law of definite proportions and are often **interstitial compounds**.
9. Transition elements and their compounds often act as good **catalysts** due to their variable oxidation states.
10. Negative oxidation states are shown by transition elements in **complexes** and **carbonyls**.

### 2. Electronic Configurations and Paramagnetism

11. The electronic configuration of Chromium (Cr, Z=24) is  $3d^5 4s^1$ , not  $3d^4 4s^2$ , due to the extra stability of a half-filled d-subshell.
12. The number of **unpaired electrons** in an atom or ion determines its **paramagnetic character**.
13. The ion with the maximum number of unpaired electrons will exhibit the **maximum paramagnetic character**.
14.  $Mn^{2+}$  ion has the electronic configuration  $[Ar] 3d^5$ , meaning it has **5 unpaired electrons**.
15.  $Fe^{3+}$  ion has the electronic configuration  $[Ar] 3d^5$ , meaning it also has **5 unpaired electrons**.
16.  $Cu^{2+}$  ion has the electronic configuration  $[Ar] 3d^9$ , meaning it has only **1 unpaired electron**.
17. The **least paramagnetism** is shown by ions with the fewest or zero unpaired electrons, such as  $Cu^{2+}$ .
18. Along a period in the transition series, the **paramagnetic character** first increases to a maximum and then decreases.
19. Along a period, the **covalent radii** of transition elements in their ionic state generally **decrease**.

2. Which element has three unpaired electrons?

- A) Al
- B) Sc
- C) Cr
- D) Ni

Answer: Cr

3. The geometry of which complex is square planar?

- A)  $[\text{MnCl}_4]^{2-}$
- B)  $[\text{Cu}(\text{NH}_3)_4]^{2+}$
- C)  $\text{PCl}_5$
- D)  $[\text{Co}(\text{NH}_3)_6]^{3+}$

Answer:  $[\text{Cu}(\text{NH}_3)_4]^{2+}$

4. Which one of the following sets has coinage metals in it?

- A) Cu, Hg, Au
- B) Cu, Ag, Au
- C) Ag, Au, Hg
- D) Cu, Fe, Au

Answer: Cu, Ag, Au

5. Which of the following is the purest form of iron?

- A) Steel
- B) Cast iron
- C) Wrought iron
- D) Pig iron

Answer: Wrought iron

6. Geometry of complex compound depends upon:

- A) No of ligands
- B) No of chelates
- C) Hybridization of central metal
- D) All the above

Answer: Hybridization of central metal

7. When a compound of transition element is dissolved in a solution, it produces:

- A) Simple ion
- B) Complex ions
- C) Double salt
- D) Strong anions

Answer: Complex ions

8. In the production of wrought iron, Mn, Si, P are removed in the form of:

- A) Oxides
- B) Silicates
- C) Slag
- D) Carbonates

Answer: Slag

9. When the impurities are P and S, the furnace is lined with:

- A)  $\text{SiO}_2$
- B)  $\text{Fe}_2\text{O}_3$
- C) FeO
- D) CaO, MgO

Answer: CaO, MgO

10. When an active metal like Al comes in contact with less active metal like Cu, then it produces:

- A) Voltaic cell
- B) Galvanic cell
- C) Electrolytic cell
- D) Both (a) and (b)

Answer: Both (a) and (b)

11. In the silver ammine complex  $[\text{Ag}(\text{NH}_3)_2]^+$ , the co-ordination number



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# **PART II: ENGLISH**

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## Chapter 1

# The Noun

# 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.

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Material Noun	Abstract Noun
Water	Honesty
Iron	Strength
Milk	Whiteness

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### 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



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### 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

Things that are considered to have two main parts are also treated as plural nouns.

- These **scissors are** dull.



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- My **trousers are** torn.
- His **glasses are** new.

### Rule 7: Nouns that are Plural in Meaning

Some nouns appear to be singular but are treated as plural and take plural verbs and pronouns.

- The **police are** investigating the case.
- The **poultry are** being fed.
- The **cattle are** grazing in the field.
- **People are** waiting outside.

### Rule 8: Nouns that are Singular in Meaning

Some nouns appear to be plural in form (ending in "-s") but are actually singular in meaning and take singular verbs and pronouns. These often include names of academic subjects, games, and diseases.

- This **news is** surprising.
- **Politics is** a complicated field.
- **Physics has** always been my favorite subject.
- **Measles is** a contagious disease.

### Rule 9: Quantifying Uncountable Nouns

Since uncountable nouns cannot be counted directly, we use specific phrases to express quantity.

- two **pieces of** advice
- three **slices of** bread
- several **articles of** furniture
- many **pieces of** mail/information

### Rule 10: Collective Nouns – Singular or Plural Verb

A collective noun can take a singular verb when the group is acting as a single unit. It takes a plural verb when the focus is on the individual members acting separately.

- The **team has** won the championship. (The team as one unit)
- The **team are** arguing about the strategy. (Individual team members)

### Rule 11: Nouns with Identical Singular and Plural Forms

Some nouns have the same form for both singular and plural. The meaning is determined by the context and verb used.

- That **sheep is** white. | Those **sheep are** black.
- A **deer was** spotted. | Many **deer were** spotted.
- I caught a **fish**. | I caught five **fish**.

### Rule 12: Plural of Foreign Origin Nouns



Many nouns borrowed from Latin and Greek retain their original plural forms.

- **-is** → **-es**: analysis → analyses, crisis → crises, basis → bases
- **-um** → **-a**: datum → data, bacterium → bacteria, curriculum → curricula
- **-us** → **-i**: syllabus → syllabi, nucleus → nuclei, fungus → fungi
- **-a** → **-ae**: formula → formulae/formulas, vertebra → vertebrae
- **-ex/-ix** → **-ices**: index → indices/indexes, matrix → matrices

### Rule 13: Subject-Verb Agreement with "Number of" vs. "A Number of"

**M** The phrases "the number of" and "a number of" are followed by different verb forms.

- **The number of** students **is** increasing. (Refers to the number itself, which is singular)
- **A number of** students **are** absent today. (Means "several," referring to the students, which is plural)

### Rule 14: Nouns Ending in "-ics" (Academic Subjects)

**P** Names of academic subjects ending in "-ics" are generally singular. However, when they refer to specific activities, qualities, or practical applications, they can be plural.

- **Mathematics is** easy for her. (As a field of study)
- Her **mathematics are** weak. (Referring to her mathematical skills/calculations)

### Rule 15: Agreement with Paired Nouns

**P** 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)

PREPARATIONS  
LET'S MAKE IT HAPPEN

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## Practice MCQ

## 1. The Noun

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**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

13. The grammatical structure "three pieces of mail" is used because the noun 'mail' is:

- A. A collective noun that must be quantified individually.
- B. An uncountable noun that requires a counter or a unit of measurement to express plurality.
- C. A countable noun that has an irregular plural form.
- D. A compound noun that is always used in the singular.

Answer: B

14. Select the sentence with a correct subject-verb agreement for a noun that appears plural but is singular.

- A. Physics are a difficult subject.
- B. Mathematics are my favorite.
- C. The news are at ten.

D. Politics is a complex field.  
Answer: D

15. Which of the following statements about the noun 'series' is CORRECT?

- A. It is a noun that appears plural and always takes a plural verb.
- B. It is a noun that appears singular but must always take a plural verb.
- C. It is a noun that can be both singular and plural in form and usage, depending on the context.
- D. It is an uncountable noun and therefore has no plural form.

Answer: C

16. The noun "surroundings" falls under which category?

- A. Nouns that have only a plural form
- B. Abstract Nouns
- C. Compound Nouns
- D. Material Nouns

Answer: A

17. In the sentence "The jealousy of her friend was obvious," the article "the" is used with "jealousy" because:

- A. It is a countable noun
- B. It is specified
- C. It is a proper noun
- D. It is always used with 'the'

Answer: B

18. Identify the uncountable noun from the options.

- A. Egg
- B. Orange
- C. Sugar
- D. Chair

Answer: C

19. Which sentence violates the noun correction rules?

- A. His savings are enough for retirement.
- B. The cattle is grazing in the field.

C. These trousers are too long.  
D. The police have arrested the suspect.  
**Answer: B (Cattle takes a plural verb)**

**20. The word "mumps" is an example of a noun that:**

- A. Is always plural
- B. Appears plural but is singular
- C. Is a collective noun
- D. Is a compound noun

**Answer: B**

**21. According to the rules, which noun can be used with an indefinite article in a particular sense?**

- A. Water
- B. Music
- C. Experience
- D. Hair

**Answer: C**

**22. "A group of students" - The word "group" is a:**

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

**Answer: B**

**23. Choose the correct sentence.**

- A. The scenery of Swat are beautiful.
- B. The scenery of Swat is beautiful.
- C. A scenery of Swat is beautiful.
- D. Sceneries of Swat are beautiful.

**Answer: B**

**24. Which of the following is NOT a collective noun?**

- A. Team
- B. Class
- C. Honesty
- D. Committee

**Answer: C**

**25. The noun "bread" in "a few slices of bread" is:**

- A. Countable
- B. Uncountable
- C. Collective
- D. Abstract

**Answer: B**

**26. Identify the proper noun.**

- A. City
- B. Mosque
- C. Karachi
- D. Boy

**Answer: C**

**27. The rule "Uncountable nouns have no plural form" is best exemplified by:**

- A. Chairs and tables
- B. Eggs and oranges
- C. Sugar and milk
- D. Boys and girls

**Answer: C**

**28. Which noun type is "Driving License"?**

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

**Answer: C**

**29. Select the option where the noun takes a singular verb.**

- A. The people \_\_\_\_\_ demanding their rights.
- B. The poultry \_\_\_\_\_ inoculated.
- C. The series \_\_\_\_\_ become very popular.
- D. The cattle \_\_\_\_\_ grazing.

**Answer: C**



**30. In the context of material nouns, the word "plasma" is categorized as such because it:**

- A. Represents an idea or quality that has no material existence.
- B. Is the name of a specific, unique entity.
- C. Denotes a physical substance that exists in a state of matter.
- D. Functions as a collective term for a group of items.

**Answer: C**

**31. The word "clergy" belongs to the same category as:**

- A. Scissors
- B. Police
- C. Mathematics
- D. Series

**Answer: B**

**32. The sentence "Please extend my warmest regards to your family" is grammatically sound because:**

- A. The noun 'regards' is an uncountable noun and always takes a singular verb.
- B. The noun 'regards' is one of a category of nouns that have only a plural form and thus take a plural verb.
- C. The noun 'regards' is a collective noun being treated as a single unit.

D. The noun 'regards' is a compound noun formed from a verb and an object.

**Answer: B**

**33. Identify the sentence with an error in noun usage.**

- A. He provided me with two pieces of information.
- B. I need a new jeans.
- C. The surroundings are peaceful.
- D. His knowledge is vast.

**Answer: B (It should be "a pair of jeans")**

**34. "A bitter experience" - Here "experience" is used as a/an:**

- A. Uncountable Noun
- B. Countable Noun
- C. Abstract Noun in a general sense
- D. Collective Noun

**Answer: B**

**35. The noun 'stone' can be used as a material noun ("The house is made of stone") and, in a different context, as a:**

- A. Proper Noun (e.g., "The Stone Age")
- B. Countable Noun (e.g., "He threw a stone")
- C. Abstract Noun (e.g., "She had a heart of stone" - metaphorical)
- D. Both B and C

**Answer: D**

LET'S MAKE IT HAPPEN



## Chapter 2

# The Pronoun

# 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.

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## Practice MCQs

## 2. The Pronoun

- 1. Choose the sentence that is grammatically correct.**  
 A. This matter is between you and I.  
 B. This matter is between you and me.  
 C. This matter is between yourself and myself.  
 D. This matter is among you and I.

**M** Answer: B

- 2. Which of the following is a distributive pronoun?**  
 A. Themselves  
 B. Someone  
 C. Each  
 D. This

**P** 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.

**R** Answer: C

- 4. Fill in the blank: She is smarter than \_\_\_\_.**  
 A. me  
 B. I  
 C. myself  
 D. mine

**A** 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.

**S** 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



## Chapter 3

# The Verb

# 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

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## Practice MCQs

## 3. The Verb

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

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

**Answer: C**

**2. Which sentence uses a ditransitive verb?**

- A. The sun rises in the east.
- B. She sang a beautiful song.
- C. He told the children a story.
- D. They arrived late.

**Answer: C**

**3. Choose the correct causative structure:**

- A. I made him to apologize.
- B. I had him apologize.
- C. I got him apologize.
- D. I let him to leave.

**Answer: B**

**4. The verb in "The flowers smell wonderful" is:**

- A. Transitive
- B. Intransitive
- C. Linking
- D. Auxiliary

**Answer: C**

**5. Which verb is followed by a gerund?**

- A. decide
- B. want
- C. avoid
- D. hope

**Answer: C**

**6. Select the correct sentence:**

- A. She suggested to go early.
- B. She suggested going early.
- C. She suggested go early.

D. She suggested to going early.

**Answer: B**

**7. Identify the intransitive verb:**

- A. write
- B. build
- C. arrive
- D. make

**Answer: C**

**8. "The committee has reached its decision." Here 'has' is:**

- A. Main verb
- B. Primary auxiliary
- C. Modal auxiliary
- D. Linking verb

**Answer: B**

**9. Which sentence shows correct verb agreement?**

- A. The list of items are long.
- B. Each of the students are present.
- C. Neither answer is correct.
- D. The team are winning.

**Answer: C**

**10. Choose the correct past participle form:**

- A. swimmmed
- B. swam
- C. swum
- D. swim

**Answer: C**

**11. The error in "She laid on the bed all day" is:**

- A. Wrong tense
- B. Wrong verb form
- C. Missing object
- D. Subject-verb disagreement

**Answer: B (Should be 'lay')**

**12. Which modal verb expresses necessity?**



## Chapter 4

# Tenses

# 4. Tenses

### 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.

## M The Twelve Tenses: Structure and Usage

### K 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

### R Examples:

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

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

A • **Do** you **work** here?

• **Does** she **live** in London?

**Negative:** Subject + do not/does not + V1 + Object

I • They **do not like** coffee.

• He **does not play** tennis.

### O 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.

## Practice MCQs

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**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**



## 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

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5. Subject - Verb Agreement



## Practice MCQs

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1. The criteria for selection \_\_\_\_\_ significantly more rigorous this year.

(a) is  
(b) are  
(c) was  
(d) were

Answer: (b) are

2. A series of lectures on quantum mechanics \_\_\_\_\_ scheduled for this semester.

(a) is  
(b) are  
(c) have been  
(d) were

Answer: (a) is

3. Neither the shareholders nor the CEO \_\_\_\_\_ content with the quarterly report.

(a) is  
(b) are  
(c) were  
(d) have been

Answer: (a) is

4. The number of applicants for the prestigious fellowship \_\_\_\_\_ exceeded expectations.

(a) have  
(b) has  
(c) are  
(d) were

Answer: (b) has

5. Fifty percent of the data \_\_\_\_\_ been corrupted and \_\_\_\_\_ unrecoverable.

(a) has, is  
(b) have, are  
(c) has, are  
(d) have, is

Answer: (a) has, is

6. \_\_\_\_\_ either of the candidates submitted their portfolio yet?

(a) Has  
(b) Have  
(c) Do  
(d) Does

Answer: (a) Has

7. The jury \_\_\_\_\_ divided in their opinions, which \_\_\_\_\_ the deliberation process.

(a) is, prolong  
(b) are, prolongs  
(c) is, prolongs  
(d) are, prolong

Answer: (b) are, prolongs

8. "The Brothers Karamazov" \_\_\_\_\_ one of the most profound novels ever written.

(a) is  
(b) are  
(c) were  
(d) have been

Answer: (a) is

9. More than one scientist \_\_\_\_\_ attempting to replicate the controversial experiment.

(a) is  
(b) are  
(c) were  
(d) have been

Answer: (a) is

10. All of the research, including the preliminary findings, \_\_\_\_\_ a radical new hypothesis.

(a) support  
(b) supports  
(c) are supporting



## Chapter 6

# The Adverb

# 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.

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### The Versatile Roles of an Adverb

Adverbs can modify various parts of speech:

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➤ **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



## Practice MCQs

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1. Identify the type of adverb in the sentence: "He will probably complete the project by tomorrow."

- A. Adverb of Manner
- B. Adverb of Time
- C. Adverb of Affirmation
- D. Adverb of Degree

Answer: C

2. Choose the sentence with the correct adverb order:

- A. She sang beautifully at the concert last night.
- B. She sang at the concert beautifully last night.
- C. She beautifully sang last night at the concert.
- D. Last night at the concert she sang beautifully.

Answer: A

3. The error in the sentence "I am very pleased to meet you" is:

- A. Incorrect use of 'very'
- B. Incorrect verb tense
- C. Wrong pronoun
- D. No error

Answer: A (Should be 'much pleased')

4. Which sentence uses the correct comparative form of the adverb?

- A. She works more harder than anyone else.
- B. She works harder than anyone else.
- C. She works more hard than anyone else.
- D. She works hardest than anyone else.

Answer: B

5. Identify the relative adverb in: "I remember the day when we first met."

- A. I
- B. remember
- C. day

D. when

Answer: D

6. The sentence "He reached the station lately" is incorrect because:

- A. 'lately' means recently, not 'late'
- B. Wrong preposition
- C. Incorrect verb form
- D. Missing article

Answer: A

7. Choose the correct negative inversion:

- A. Hardly had I left when the storm began.
- B. Hardly I had left when the storm began.
- C. Hardly I left when the storm began.
- D. I had left hardly when the storm began.

Answer: A

8. Which adverb modifies the entire sentence?

- A. quickly
- B. here
- C. unfortunately
- D. very

Answer: C

9. The error in "She is too beautiful" is that:

- A. 'too' implies excess and should be 'very'
- B. Wrong adjective form
- C. Incorrect verb agreement
- D. No error

Answer: A

10. Identify the adverb of degree: "The project is almost complete."

- A. project
- B. is
- C. almost
- D. complete

Answer: C



## Chapter 7

# The Adjective

# 7. The Adjective

### Definition of Adjective

An adjective is a word that modifies a noun or a pronoun by describing, identifying, or quantifying it. It adds meaning by answering questions like *What kind? Which one? How many? or How much?*

**Core Function:** To provide more information about a noun or pronoun.

**Placement Rules:**

M

K

1. **Before a Noun (Attributive Position):** A **brilliant** idea, the **blue** sky
2. **After a Linking Verb (Predicative Position):** The idea is **brilliant**. The sky appears **blue**.

### Types of Adjective

P

Adjectives can be categorized based on their specific function and meaning.

R

#### 1. Proper Adjective

E

Formed from proper nouns and used to describe something related to that noun.

P

- **Examples:** Chinese food, Pakistani culture, Victorian era, Shakespearean drama

A

#### 2. Descriptive Adjective (Adjective of Quality)

R

Describes the quality, state, or kind of a noun.

Examples: a brave soldier, a sick patient, a beautiful painting, an honest person

A

#### 3. Adjective of Quantity

T

Indicates the amount or quantity of a noun (used with uncountable nouns).

Examples: some water, much effort, little hope, enough time, all people

I

#### 4. Adjective of Number (Numeral Adjective)

O

Shows the number or order of nouns (used with countable nouns).

N

- **Definite Numeral:** one, two, first, second (shows exact number)
- **Indefinite Numeral:** many, few, several, some (shows approximate number)
- **Distributive Numeral:** each, every, either, neither (refers to individual members)

S

#### 5. Demonstrative Adjective

Points out or demonstrates which specific noun is being referred to.

- **Definite Demonstrative:** this, that, these, those, the
- **Indefinite Demonstrative:** a, an, any, one, certain, some, other, another

#### 6. Interrogative Adjective

## Practice MCQS

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S

**1. Identify the type of adjective in the phrase: "He has sufficient evidence to prove his point."**

- A. Adjective of Quality
- B. Adjective of Quantity
- C. Demonstrative Adjective
- D. Proper Adjective

**Answer: B**

**2. Choose the sentence that correctly uses a proper adjective:**

- A. We studied about the Shakespearean era in literature class.
- B. We studied about the Shakespeare era in literature class.
- C. We studied about the Shakespeare's era in literature class.
- D. We studied about Shakespearean era in literature class.

**Answer: A**

**3. The error in the sentence "This is the most perfect specimen I have ever seen" is:**

- A. Incorrect use of superlative degree
- B. 'Perfect' is an absolute adjective
- C. Wrong verb tense
- D. Missing article

**Answer: B**

**4. Which sentence demonstrates correct use of adjectives after linking verbs?**

- A. The flowers smell sweetly.
- B. The flowers smell sweet.
- C. The flowers are smelling sweetly.
- D. The flowers are smelling sweet.

**Answer: B**

**5. Identify the demonstrative adjective: "Those buildings across the street are historical landmarks."**

- A. Those

- B. buildings
- C. across
- D. historical

**Answer: A**

**6. Choose the correct comparative form: "Her performance was \_\_\_\_\_ than expected."**

- A. more better
- B. better
- C. gooder
- D. more good

**Answer: B**

**7. The sentence "He is senior than all other officers" is incorrect because:**

- A. Wrong preposition after 'senior'
- B. Incorrect use of comparative degree
- C. Wrong subject-verb agreement
- D. Missing article

**Answer: A**

**8. Which of these is an adjective of number?**

- A. several
- B. much
- C. some
- D. enough

**Answer: A**

**9. Identify the sentence with correct adjective order:**

- A. She wore a beautiful red silk dress.
- B. She wore a red beautiful silk dress.
- C. She wore a silk beautiful red dress.
- D. She wore a beautiful silk red dress.

**Answer: A**

**10. The error in "She feels badly about the situation" is:**

- A. 'Badly' should be 'bad' after linking verb
- B. Wrong adverb form

7. The Adjective



## Chapter 8

# The Article

# 8. The Article

### Introduction

The words \*a\*, *an*, and *the* are a special part of speech called **articles**. They are used with nouns to specify whether we are referring to something specific or something non-specific. Articles are a key component of English grammar.

There are two types of articles:

1. **Indefinite Articles:** *A* and *An*
2. **Definite Article:** *The*

### The Indefinite Articles – A & An

The indefinite articles \*a\* and *an* are used with singular, countable nouns when we are referring to something for the first time, or when it is non-specific (i.e., any one of that kind).

#### The Rule:

- Use **a** before words that begin with a **consonant sound**.
- Use **an** before words that begin with a **vowel sound**.

#### Examples:

- John is reading **a book**.
- Would you like **a peach**?
- I always take **an apple** to school.
- Do you have **an umbrella** I can borrow?

### Important Notes on Sound

1. **Some words begin with a vowel but have a consonant sound.**  
The sound is what matters, not the spelling. Words like "university" and "European" begin with a 'yoo' sound (a consonant sound).
  - Is there **a university** in your town?
  - Does every child wear **a uniform**?
  - We are taking **a European** vacation.
2. **Some words begin with a silent 'h'.**  
When the 'h' is not pronounced, the word begins with a vowel sound.

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## Practice MCQs

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1. Despite his reputation as \_\_\_\_\_ miser, he made \_\_\_\_\_ unexpected donation to the university.

- (a) a, an
- (b) the, a
- (c) a, the
- (d) the, an

Answer: (a) a, an

2. The committee is tasked with reviewing the status of \_\_\_\_\_ needy and \_\_\_\_\_ disabled in our city.

- (a) the, the
- (b) a, the
- (c) -, -
- (d) the, a

Answer: (a) the, the

3. It is often said that \_\_\_\_\_ man is the only creature that uses \_\_\_\_\_ language.

- (a) the, the
- (b) a, a
- (c) -, -
- (d) the, -

Answer: (c) -, -

4. She holds \_\_\_\_\_ honorary degree from \_\_\_\_\_ university in the Netherlands.

- (a) an, a
- (b) a, an
- (c) the, a
- (d) an, the

Answer: (a) an, a

5. \_\_\_\_\_ rich cultural tapestry of \_\_\_\_\_ Philippines is fascinating to anthropologists.

- (a) A, the
- (b) The, -
- (c) The, the

(d) -, the

Answer: (c) The, the

6. After \_\_\_\_\_ hour-long debate, the jury reached \_\_\_\_\_ unanimous verdict.

- (a) a, a
- (b) an, a
- (c) an, an
- (d) the, a

Answer: (b) an, a

7. He was sent to \_\_\_\_\_ prison for \_\_\_\_\_ crime he didn't commit.

- (a) the, the
- (b) a, a
- (c) -, a
- (d) -, the

Answer: (d) -, the

8. \_\_\_\_\_ wisdom of using \_\_\_\_\_ nuclear energy is a subject of intense debate.

- (a) The, the
- (b) -, -
- (c) The, -
- (d) -, the

Answer: (c) The, -

9. As \_\_\_\_\_ child, she dreamed of playing \_\_\_\_\_ piano at Carnegie Hall.

- (a) a, the
- (b) a, a
- (c) the, the
- (d) the, a

Answer: (a) a, the

10. Which sentence is grammatically incorrect?

- (a) The Alps are a popular destination for skiers.
- (b) He is in hospital recovering from surgery.
- (c) I need to go to the school for a

8. The Article



## Chapter 9

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

### Prepositions of Place and Location

These prepositions tell us where something is located.

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9. Preposition



## Practice MCQs

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1. The renowned architect is absorbed \_\_\_\_\_ the design of a revolutionary sustainable city.

- (a) at
- (b) by
- (c) in
- (d) with

Answer: (c) in

2. His thesis provides a compelling argument, but I must disagree \_\_\_\_\_ his fundamental premise.

- (a) to
- (b) with
- (c) on
- (d) against

Answer: (b) with

3. The CEO was accused \_\_\_\_\_ the board \_\_\_\_\_ gross financial misconduct.

- (a) by, for
- (b) to, of
- (c) by, of
- (d) from, with

Answer: (c) by, of

4. The artist's work, which consists \_\_\_\_\_ found objects, comments \_\_\_\_\_ consumerist society.

- (a) of, on
- (b) with, about
- (c) from, for
- (d) in, to

Answer: (a) of, on

5. The country's economy is largely dependent \_\_\_\_\_ the export \_\_\_\_\_ crude oil.

- (a) on, of
- (b) from, for
- (c) by, in
- (d) with, about

Answer: (a) on, of

6. The investigator warned the public \_\_\_\_\_ a sophisticated new phishing scam.

- (a) for
- (b) from
- (c) about
- (d) on

Answer: (c) about

7. Her latest novel is reminiscent \_\_\_\_\_ the magical realism of Gabriel García Márquez.

- (a) to
- (b) with
- (c) of
- (d) from

Answer: (c) of

8. The diplomat was anxious \_\_\_\_\_ the potential repercussions \_\_\_\_\_ the trade agreement.

- (a) for, from
- (b) about, of
- (c) with, for
- (d) at, with

Answer: (b) about, of

9. The new policy is inferior \_\_\_\_\_ the previous one \_\_\_\_\_ almost every measurable aspect.

- (a) than, in
- (b) to, in
- (c) from, for
- (d) against, by

Answer: (b) to, in

10. He is highly regarded \_\_\_\_\_ his peers \_\_\_\_\_ his integrity and work ethic.

- (a) by, for
- (b) from, about
- (c) with, in
- (d) to, because of

Answer: (a) by, for



## Chapter 10

# Sentence, Phrase and Clause

# 10. Sentence, Phrase and Clause

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### 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.

## Practice MCQs

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- \_\_\_\_\_, the renowned scientist presented her groundbreaking research on quantum computing.
  - After years of meticulous experimentation
  - A woman of great intellect and determination
  - In the prestigious international conference
  - Which was attended by Nobel laureates

**Answer: (c) In the prestigious international conference** (This is a prepositional phrase setting the scene. The other options are either a dependent clause (a, d) or a noun phrase (b) that cannot stand alone before the comma.)
- The hypothesis, \_\_\_\_\_, was later proven to be fundamentally flawed.
  - although initially met with great acclaim
  - the result of an inspired guess
  - a complex and seemingly logical construct
  - which the young researcher had passionately defended

**Answer: (d) which the young researcher had passionately defended** (This is an adjective clause correctly modifying "hypothesis." Option (a) is an adverb clause, (b) and (c) are appositive phrases.)
- Which of the following is a classic example of a compound-complex sentence?
  - The storm raged, and the sailors fought bravely.
  - Although the storm raged, the sailors fought bravely, and they eventually reached the shore.
  - The brave sailors fought the raging

storm.  
 (d) Fighting the storm, the brave sailors persevered.  
**Answer: (b) Although the storm raged, the sailors fought bravely, and they eventually reached the shore.** (It has two independent clauses and one dependent clause.)

- In the sentence "His ultimate goal is to decipher the enigmatic code," the phrase "to decipher the enigmatic code" functions as a:
  - Noun Phrase
  - Adjective Phrase
  - Adverb Phrase
  - Prepositional Phrase

**Answer: (a) Noun Phrase** (It acts as a subject complement, renaming the subject "goal.")
- "The committee will approve the proposal provided that the necessary funds are allocated." The underlined segment is a/an:
  - Adverb Clause of Condition
  - Noun Clause as Object
  - Adjective Clause
  - Independent Clause

**Answer: (a) Adverb Clause of Condition** (It begins with the subordinating conjunction "provided that" and shows the condition for the main action.)
- Which sentence is correctly punctuated?
  - May you succeed in all your endeavors, and may you find true happiness.
  - May you succeed in all your endeavors and may you find true happiness.

10. Sentence, Phrase and Clause



## Chapter 11

# Active and Passive Voice

# 11. 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.

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

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

### R E Rules for Converting Active to Passive Voice

- P** 1. The **object** of the active verb becomes the **subject** of the passive verb.
- A** 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.
- R** 3. The main verb is changed into its **past participle** form (V3).
- A** 4. An appropriate **helping verb** (a form of 'be' or modals) is added, which must agree with the new subject in number and person.

### T I O N S 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

## Practice MCQs

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

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.



## Chapter 12

# Direct and Indirect Narration

### 1. Introduction

Speech or narration can be reported in two ways:

- Direct Narration:** We quote the exact words of the speaker, enclosed within quotation marks.
  - Example: He said, "I am busy."
- 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:

- First Person (I, we)** changes according to the **subject** of the reporting verb.
- Second Person (you)** changes according to the **object** of the reporting verb.
- 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

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12. Direct and Indirect Narration



## Practice MCQs – Direct and Indirect Narration

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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.

12. Direct and Indirect Narration

## Chapter 13

# 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
<b>Above board</b>	Honest and open.	دیانتداری، صاف بازی	Don't worry, the deal was completely above board.
<b>To smell a rat</b>	To suspect foul dealings.	شک کرنا، کھوتا محسوس کرنا	When he offered to double my investment, I began to smell a rat.
<b>To throw dust in someone's eyes</b>	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.
<b>To give a false coloring</b>	To misrepresent something.	غلط رنگ چڑھانا، مسخ کرنا	He gave a false coloring to the events to make himself look like a hero.
<b>To play fast and loose</b>	To behave in an unreliable and insincere way.	عہد شکنی کرنا، بے وفائی کرنا	You can't trust him; he plays fast and loose with the truth.
<b>Sharp practices</b>	Dishonest business dealings.	عیاری، بددیانتی	The company was accused of sharp practices to eliminate competition.
<b>Crocodile tears</b>	Pretended or insincere sorrow.	مگر مچھ کے آنسو، دکھاوے کے آنسو	She shed crocodile tears at his dismissal, though she had advocated for it.

## Practice MCQs – Idioms and Phrasal Verbs

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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.

## Chapter 14

### 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.

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14. Synonyms and Antonyms

Word	Urdu Meaning	Synonyms	Antonyms	Sentence
Abate	کم ہونا، گھٹنا	Subside, Diminish, Decrease, Lessen	Intensity, Increase, Augment, Escalate	The storm finally began to <b>abate</b> after raging for hours.
Aberration	خلل، انحراف	Anomaly, Deviation, Irregularity, Oddity	Normality, Regularity, Standard, Conformity	His poor performance was an <b>aberration</b> from his usual excellence.
Abhor	نفرت کرنا، کراہت کرنا	Despise, Detest, Loathe, Hate	Admire, Adore, Cherish, Love	She <b>abhors</b> any form of cruelty towards animals.
Abridge	مختصر کرنا، خلاصہ کرنا	Shorten, Condense, Abbreviate, Curtail	Elongate, Expand, Amplify, Extend	The publisher released an <b>abridged</b> version of the classic novel for students.
Acrimonious	تلخ، کڑواہٹ بھرا	Bitter, Caustic, Hostile, Sarcastic	Harmonious, Kind, Gentle, Amicable	The divorce proceedings were <b>acrimonious</b> and lengthy.
Admonish	ڈانٹنا، تنبیہ کرنا	Reprimand, Rebuke, Chide, Warn	Praise, Commend, Applaud, Encourage	The teacher had to <b>admonish</b> the student for talking in class.

## 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

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14. Synonyms and Antonyms



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# **PART III: PEDAGOGY**

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## Chapter 1

# Teaching Techniques and Methodologies

## 1. Introduction to Teaching: Concept, Nature, and Evolution

### Definition of Teaching:

Teaching is a deliberate, interactive, and planned process implemented by an educator to facilitate learning. It involves the systematic transmission and facilitation of knowledge (cognitive skills), practical abilities (psychomotor skills), and values or attitudes (affective skills) within a structured educational context. A refined definition characterizes teaching as the process of preparing students for learning by providing an initial structure, clarifying intended outcomes, indicating effective learning strategies, creating opportunities for practice and application, and delivering improvement-oriented feedback.

### The Nature and Evolution of Teaching:

- **Teaching as a Mutual Exchange:** It is not a one-way transmission but a dynamic interaction involving the mutual exchange of experiences and information between the teacher and the students.
- **Teaching as a Provocative Activity:** Its purpose is to stimulate and provoke academic, mental, and personal development in learners.
- **Shift from Traditional to Modern Role:**
  - **Traditional (Teacher-Centered) Role:** The teacher was viewed as the primary source or "fountainhead" of knowledge. The focus was on the dissemination of information through methods like lecturing ("chalk-and-talk"), and students were passive recipients.
  - **Modern (Student-Centered) Role:** The teacher acts as a facilitator, guide, and co-learner. The focus shifts to creating environments where students can discover, construct, and collaborate on knowledge. This approach caters to individual differences and uses methods like group work, experiments, and research-based learning.

### The Process of Learning and Teaching:

- Students possess unique ways of understanding, processing, and demonstrating knowledge, and they learn at their own pace.



- Teachers must be diagnosticians of learning, considering students' background knowledge, the learning environment, and educational goals when selecting appropriate teaching methods.
- A wide spectrum of methods exists, ranging from traditional (explaining, questioning) to modern (role-play, seminars, case studies, technology-integrated learning).

## 2. The Roles and Characteristics of an Effective Teacher

**M** An effective teacher seamlessly transitions between multiple roles, embodying a blend of personal and professional qualities.

**K** **The Five Major Roles of a Teacher:**

1. **Subject Matter Expert:** Possesses deep, extensive, and current knowledge of the subject, going beyond textbooks to develop original thoughts and a genuine passion for the discipline.
2. **Pedagogical Expert:** Sets clear, achievable learning goals; demonstrates a positive attitude; helps students overcome learning difficulties; guides critical thinking and problem-solving; and provides fair and constructive evaluation.
3. **Excellent Communicator:** Demonstrates effective oral and written communication, strong organizational abilities, and planning skills. Actively helps students develop their own communication competencies.
4. **Student-Centered Mentor:** Encourages each student to learn through varied methods, promotes active participation, and challenges students to reach higher intellectual and personal levels.
5. **Systematic and Continual Assessor:** Develops and implements procedures for assessing student learning outcomes; systematically evaluates their own teaching effectiveness; and refreshes instructional materials and styles to improve student learning.

**O** **Characteristics of an Effective Teacher:**

**N** **A. Personal Qualities:**

- **Fairness:** Avoids any form of favoritism; treats all students justly and equitably.
- **Positive Attitude:** Believes in student success, uses meaningful verbal praise, and proactively "catches students doing things right."
- **Preparedness:** Is competent in the subject matter and thoroughly prepared for lessons, which allows for better management of behavioral matters.

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- **Personal Touch:** Connects with students personally by using their names, sharing relevant stories, and showing genuine interest in their lives.
- **Sense of Humor:** Uses wit and humor to break the ice, reduce anxiety, and make learning an enjoyable experience.
- **Creativity:** Employs unusual, engaging, and innovative methods to motivate students and present content.
- **Willingness to Admit Mistakes:** Apologizes for errors, modeling humility, integrity, and a growth mindset for students.
- **Forgiving:** Shows a willingness to forgive student misbehavior and move forward without holding grudges.
- **Respect:** Gives respect to students to earn it in return; handles situations with sensitivity and dignity.
- **High Expectations:** Sets challenging yet realistic academic and behavioral standards, motivating students to consistently do their best.
- **Compassion:** Cares for students' emotional well-being and works to reduce the impact of hurt feelings on learning.
- **Sense of Belonging:** Actively builds a classroom community and unity to create an emotionally safe space where every student feels valued and included.

### B. Professional Qualities:

- **Collaboration:** Works constructively and cooperatively with colleagues, parents, and the community to achieve common educational goals.
- **Honesty and Integrity:** Demonstrates truthfulness, maintains confidentiality, and is trustworthy in all professional dealings.
- **Respect (Professional):** Values diversity, establishes rapport with students and colleagues, and addresses varied learning and cultural needs.
- **Commitment to Learning:** Values lifelong learning for both self and students; uses research-based strategies; and continuously reflects on and improves their own practice.
- **Emotional Maturity:** Is self-confident, enthusiastic, punctual, reliable, and handles all situations with appropriate professionalism and composure.



## 3. Theoretical Foundations of Learning and Teaching

### Vygotsky's Zone of Proximal Development (ZPD)

- **Theory:** Lev Vygotsky theorized that a child's cognitive development is defined by two levels:
  1. **The Actual Developmental Level:** What a child can do independently without any assistance.
  2. **The Zone of Proximal Development (ZPD):** The difference between what a learner can do without help and what they can achieve with guidance and encouragement from a skilled partner (e.g., a teacher or more capable peer).
- **Implication for Teaching:** Effective teaching occurs within the ZPD. It consists of "assisting performance" to "awaken" and nurture mental functions that are in a stage of maturing. Teaching is only effective when it precedes development.
- **Scaffolding (Means of Assistance):** This is the supportive framework provided by the teacher to help students bridge the gap in their ZPD. Techniques include:
  - **Modeling:** Demonstrating a behavior or skill for imitation.
  - **Feeding Back:** Providing constructive information on performance, allowing learners to compare against a standard and self-correct.
  - **Contingency Managing:** Using principles of reinforcement and punishment to shape and encourage desirable behavior.
  - **Directing:** Requesting specific actions from the student to clarify the correct response.
  - **Questioning:** Prompting mental operations that the learner cannot produce alone.
  - **Explaining:** Providing rationale and logical connections to help learners organize new information.
  - **Task Structuring:** Breaking down a complex task into smaller, manageable parts by chunking, segregating, and sequencing.

### The Constructivist Approach

- **Core Idea:** Learners **construct** their own knowledge and meaning through active interaction between their existing experiences and new ideas. Knowledge is not passively received but is actively built.

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1. Teaching Techniques & Methodologies



- **Key Principles:**

- Learning is an active, interpretive, and iterative process.
- New knowledge is built upon and connected to prior knowledge (through Assimilation and Accommodation).
- Learning is inherently social and culturally influenced.
- The teacher's role shifts from instructor to **facilitator** of learning.

- **Implications for Teaching:**

- Use active learning techniques (problem-solving, experiments, inquiry).
- Pose problems that are relevant to students' lives.
- Encourage dialogue, collaboration, and peer learning.
- Assess learning continuously within the context of teaching.

#### 4. The Concept of Effective Teaching and a Conducive Learning Environment

##### Defining Effective Teaching

Effective teaching is the professional practice that demonstrably leads to improved student learning, achievement, and holistic development. It involves talking to learners about their learning and, crucially, listening to them.

##### Aspects of Effective Teaching:

- Effectively managing the classroom.
- Starting each class with a clear objective.
- Engaging students with strategic questioning.
- Consolidating the lesson at the end for retention.
- Diagnosing and correcting common student errors.

##### Approaches to Teaching Effectiveness:

- **The 'Style' View:** Effectiveness is determined by the teacher's actions and behaviors (e.g., displaying warmth and enthusiasm, minimizing direct instruction, facilitating knowledge construction through dialogue, using research-based techniques).
- **The 'Outcomes' Approach:** Effectiveness is determined by student results, measured by achievement and the *added value* a teacher contributes to student growth.



- **The 'Inquiry' Approach:** Effectiveness is determined by the quality of a teacher's inquiry into the relationship between their teaching style and student outcomes. It involves a continuous cycle of reflection, action, and evaluation.

## Key Factors for Effective Teaching (Gurney, 2007):

1. **Teacher Knowledge, Enthusiasm, and Responsibility:** Creating an environment where knowledge is shared and enjoyed, and the teacher takes responsibility for fostering a love for learning.
2. **Classroom Activities That Encourage Learning:** Designing activities that allow students to explore, experiment, and feel a sense of mastery and ownership over their learning.

## Creating a Conducive Learning Environment

A conducive learning environment is positive, safe, respectful, and well-managed, enabling efficient learning and fostering self-directed students.

## Teacher's Responsibilities in Fostering this Environment:

- **Instructor of Knowledge:** Imparting curriculum knowledge through diverse methods.
- **Creator of Classroom Environment:** Setting a positive, warm, and happy tone that influences student behavior and social interactions.
- **Role Model:** Serving as an exemplar whom students imitate, reflecting positive values, behavior, and a love for learning.
- **Mentor:** Encouraging students to do their best, enjoy learning, and building their confidence through active listening and support.
- **Protector:** Being vigilant for signs of trouble (e.g., behavioral changes, abuse) and taking appropriate, timely action.

## Strategies for a Conducive Environment:

- **Keep Students Motivated:** Prevent discipline problems by intrinsically engaging students in learning.
- **Meet Basic Needs:** Ensure students feel physically and emotionally safe, accepted, and valued.
- **Exercise Moderate Control:** Balance between authoritarian and laissez-faire approaches; too much control harms critical and creative thinking.

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- **Empower Students:** Make them responsible for their own learning to develop independence.
- **Differentiate Instruction:** Tailor instruction to students' developmental levels, readiness, and learning styles.
- **Build Relationships:** Learn names and positive information about each student.
- **Show Interest:** Use eye contact, gestures, and proximity to communicate care and attention.
- **Use Positive Language:** When addressing misbehavior, describe the act, don't characterize the student (e.g., "That comment was rude," not "You are rude").
- **Maximize Engaged Time:** Use wit, smooth transitions, and group focus strategies to keep students on task.
- **Establish Rules and Routines:** Teach procedures explicitly and display a few general, positive, and applicable rules.
- **Be Assertive in Discipline:** Enforce rules fairly, consistently, and calmly.
- **Handle Misbehavior Effectively:**
  - Deal with the present problem immediately.
  - Talk to the student directly and privately.
  - Stay calm and avoid anger, empty threats, or physical handling.

### 5. Core Teaching Methodologies and Strategies

#### Classroom Management

Classroom management encompasses the techniques and actions teachers use to create an environment that supports both academic and social-emotional learning, including preventing and responding to disruptive behavior.

#### Principles of Classroom Management and Setup:

- Teachers should have a clear view of all students at all times.
- Teaching materials should be readily accessible.
- High-traffic areas should be free of congestion.
- All students should be able to see instructional presentations.



- Procedures and routines must be explicitly taught and reinforced.

## Time Management in the Classroom:

- **Allocated Time:** The total time scheduled for a subject (e.g., 30 minutes for mathematics).
- **Engaged Time:** The portion of allocated time during which students are actively involved in the academic subject.
- **Academic Learning Time:** The subset of engaged time during which students are working with a high success rate (70-80% correct). This is the most critical factor directly linked to student achievement.

## Teaching Methods & Strategies:

- **Lecture Method:**
  - **Pros:** Efficient for delivering large amounts of information to large groups; instructor-controlled.
  - **Cons:** Minimizes student feedback and interaction; can be passive; information retention is often low.
  - **Improving Lectures:** Fit the lecture to the audience, focus the topic, prepare a clear outline, use relevant examples, be aware of and responsive to audience feedback, and deliver with enthusiasm.
- **Direct Instruction:**
  - A highly structured, teacher-centered, and explicit strategy for the efficient transmission of knowledge and skills.
  - **Common Steps:** Review previous learning, state goals, present new material in small steps, provide guided and independent practice, ask many questions, and provide immediate feedback and corrections.
- **Indirect Instruction:**
  - A student-centered strategy where the teacher is a facilitator, leveraging student curiosity and encouraging observation, investigation, and hypothesis formation.
  - **Main Strategies:** Problem-solving, case studies, and reading for meaning.
- **Case Method:** Engages students in active discussion about real-world issues and problems, applying theoretical classroom learning to practical scenarios.

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1. Teaching Techniques & Methodologies



- **Discussion Method:** Engages students in active dialogue about issues, initiated by a probing question from the teacher. Requires careful planning and student preparation.
- **Active Learning:** Creates environments where students talk, listen, read, write, and reflect through problem-solving, group work, simulations, etc. It enhances critical thinking and retention.
- **Cooperative Learning:** A systematic pedagogical strategy where small, mixed-ability teams work toward a common goal.
  - **Key Elements:** Positive interdependence, face-to-face interaction, individual accountability, teaching of social skills, and group processing.
  - **Advantages:** Improves academic achievement, retention, social skills, self-esteem, and promotes positive race relations.
- **Collaborative Teaching (Team Teaching):** Two or more teachers share responsibility for planning, instructing, and assessing the same group of students.
  - **Models:** Traditional Team Teaching, Linked Courses, Connected Courses.
  - **Co-teaching Strategies:** One Teach/One Observe, One Teach/One Assist, Parallel Teaching, Station Teaching, Alternative Teaching.
- **Integrating Technology:** Using tools like educational software, online resources, and interactive platforms to extend and enhance learning. Requires addressing varying levels of student digital literacy.
- **Distance Learning:** Any form of teaching where the teacher and learner are not in the same place at the same time (e.g., online courses, virtual classrooms).

## 6. Essential Teaching Techniques

- **Questioning:** Used to assess prior learning, stimulate critical thinking, clarify doubts, and encourage an inquisitive mindset. It helps teachers gauge what students have learned and decide the direction of further teaching.
- **Explaining:** Involves presenting information in a direct, logical, and structured way, often through mini-lectures, supported by examples and summaries. Its purpose is to provide explanations that help learners organize new learning.
- **Modeling:** A visual aid where learning occurs through observation, retention, and replication of demonstrated behavior. It works on the three criteria of observing, retaining, and replicating and is crucial for reinforced learning.



- **Demonstrating:** A step-by-step explanation that includes the reasons and significance behind each step, often involving practical experimentation. It enhances understanding and skill application through practical demonstration.
- **Collaborating (Group Work):** Teaching students to work effectively in teams, promoting mutual responsibility, research skills, critical analysis, and problem-solving through discussion.
- **Brainstorming:** A group creativity technique designed to generate a large number of ideas for creative problem-solving.
  - **Rules:** Withhold criticism, welcome free-wheeling and unconventional ideas, aim for quantity, and combine and improve upon ideas.
- **Problem-Solving Method:** A process that involves choosing effective tools and behaviors to reach a target using scientific and critical thinking.
  - **Steps:** Identify and delimit the problem, plan an approach, prepare a guide, provide resources, examine the problem, conclude, and discuss findings.
  - **Advantages:** Promotes active participation, scientific thinking, and a sense of responsibility.
  - **Disadvantages:** Can be time-consuming, not suitable for all subjects, and may be resource-intensive.
- **Drama Technique:** Uses theatrical methods to enhance learning.
  - **Types:** Informal Drama (unrehearsed, improvisational), Role-Playing (preparing for a role before acting), Formal Drama (scripted performances).
  - **Advantages:** Makes learning fun, improves language and communication skills, and allows for the exploration of solutions to problems.
  - **Disadvantages:** Time-consuming, can be costly, and some students may feel self-conscious or threatened.



## Teaching Techniques & Methodologies: One - Liners

### 1. Introduction to Teaching

1. **Teaching** is a deliberate, interactive, and planned process to facilitate learning.
2. It involves the systematic transmission of **knowledge (cognitive), practical abilities (psychomotor), and values (affective)**.
3. Teaching prepares students for learning by providing an **initial structure and clarifying intended outcomes**.
4. The nature of teaching is a **mutual exchange** of experiences between teacher and students.
5. Teaching is a **provocative activity** aimed at stimulating academic, mental, and personal development.
6. The **traditional role** of a teacher is as the primary source or "**fountainhead**" of **knowledge**.
7. The **modern role** of a teacher is as a **facilitator, guide, and co-learner**.
8. The traditional method focuses on "**chalk-and-talk**" lecturing with students as passive recipients.
9. The modern method focuses on creating environments for students to **discover, construct, and collaborate** on knowledge.
10. Teachers must be **diagnosticians of learning**, considering students' background knowledge and the learning environment.

### 2. Roles and Characteristics of an Effective Teacher

11. The five major roles of a teacher are **Subject Matter Expert, Pedagogical Expert, Excellent Communicator, Student-Centered Mentor, and Systematic Assessor**.
12. A **Subject Matter Expert** possesses deep, current knowledge and a genuine passion for the discipline.
13. A **Pedagogical Expert** sets clear learning goals and guides critical thinking and problem-solving.
14. An **Excellent Communicator** helps students develop their own communication competencies.
15. A **Student-Centered Mentor** encourages learning through varied methods and promotes active participation.

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1. Teaching Techniques & Methodologies



16. A **Systematic and Continual Assessor** evaluates student outcomes and their own teaching effectiveness.
17. **Personal qualities** of an effective teacher include **fairness, positive attitude, and preparedness**.
18. **Fairness** means treating all students justly and equitably without favoritism.
19. A **positive attitude** involves believing in student success and using meaningful verbal praise.
20. **Preparedness** in subject matter and lessons allows for better management of behavioral matters.
21. **Personal touch** involves connecting with students by using their names and showing genuine interest.
22. A **sense of humor** is used to break the ice, reduce anxiety, and make learning enjoyable.
23. **Creativity** involves using unusual and innovative methods to motivate students.
24. **Willingness to admit mistakes** models humility, integrity, and a growth mindset for students.
25. A **forgiving** nature means moving forward from student misbehavior without holding grudges.
26. **Respect** is given to students to earn it in return, handling situations with sensitivity.
27. **High expectations** involve setting challenging yet realistic academic and behavioral standards.
28. **Compassion** involves caring for students' emotional well-being and reducing the impact of hurt feelings.
29. A **sense of belonging** is created by building a classroom community where every student feels valued.
30. **Professional qualities** include **collaboration, honesty, integrity, and respect**.
31. **Collaboration** means working constructively with colleagues, parents, and the community.
32. **Commitment to learning** involves valuing lifelong learning for both self and students.
33. **Emotional maturity** involves being self-confident, reliable, and handling situations with composure.



### 3. Theoretical Foundations of Learning and Teaching

- 34. **Vygotsky's Zone of Proximal Development (ZPD)** defines two levels of cognitive development.
- 35. The **Actual Developmental Level** is what a child can do independently without assistance.
- 36. The **Zone of Proximal Development (ZPD)** is what a learner can achieve with guidance from a skilled partner.
- 37. Effective teaching occurs within the learner's **ZPD**.
- 38. **Scaffolding** is the supportive framework provided by the teacher to help students bridge their ZPD.
- 39. Scaffolding techniques include **modeling, feeding back, contingency managing, and directing**.
- 40. Other scaffolding techniques are **questioning, explaining, and task structuring**.
- 41. **Task structuring** involves breaking down a complex task into smaller, manageable parts.
- 42. The **Constructivist Approach** posits that learners **construct** their own knowledge through active interaction.
- 43. In constructivism, knowledge is not passively received but is **actively built**.
- 44. Learning is an **active, interpretive, and iterative process**.
- 45. New knowledge is built upon and connected to **prior knowledge**.
- 46. Learning is inherently **social and culturally influenced**.
- 47. In constructivism, the teacher's role shifts from instructor to **facilitator** of learning.

### 4. Effective Teaching and Conducive Learning Environment

- 48. **Effective teaching** demonstrably leads to improved student learning and holistic development.
- 49. Effective teaching involves **talking to learners** about their learning and **listening to them**.
- 50. Aspects of effective teaching include managing the classroom and starting with a **clear objective**.
- 51. The **'Style' View** of teaching effectiveness is determined by the teacher's actions and behaviors.



- 52. The '**Outcomes' Approach** measures effectiveness by student results and the **added value** from the teacher.
- 53. The '**Inquiry' Approach** focuses on the teacher's reflection on the relationship between their style and student outcomes.
- 54. A **conducive learning environment** is positive, safe, respectful, and well-managed.
- 55. The teacher's role includes being an **instructor of knowledge** and a **creator of the classroom environment**.
- 56. The teacher is a **role model** whom students imitate, reflecting positive values.
- 57. The teacher acts as a **mentor** to encourage students and build their confidence.
- 58. The teacher is a **protector**, vigilant for signs of trouble like behavioral changes or abuse.
- 59. A key strategy is to **keep students motivated** to prevent discipline problems.
- 60. A conducive environment requires meeting students' **basic needs** for physical and emotional safety.
- 61. Teachers should exercise **moderate control**, balancing authoritarian and laissez-faire approaches.
- 62. **Empowering students** makes them responsible for their own learning, developing independence.
- 63. **Differentiating instruction** means tailoring it to students' developmental levels and learning styles.
- 64. Using **positive language** when addressing misbehavior means describing the act, not characterizing the student.

## 5. Core Teaching Methodologies and Strategies

- 65. **Classroom management** involves techniques to create an environment that supports academic and social-emotional learning.
- 66. A principle of classroom setup is that teachers should have a **clear view of all students** at all times.
- 67. **Allocated Time** is the total time scheduled for a subject.
- 68. **Engaged Time** is the portion of allocated time students are actively involved in the subject.



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- 69. **Academic Learning Time** is when students work with a high success rate (70-80% correct).
- 70. **Academic Learning Time** is the most critical factor directly linked to student achievement.
- 71. The **Lecture Method** is efficient for delivering large amounts of information to large groups.
- 72. A disadvantage of the **Lecture Method** is low information retention and minimal student interaction.
- 73. **Direct Instruction** is a highly structured, teacher-centered strategy for efficient knowledge transmission.
- 74. Steps in **Direct Instruction** include reviewing previous learning, stating goals, and providing immediate feedback.
- 75. **Indirect Instruction** is a student-centered strategy where the teacher is a facilitator.
- 76. Main strategies of **Indirect Instruction** are problem-solving, case studies, and reading for meaning.
- 77. The **Case Method** engages students in active discussion about real-world issues.
- 78. The **Discussion Method** engages students in active dialogue initiated by a probing question.
- 79. **Active Learning** creates environments where students talk, listen, read, write, and reflect.
- 80. **Cooperative Learning** involves small, mixed-ability teams working toward a common goal.
- 81. A key element of **Cooperative Learning** is **positive interdependence**.
- 82. Other key elements are **face-to-face interaction, individual accountability, and teaching of social skills**.
- 83. **Collaborative Teaching (Team Teaching)** involves two or more teachers sharing responsibility.
- 84. Co-teaching strategies include **One Teach/One Observe, Parallel Teaching, and Station Teaching**.

### 6. Essential Teaching Techniques

- 85. **Questioning** is used to assess prior learning, stimulate critical thinking, and clarify doubts.



86. **Explaining** involves presenting information in a direct, logical, and structured way.
87. **Modeling** is a visual aid where learning occurs through observation, retention, and replication.
88. **Demonstrating** is a step-by-step explanation that includes the reasons behind each step.
89. **Collaborating (Group Work)** teaches students to work effectively in teams, promoting mutual responsibility.
90. **Brainstorming** is a group creativity technique to generate a large number of ideas.
91. Rules for **Brainstorming** include withholding criticism and welcoming unconventional ideas.
92. The **Problem-Solving Method** involves choosing effective tools and behaviors using scientific thinking.
93. Steps in the **Problem-Solving Method** include identifying the problem, planning an approach, and examining the problem.
94. An advantage of the **Problem-Solving Method** is that it promotes active participation and scientific thinking.
95. A disadvantage is that it can be **time-consuming and resource-intensive**.
96. The **Drama Technique** uses theatrical methods like role-playing to enhance learning.
97. **Informal Drama** is unrehearsed and improvisational.
98. **Role-Playing** involves preparing for a role before acting it out.
99. An advantage of the **Drama Technique** is that it makes learning fun and improves communication skills.
100. A disadvantage is that some students may feel **self-conscious or threatened**.

## Practice MCQ

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**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**



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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

Answer: To generate a large number of ideas for creative problem-solving

12. Which characteristic involves a teacher using wit to break the ice and reduce anxiety?

- A) Preparedness
- B) Sense of Humor
- C) Personal Touch

D) Creativity

Answer: Sense of Humor

13. The process of breaking down a complex task into smaller, manageable parts is known as:

- A) Modeling
- B) Task Structuring
- C) Directing
- D) Explaining

Answer: Task Structuring

14. Which teaching method is described as a highly structured, teacher-centered strategy for efficient knowledge transmission?

- A) Indirect Instruction
- B) Case Method
- C) Direct Instruction
- D) Discussion Method

Answer: Direct Instruction

15. When addressing student misbehavior, a teacher should use positive language by:

- A) Characterizing the student as rude
- B) Describing the specific act that was inappropriate
- C) Ignoring the behavior to avoid confrontation
- D) Using sarcasm to correct the behavior

Answer: Describing the specific act that was inappropriate

16. What is the defining feature of a conducive learning environment?

- A) It is competitive and high-pressure
- B) It is positive, safe, respectful, and well-managed
- C) It is completely student-led with no



teacher intervention

D) It focuses solely on academic achievement

**Answer: It is positive, safe, respectful, and well-managed**

17. Which of the following is a disadvantage of the Problem-Solving Method?

- A) It does not promote scientific thinking
- B) It is always suitable for all subjects
- C) It can be time-consuming and resource-intensive
- D) It discourages active participation

**Answer: It can be time-consuming and resource-intensive**

18. In the context of teaching, what does "scaffolding" refer to?

- A) The physical structure of the classroom
- B) A supportive framework provided by the teacher to bridge the ZPD
- C) The final assessment given to students
- D) The curriculum designed by the school board

**Answer: A supportive framework provided by the teacher to bridge the ZPD**

19. Which type of drama involves unrehearsed, improvisational activities?

- A) Formal Drama
- B) Role-Playing
- C) Informal Drama
- D) Scripted Drama

**Answer: Informal Drama**

20. The teacher's role as a "protector" primarily involves:

- A) Imparting curriculum knowledge

B) Being vigilant for signs of trouble like abuse or behavioral changes

C) Setting a positive tone in the classroom

D) Serving as an exemplar for students

**Answer: Being vigilant for signs of trouble like abuse or behavioral changes**

21. Which professional quality of a teacher involves working constructively with colleagues and parents?

- A) Honesty and Integrity
- B) Emotional Maturity
- C) Collaboration
- D) Respect

**Answer: Collaboration**

22. What is the core idea behind the 'Outcomes' Approach to teaching effectiveness?

- A) The teacher's enthusiastic delivery
- B) The student results and the added value from the teacher
- C) The teacher's use of dialogue and discussion
- D) The teacher's inquiry into their own practice

**Answer: The student results and the added value from the teacher**

23. Differentiating instruction means tailoring it to students':

- A) Parental expectations only
- B) Developmental levels, readiness, and learning styles
- C) Performance on the final exam only
- D) Preferences for easy work

**Answer: Developmental levels, readiness, and learning styles**

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24. Which of the following is a principle of effective classroom management and setup?

- A) High-traffic areas should be free of congestion
- B) Students should not be able to see all instructional presentations
- C) Teaching materials should be kept locked away
- D) Procedures should be assumed and not taught

**Answer: High-traffic areas should be free of congestion**

25. The technique of "feeding back" in scaffolding involves:

- A) Demonstrating a skill for imitation
- B) Providing constructive information on performance for self-correction
- C) Using reinforcement to shape behavior
- D) Requesting specific actions from the student

**Answer: Providing constructive information on performance for self-correction**

26. What is a major advantage of the Cooperative Learning method?

- A) It requires no planning from the teacher
- B) It improves academic achievement, retention, and social skills
- C) It ensures that only the brightest students do the work
- D) It is the fastest way to cover the curriculum

**Answer: It improves academic achievement, retention, and social skills**

27. According to the document, teaching is defined as a process that is:

- A) Accidental and unplanned
- B) Deliberate, interactive, and planned
- C) Solely focused on psychomotor skills
- D) A one-way transmission of information

**Answer: Deliberate, interactive, and planned**

28. Which teaching strategy leverages student curiosity and encourages observation and investigation?

- A) Direct Instruction
- B) Lecture Method
- C) Indirect Instruction
- D) Demonstrating

**Answer: Indirect Instruction**

29. The characteristic of "willingness to admit mistakes" in a teacher primarily models what for students?

- A) Inflexibility
- B) Humility, integrity, and a growth mindset
- C) That the teacher is not an expert
- D) A lack of preparedness

**Answer: Humility, integrity, and a growth mindset**

30. In the Lecture Method, information retention is often:

- A) Very high
- B) Low
- C) Guaranteed
- D) Not a concern

**Answer: Low**

31. What is the primary goal of using the questioning technique in teaching?

- A) To fill up class time
- B) To intimidate students who are not paying attention
- C) To assess prior learning and stimulate



critical thinking

D) To avoid explaining concepts

**Answer: To assess prior learning and stimulate critical thinking**

**32. Which of the following best describes "Academic Learning Time"?**

A) The total time scheduled for a subject

B) The time when students are passively listening

C) The engaged time when students are working with a high success rate

D) The time spent on disciplinary actions

**Answer: The engaged time when students are working with a high success rate**

**33. The "Style View" of teaching effectiveness is determined by:**

A) Student test scores

B) The teacher's actions and behaviors, like displaying enthusiasm

C) The teacher's annual self-evaluation report

D) The number of degrees a teacher holds

**Answer: The teacher's actions and behaviors, like displaying enthusiasm**

**34. What does the "Personal Touch" characteristic of a teacher involve?**

A) Using students' names and showing genuine interest in their lives

B) Giving personal gifts to students

C) Sharing personal problems with the class

D) Allowing students to do whatever they want

**Answer: Using students' names and showing genuine interest in their lives**

**35. Which of the following is a key principle of the Constructivist Approach?**

A) Learning is a passive process of receiving information

B) New knowledge is built upon and connected to prior knowledge

C) The teacher is the sole source of knowledge

D) Learning is independent of social and cultural context

**Answer: New knowledge is built upon and connected to prior knowledge**

**36. The teacher's role as a "facilitator" is most closely associated with which teaching approach?**

A) Traditional Teacher-Centered Role

B) Modern Student-Centered Role

C) Chalk-and-Talk Method

D) Fountainhead of Knowledge Role

**Answer: Modern Student-Centered Role**

**37. Which technique involves a step-by-step explanation that includes the reasons behind each step?**

A) Modeling

B) Demonstrating

C) Brainstorming

D) Questioning

**Answer: Demonstrating**

**38. What is a recommended way to improve the effectiveness of a lecture?**

A) Read directly from the textbook for accuracy

B) Fit the lecture to the audience and deliver it with enthusiasm

C) Avoid using any examples to save time

D) Ignore audience feedback to stay on track

**Answer: Fit the lecture to the audience and deliver it with enthusiasm**

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39. According to Gurney (2007), one key factor for effective teaching is:

- A) Strict authoritarian control
- B) Teacher knowledge, enthusiasm, and responsibility
- C) Focusing only on high-achieving students
- D) Using only traditional teaching methods

**Answer: Teacher knowledge, enthusiasm, and responsibility**

40. What is the main purpose of establishing rules and routines in the classroom?

- A) To punish students frequently
- B) To create a structured and predictable environment for efficient learning
- C) To show the teacher's authority
- D) To eliminate the need for student interaction

**Answer: To create a structured and predictable environment for efficient learning**

41. In Vygotsky's theory, the "Actual Developmental Level" refers to what a child can do:

- A) With guidance from a peer
- B) Independently without any assistance
- C) In the distant future
- D) Under stress

**Answer: Independently without any assistance**

42. Which of the following is a strategy for creating a conducive learning environment?

- A) Meeting students' basic needs for physical and emotional safety
- B) Exercising maximum control over all student actions

C) Avoiding building relationships to maintain objectivity

D) Using negative language to correct behavior effectively

**Answer: Meeting students' basic needs for physical and emotional safety**

43. The Discussion Method of teaching requires:

- A) No preparation from students
- B) Careful planning and student preparation
- C) The teacher to do all the talking
- D) Avoiding any probing questions

**Answer: Careful planning and student preparation**

44. What is the primary focus of the "Case Method" in teaching?

- A) Rote memorization of facts
- B) Applying theoretical learning to practical, real-world scenarios
- C) Silent individual study
- D) Practicing handwriting skills

**Answer: Applying theoretical learning to practical, real-world scenarios**

45. Which characteristic involves a teacher proactively "catching students doing things right"?

- A) Fairness
- B) Positive Attitude
- C) Forgiving
- D) Sense of Belonging

**Answer: Positive Attitude**

46. The technique of "contingency managing" in scaffolding involves:

- A) Providing logical connections for new information
- B) Using reinforcement and punishment to



shape behavior

- C) Breaking tasks into smaller parts
- D) Demonstrating a skill for imitation

**Answer: Using reinforcement and punishment to shape behavior**

**47. What is a significant disadvantage of the Drama Technique?**

- A) It never improves communication skills
- B) It makes learning boring
- C) It can be time-consuming and may make some students self-conscious
- D) It is the cheapest method to implement

**Answer: It can be time-consuming and may make some students self-conscious**

**48. Empowering students in a conducive learning environment primarily aims to:**

- A) Make the teacher's job easier
- B) Develop student independence and responsibility for their own learning
- C) Reduce the amount of homework
- D) Entertain students with fun activities

**Answer: Develop student independence and responsibility for their own learning**

**49. Which of the following is a professional quality of an effective teacher?**

- A) Sense of Humor
- B) Compassion
- C) Commitment to Learning
- D) Creativity

**Answer: Commitment to Learning**

**50. The process of "assisting performance" to awaken mental functions is central to teaching within the:**

- A) Actual Developmental Level
- B) Zone of Proximal Development (ZPD)

- C) Lecture Hall
- D) Traditional Curriculum

**Answer: Zone of Proximal Development (ZPD)**

**51. What does the "Systematic and Continual Assessor" role of a teacher involve?**

- A) Only assessing students at the end of the year
- B) Evaluating student learning outcomes and their own teaching effectiveness
- C) Focusing solely on subject matter expertise
- D) Avoiding feedback to students

**Answer: Evaluating student learning outcomes and their own teaching effectiveness**

**52. Which co-teaching strategy involves one teacher leading the lesson while the other circulates to provide assistance?**

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

**Answer: One Teach/One Assist**

**53. A teacher who serves as an exemplar for students, reflecting positive values, is fulfilling the role of a:**

- A) Protector
- B) Role Model
- C) Mentor
- D) Subject Matter Expert

**Answer: Role Model**

**54. In brainstorming, one of the key rules is to:**

- A) Criticize ideas as they are generated

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- B) Welcome free-wheeling and unconventional ideas
- C) Aim for a small number of perfect ideas
- D) Allow only the teacher to generate ideas

**Answer: Welcome free-wheeling and unconventional ideas**

**55. What is the main advantage of using Active Learning strategies?**

- A) They require minimal effort from the teacher
- B) They enhance critical thinking and retention of knowledge
- C) They ensure complete silence in the classroom
- D) They are the same as the traditional lecture method

**Answer: They enhance critical thinking and retention of knowledge**

**56. The nature of teaching as a "mutual exchange" emphasizes that it is:**

- A) A one-way transmission from teacher to student
- B) A dynamic interaction between teacher and students
- C) Only about the teacher's experiences
- D) Independent of student input

**Answer: A dynamic interaction between teacher and students**

**57. Which of the following is a component of Direct Instruction?**

- A) Presenting new material in large, complex chunks
- B) Providing immediate feedback and corrections
- C) Relying solely on student discovery
- D) Avoiding the review of previous learning

**Answer: Providing immediate feedback and corrections**

**58. The characteristic of "fairness" in a teacher requires:**

- A) Treating all students justly and equitably, avoiding favoritism
- B) Giving everyone the same grade regardless of performance
- C) Focusing only on the most talented students
- D) Punishing all students for one student's mistake

**Answer: Treating all students justly and equitably, avoiding favoritism**

**59. What is the purpose of the "explaining" technique in teaching?**

- A) To confuse students with complex language
- B) To provide rationale and help learners organize new information
- C) To avoid answering student questions
- D) To fill time when unprepared

**Answer: To provide rationale and help learners organize new information**

**60. According to the document, a teacher acting as a "diagnostician of learning" must consider:**

- A) Only the final exam results
- B) Students' background knowledge and the learning environment
- C) Their own salary
- D) The opinions of other teachers only

**Answer: Students' background knowledge and the learning environment**

**61. Which teaching method is characterized by small, mixed-ability**

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teams working toward a common goal?

- A) Lecture Method
- B) Direct Instruction
- C) Cooperative Learning
- D) Distance Learning

**Answer: Cooperative Learning**

**62. The term "scaffolding" in educational theory is most closely associated with the work of:**

- A) Piaget
- B) Vygotsky
- C) Gurney
- D) Skinner

**Answer: Vygotsky**

**63. What is a key element of a conducive learning environment regarding control?**

- A) Exercising moderate control, balancing authoritarian and laissez-faire approaches
- B) Exercising maximum control at all times
- C) Having no control and letting students do whatever they want
- D) Letting the parents control the classroom

**Answer: Exercising moderate control, balancing authoritarian and laissez-faire approaches**

**64. Which of the following is a type of Formal Drama?**

- A) Improvisational activities
- B) Role-Playing with preparation
- C) Scripted performances
- D) Unrehearsed plays

**Answer: Scripted performances**

**65. The "Added Value" a teacher contributes is a concept central to which approach to teaching effectiveness?**

- A) The Style View

B) The Outcomes Approach

C) The Inquiry Approach

D) The Traditional Approach

**Answer: The Outcomes Approach**

**66. In the context of teaching, "Assimilation and Accommodation" are processes related to:**

- A) Building new knowledge upon prior knowledge in constructivism
- B) The lecture method
- C) Classroom seating arrangements
- D) Salary negotiations for teachers

**Answer: Building new knowledge upon prior knowledge in constructivism**

**67. Which of the following is a responsibility of a teacher as a "creator of the classroom environment"?**

- A) Setting a positive, warm, and happy tone
- B) Only delivering the curriculum
- C) Focusing solely on administrative tasks
- D) Ignoring student behavior

**Answer: Setting a positive, warm, and happy tone**

**68. What is the primary focus when a teacher uses the "One Teach/One Observe" co-teaching strategy?**

- A) Both teachers teaching the same content simultaneously
- B) One teacher teaching while the other gathers data on student learning
- C) Dividing the class into two groups based on ability
- D) Having one teacher manage discipline while the other teaches

**Answer: One teacher teaching while the other gathers data on student learning**

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69. The technique of "directing" in scaffolding involves:

- A) Providing constructive feedback
- B) Requesting specific actions from the student to clarify the correct response
- C) Demonstrating a skill for imitation
- D) Using reinforcement to shape behavior

**Answer: Requesting specific actions from the student to clarify the correct response**

70. Which of the following is a recommended strategy for handling student misbehavior?

- A) Deal with the present problem immediately and talk to the student privately
- B) Ignore all misbehavior to avoid attention
- C) Use empty threats to scare students
- D) Handle the student with anger to show authority

**Answer: Deal with the present problem immediately and talk to the student privately**

71. What does "Differentiating Instruction" primarily involve?

- A) Teaching the same way to every student
- B) Tailoring instruction to students' individual needs, readiness, and learning styles
- C) Making the curriculum easier for everyone
- D) Focusing only on gifted students

**Answer: Tailoring instruction to students' individual needs, readiness, and learning styles**

72. The "Pedagogical Expert" role of a teacher includes:

- A) Only knowing the subject matter deeply
- B) Setting clear learning goals and guiding

critical thinking

- C) Handling the school's finances
- D) Communicating only with parents

**Answer: Setting clear learning goals and guiding critical thinking**

73. Which of the following is an advantage of using the Role-Playing technique?

- A) It requires no preparation
- B) It allows for the exploration of solutions to problems in a safe environment
- C) It is the least time-consuming method
- D) It ensures all students will be extroverted

**Answer: It allows for the exploration of solutions to problems in a safe environment**

74. In the Problem-Solving Method, what is the first step?

- A) Conclude and discuss findings
- B) Provide resources
- C) Identify and delimit the problem
- D) Plan an approach

**Answer: Identify and delimit the problem**

75. What is the main goal of "maximizing engaged time" in the classroom?

- A) To have the longest school day possible
- B) To keep students on task and actively involved in learning
- C) To give students more free time
- D) To reduce the amount of curriculum covered

**Answer: To keep students on task and actively involved in learning**

76. Which personal quality involves a teacher showing a willingness to move forward after student misbehavior?



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- A) Fairness
- B) Forgiving
- C) Respect
- D) High Expectations

**Answer: Forgiving**

**77. The concept that "teaching is only effective when it precedes development" is associated with:**

- A) The Lecture Method
- B) Vygotsky's ZPD
- C) Direct Instruction
- D) The Outcomes Approach

**Answer: Vygotsky's ZPD**

**78. What is a key function of the "questioning" technique in scaffolding?**

- A) To punish students for not knowing the answer
- B) To prompt mental operations the learner cannot produce alone
- C) To fill silence in the classroom
- D) To avoid giving explanations

**Answer: To prompt mental operations the learner cannot produce alone**

**79. Which of the following describes the "Linked Courses" model of Collaborative Teaching?**

- A) Two teachers plan and teach the same course content together.
- B) Two separate courses are linked by a common theme and sometimes shared assignments.
- C) Teachers teach in rotating stations.
- D) One teacher teaches while the other assists.

**Answer: Two separate courses are linked by a common theme and sometimes shared assignments.**

**80. A teacher who actively builds a classroom community to make every student feel valued is promoting:**

- A) High Expectations
- B) Sense of Belonging
- C) Compassion
- D) Preparedness

**Answer: Sense of Belonging**

**81. According to the document, effective teaching demonstrably leads to improved student:**

- A) Learning, achievement, and holistic development
- B) Only rote memorization skills
- C) Performance in sports
- D) Obedience without question

**Answer: Learning, achievement, and holistic development**

**82. Which of the following is a component of "task structuring" as a scaffolding technique?**

- A) Using reinforcement
- B) Providing immediate feedback
- C) Chunking, segregating, and sequencing a complex task
- D) Demonstrating a skill

**Answer: Chunking, segregating, and sequencing a complex task**

**83. The "Station Teaching" co-teaching strategy involves:**

- A) Both teachers teaching the same content to the whole class
- B) Dividing the class and content into multiple stations, with teachers at separate stations
- C) One teacher teaching while the other observes



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D) Teaching different courses in the same room

**Answer: Dividing the class and content into multiple stations, with teachers at separate stations**

**84. What is the primary purpose of consolidating the lesson at the end of a class?**

- A) To introduce new topics for the next day
- B) To give students a break
- C) To aid in retention of the material covered
- D) To assign homework quickly

**Answer: To aid in retention of the material covered**

**85. Which characteristic involves a teacher caring for students' emotional well-being?**

- A) Respect
- B) Compassion
- C) Fairness
- D) Positive Attitude

**Answer: Compassion**

**86. In the context of learning, what does "ZPD" stand for?**

- A) Zero Problem Domain
- B) Zone of Proximal Development
- C) Zealous Pupil Development
- D) Zonal Performance Data

**Answer: Zone of Proximal Development**

**87. Which teaching method is most associated with the "chalk-and-talk" approach?**

- A) Cooperative Learning
- B) Traditional Teacher-Centered Role
- C) Modern Student-Centered Role

D) Constructivist Approach

**Answer: Traditional Teacher-Centered Role**

**88. What is a key principle for establishing classroom rules?**

- A) They should be numerous and highly specific
- B) They should be few, general, positive, and applicable
- C) They should be created by the principal only
- D) They should never be displayed for students to see

**Answer: They should be few, general, positive, and applicable**

**89. The professional quality of "Respect" in a teacher involves:**

- A) Valuing diversity and establishing rapport with students
- B) Demanding respect from students without giving any
- C) Only respecting other teachers
- D) Ignoring cultural differences in the classroom

**Answer: Valuing diversity and establishing rapport with students**

**90. Which technique is described as a group creativity technique for generating ideas?**

- A) Demonstrating
- B) Explaining
- C) Brainstorming
- D) Modeling

**Answer: Brainstorming**

**91. What is the main implication of the Constructivist Approach for teaching?**



- A) The teacher should lecture for the entire class period
- B) The teacher's role shifts from instructor to facilitator of learning
- C) Students should work in complete silence
- D) Knowledge is solely transmitted from the teacher

**Answer: The teacher's role shifts from instructor to facilitator of learning**

- A) Being self-confident, reliable, and handling situations with composure
- B) Sharing all personal emotions with the class
- C) Reacting emotionally to student misbehavior
- D) Being overly friendly with students

**Answer: Being self-confident, reliable, and handling situations with composure**

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**92. Which of the following is a strategy to build relationships in a conducive learning environment?**

- A) Learn names and positive information about each student
- B) Avoid any personal connection with students
- C) Remember only the names of the top performers
- D) Use students' names only when they misbehave

**Answer: Learn names and positive information about each student**

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**93. The "Alternative Teaching" co-teaching strategy typically involves:**

- A) Both teachers leading the whole class together
- B) One teacher teaching a large group while the other teaches a small group for remediation or enrichment
- C) Teachers teaching in parallel groups
- D) Students rotating through stations independently

**Answer: One teacher teaching a large group while the other teaches a small group for remediation or enrichment**

**94. What does "Emotional Maturity" as a professional quality entail?**

**95. According to the document, teaching involves the transmission of three types of skills: Cognitive, Psychomotor, and what else?**

- A) Digital
- B) Affective (values or attitudes)
- C) Linguistic
- D) Musical

**Answer: Affective (values or attitudes)**

**96. What is a primary advantage of the Indirect Instruction method?**

- A) It is the fastest way to deliver facts
- B) It leverages student curiosity and encourages investigation
- C) It requires no preparation from the teacher
- D) It ensures all students think identically

**Answer: It leverages student curiosity and encourages investigation**

**97. The characteristic of "creativity" in a teacher is demonstrated by using:**

- A) Only the textbook
- B) Unusual, engaging, and innovative methods
- C) The same lesson plan every year
- D) Methods that require no effort

**Answer: Unusual, engaging, and innovative methods**



98. In which teaching method does the teacher initiate dialogue with a probing question?

- A) Lecture Method
- B) Discussion Method
- C) Direct Instruction
- D) Demonstrating

**Answer: Discussion Method**

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99. What is the core idea behind "Positive Interdependence" in Cooperative Learning?

- A) Students work completely alone
- B) Students believe they sink or swim together
- C) The teacher does all the work for the group
- D) Success is based on individual performance only

**Answer: Students believe they sink or swim together**

100. Which of the following is a key responsibility of a teacher as a "mentor"?

- A) Encouraging students to do their best and enjoy learning
- B) Only delivering curriculum content
- C) Focusing solely on administrative reports
- D) Protecting the school's physical property

**Answer: Encouraging students to do their best and enjoy learning**



## Chapter 2

# Classroom Management and Discipline

### 1. Definition, Concept, and Importance of Classroom Management

#### Definition:

Classroom Management is a broad, multi-dimensional process encompassing all the strategies, methods, and practices a teacher employs to establish and maintain a supportive, orderly, predictable, and productive learning environment. It is not merely about controlling student behavior but about systematically creating conditions where both teaching and learning can flourish efficiently.

#### Key Definitions from Theorists:

- **Wong (2004):** Defines it as the practices and processes a teacher uses to uphold an environment where instruction and learning can occur smoothly.
- **Mallory (2008):** Describes it as a multifaceted process that depends on an engaging curriculum, student responsibility, effective instruction, and management skills for conflict resolution.
- **Brophy & Good:** Emphasize that it is broader than student discipline, including all things teachers do to foster student involvement, cooperation, and a productive working environment.

#### Importance of Classroom Management:

Effective classroom management is a critical indicator of student success and teacher efficacy. Its importance is multifaceted:

- **Maximizes Learning Time:** A well-managed classroom minimizes disruptions and time spent on disciplining, allowing maximum time to be allocated to instructional activities.
- **Creates a Positive and Safe Atmosphere:** It fosters an environment where students feel physically and emotionally safe, respected, and comfortable to take intellectual risks, ask questions, and participate actively.
- **Enhances Student Engagement:** Through structured routines and engaging activities, it helps keep students on-task, focused, and involved in the learning process.
- **Improves Academic Achievement:** Consistent routines, clear expectations, and a focused environment directly contribute to higher student test scores and overall academic performance.

## 2. Classroom Management and Discipline

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## Classroom Management and Discipline: One-Liners

### 1. Definition, Concept, and Importance of Classroom Management

1. **Classroom Management** is a multi-dimensional process to establish a supportive, orderly, and productive learning environment.
2. According to **Wong (2004)**, it is the practices to uphold an environment where instruction and learning occur smoothly.
3. **Mallory (2008)** describes it as a multifaceted process dependent on an engaging curriculum and effective instruction.
4. **Brophy & Good** emphasize that it is broader than discipline, fostering student involvement and cooperation.
5. Effective classroom management **maximizes learning time** by minimizing disruptions.
6. It creates a **positive and safe atmosphere** for students to take intellectual risks.
7. It **enhances student engagement** through structured routines and engaging activities.
8. It directly **improves academic achievement** and student test scores.
9. A key aim is to promote **student self-control and responsibility**.
10. It **reduces teacher stress** and prevents burnout.

### 2. Goals, Components, and Dimensions of Classroom Management

11. A goal of classroom management is **better teaching** through careful lesson planning.
12. Clear goals provide **student focus** by clarifying expectations.
13. Teacher goal-setting acts as a **model for students** to set their own objectives.
14. Well-defined goals **motivate students** toward higher academic achievement.
15. A key operational component is **classroom design**, the intentional physical arrangement.
16. **Establishing rules and procedures** is crucial for a functional classroom.
17. **Discipline with consistency** involves implementing fair and firm consequences.
18. Effective **scheduling and time management** keeps the class on task.
19. Teacher **organizational skills** set a good example and prevent wasted time.
20. **Effective instructional techniques** are tailored to the grade level and subject.

## Practice MCQs

**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 m<sup>2</sup>
- B) 1.0 m<sup>2</sup>
- C) 1.2 m<sup>2</sup>
- D) 1.5 m<sup>2</sup>

**Answer: 0.6 m<sup>2</sup>**

**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

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2. Classroom Management and Discipline



## Chapter 3

# Testing, Measurement, Assessment and Evaluation

### 1. Introduction to the Core Concepts

The process of understanding and judging student learning is built upon four fundamental, sequential concepts: Test, Measurement, Assessment, and Evaluation. These terms are often used interchangeably but have distinct, hierarchical meanings and scopes.

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- **Scope:** Test (Least in scope) → Measurement → Assessment → Evaluation (Broadest in scope).

#### A. Test

- **Definition:** A test is a formal and systematic instrument or procedure used to measure a sample of an individual's behavior, knowledge, skills, or abilities. It consists of a set of questions or tasks that require an answer orally, in writing, or through performance.
- **Purpose:** To elicit a response that can be quantified and interpreted.
- **Example:** A final exam in mathematics, a driving test, a personality inventory.
- **It answers the question: "How well?"** does the individual perform on this specific set of tasks.

#### B. Measurement

- **Definition:** Measurement is the process of obtaining a **numerical description** of the degree to which an individual possesses a particular characteristic. It is the quantification or scoring of the test.
- **Purpose:** To assign a number (a score) to the performance observed in the test.
- **Nature:** It is quantitative and objective but does not, by itself, include qualitative judgments.
- **Example:** "Rafaih solved 23 arithmetic problems out of 40." or "Sara scored 85 marks out of 100."
- **It answers the question: "How much?"**
- **Final Product:** The final product of measurement is a **Score**.

#### C. Assessment



## Practice MCQs

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1. What is the correct hierarchical sequence of the core concepts from least to broadest scope?

- A) Assessment, Measurement, Test, Evaluation
- B) Test, Measurement, Assessment, Evaluation
- C) Evaluation, Assessment, Measurement, Test
- D) Measurement, Test, Evaluation, Assessment

**Answer: Test, Measurement, Assessment, Evaluation**

2. A final exam in mathematics is a direct example of which core concept?

- A) Measurement
- B) Assessment
- C) Evaluation
- D) Test

**Answer: Test**

3. The process of assigning a numerical score to a student's performance is known as?

- A) Assessment
- B) Evaluation
- C) Measurement
- D) Testing

**Answer: Measurement**

4. Which concept answers the question, "What does the performance mean?"

- A) Test
- B) Measurement
- C) Assessment
- D) Evaluation

**Answer: Assessment**

5. Making a value judgment about the quality of a student's work is the essence of?

- A) Assessment
- B) Measurement
- C) Evaluation
- D) Testing

**Answer: Evaluation**

6. Assessment FOR Learning is synonymous with?

- A) Summative Assessment
- B) Diagnostic Assessment
- C) Formative Assessment
- D) Placement Assessment

**Answer: Formative Assessment**

7. The primary purpose of summative assessment is to?

- A) Provide ongoing feedback
- B) Monitor learning during instruction
- C) Develop metacognitive skills
- D) Measure and certify learning at the end

**Answer: Measure and certify learning at the end**

8. Assessment AS Learning primarily focuses on developing?

- A) Social skills
- B) Metacognitive skills
- C) Psychomotor skills
- D) Linguistic skills

**Answer: Metacognitive skills**

9. In which type of assessment is feedback typically detailed, descriptive, and immediate?

- A) Summative Assessment
- B) Norm-Referenced Assessment

3. Testing, Measurement, Assessment & Evaluation



## Chapter 4

# Educational Taxonomies

# 4. Educational Taxonomies

### Introduction to Educational Taxonomies

#### Definition:

Educational taxonomies are systematic frameworks or models used to classify educational goals, learning objectives, and standards into hierarchical levels of complexity and specificity.

#### M Purpose and Uses:

- K • To help educators design, implement, and assess instructional strategies and student learning outcomes effectively.
- P • To provide a common language for discussing educational objectives.
- R • To ensure that instruction, curriculum, and assessments are aligned with the intended learning goals.
- E • To guide the creation of questions, lesson plans, and curriculum mapping (e.g., Table of Specification).
- P • To differentiate instruction and provide targeted learning feedback.

#### A Bloom's Taxonomy

R Bloom's Taxonomy is the most famous and widely used taxonomy in education. It is a three-dimensional hierarchical model that classifies learning objectives into levels of complexity and specificity.

#### T The Three Domains of Bloom's Taxonomy:

- I 1. **Cognitive Domain:** Related to mental skills and knowledge (**Head**).
- O 2. **Affective Domain:** Related to attitudes, emotions, and values (**Heart**).
- N 3. **Psychomotor Domain:** Related to manual and physical skills (**Hand**).

#### S A. The Cognitive Domain (Benjamin Bloom, 1956)

This domain is concerned with knowledge outcomes, intellectual abilities, and mental skills. The original taxonomy has six levels, progressing from the simplest to the most complex.

#### Original Levels (1956):

1. **Knowledge (Lowest Level)**



## Practice MCQs

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1. **What is the primary purpose of educational taxonomies?**
  - A) To replace traditional teaching methods
  - B) To classify educational goals into hierarchical levels
  - C) To focus solely on student assessment
  - D) To standardize curriculum across countries

Answer: To classify educational goals into hierarchical levels

2. **Bloom's Taxonomy is primarily a framework for classifying what?**
  - A) Student personalities
  - B) Educational resources
  - C) Learning objectives
  - D) School administrative levels

Answer: Learning objectives

3. **Which of the following is NOT one of the three domains of Bloom's Taxonomy?**
  - A) Cognitive
  - B) Affective
  - C) Psychomotor
  - D) Sociological

Answer: Sociological

4. **The Cognitive Domain in Bloom's Taxonomy is primarily associated with which part of the human faculties?**
  - A) Heart
  - B) Hands
  - C) Head

D) Health  
Answer: Head

5. **In the original Bloom's Taxonomy, which level was considered the highest?**

- A) Synthesis
- B) Analysis
- C) Evaluation
- D) Application

 Answer: Evaluation

6. **The ability to break down material into its constituent parts is defined as which level in the cognitive domain?**

- A) Comprehension
- B) Application
- C) Analysis
- D) Synthesis

 Answer: Analysis

7. **Which verb is most associated with the 'Knowledge' level of the original cognitive domain?**

- A) Explain
- B) Summarize
- C) Define
- D) Compare

 Answer: Define

8. **The revised version of Bloom's Cognitive Domain was developed by whom?**

- A) Benjamin Bloom and Elizabeth Simpson
- B) Lorin Anderson and David Krathwohl
- C) John Biggs and Kevin Collis

4. Educational Taxonomies