



THE ULTIMATE RESOURCE FOR

GAT / HAT

GENERAL PREPARATION

EXCLUSIVELY INCLUDES:



Verbal Reasoning



Analytical Reasoning



Quantitative Reasoning

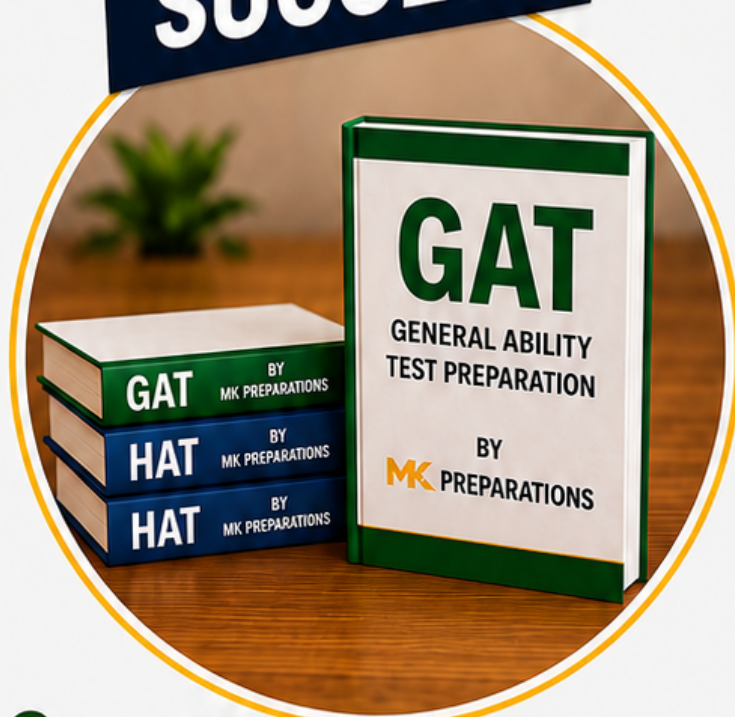


Reasoning Aptitude Tests

IDEAL FOR THE PREPARATION OF:

- GAT General
- HAT
- University Admission Test (MPhil & PhD)
- HEC Scholarship Test
- NTS Entry Test
- All Other Competitive Exams

**100%
SUCCESS**



- ✓ Concept-Based Approach
- ✓ Exam-Oriented Content
- ✓ Updated According to Latest Pattern
- ✓ High Yield MCQs
- ✓ Solved Past Papers and Practice MCQs



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Reasoning Aptitude Tests GAT/HAT



Introduction

The HEC Graduate Assessment Test (GAT) and Higher Education Aptitude Test (HAT) are competitive aptitude examinations designed to assess the academic readiness, analytical ability, quantitative skills, and language proficiency of candidates seeking admission to postgraduate programmes or applying for higher-education scholarships.

This preparation guide has been developed according to the expected aptitude-test pattern for HEC GAT/HAT 2026. It provides comprehensive, concept-based, and examination-oriented preparation material to help candidates understand fundamental concepts, improve problem-solving speed, and practise questions of varying difficulty levels.

Major Areas Covered

- Verbal Reasoning
- Vocabulary, sentence completion, analogies, reading comprehension, critical reasoning, grammar, synonyms, antonyms, and verbal relationships.
- Quantitative Reasoning
- Arithmetic, algebra, geometry, percentages, ratios, averages, profit and loss, time and work, speed and distance, probability, data interpretation, and basic statistics.
- Analytical Reasoning
- Logical arrangements, sequences, classifications, deductions, assumptions, arguments, cause-and-effect relationships, puzzles, and analytical problem-solving.

Key Features of This Guide

- Complete concept-based explanations
- Topic-wise solved examples
- Practice MCQs with answers
- Detailed explanations of difficult questions
- Exam-oriented techniques and shortcuts
- Mixed practice exercises
- Full-length model tests
- Time-management and question-solving strategies
- Coverage of frequently tested aptitude concepts

This book is suitable for students preparing for MS, MPhil, PhD, and scholarship-related aptitude tests. Candidates are encouraged to study each topic carefully, practise regularly, analyse their mistakes, and attempt complete mock tests under timed conditions.

Consistent practice, conceptual clarity, and effective time management are the keys to achieving a strong score in the HEC GAT/HAT 2026 examination.

Content Weightages for HEC HAT Regular Streams 100 MCQs Time Allowed 120 minutes

Serial No.	Title	Criteria and Subject Division	MCQ's Subject % Weight
1-	HAT-I 16 years / equal Education in Engineering & Technology, Computer Science, Mathematics, Statistics, Physics	English/Verbal Reasoning	30%
		Analytical Reasoning	30%
		Quantitative Reasoning	40%
		TOTAL	100%
2-	HAT-II 16 years / equal Education in Management Sciences, Business Education	English/Verbal Reasoning	30%
		Analytical Reasoning	40%
		Quantitative Reasoning	30%
		TOTAL	100%
3-	HAT-III 16 years / equal Education in Art and Humanities, Social Sciences, Psychology (Clinical & Applied) and Law	English/Verbal Reasoning	40%
		Analytical Reasoning	35%
		Quantitative Reasoning	25%
		TOTAL	100%
4-	HAT-IV 16 years / equal Education in Agriculture & Veterinary Sciences, Biological & Medical Sciences, Physical Sciences	English/Verbal Reasoning	40%
		Analytical Reasoning	30%
		Quantitative Reasoning	30%
		TOTAL	100%

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5-	HAT-General 16 years / equal Education Religious Studies Students	English/Verbal Reasoning	40%
		Analytical Reasoning	30%
		Quantitative Reasoning	30%
		TOTAL	100%





Verbal Reasoning



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Verbal Reasoning

Introduction to Verbal Reasoning

Verbal Reasoning is defined as the ability to understand, analyse, and use language logically. In the context of competitive aptitude tests—whether for university admissions, recruitment exams, or scholarship evaluations—this definition takes on a sharper, more urgent meaning. You are not being asked to appreciate literature or write creative prose; you are being asked to decode, deduce, and decide—quickly and correctly—under strict time constraints. The verbal section is often the differentiator between candidates, and mastering it requires a strategic approach to its twelve core areas.

Your preparation begins with the foundational pillars of language: **Vocabulary**, **Synonyms**, and **Antonyms**. In aptitude tests, rote memorization is inefficient. Instead, you must learn to recognize root words, contextual clues, and tone to determine meanings instantly. Synonyms test your ability to identify subtle shades of meaning, while Antonyms challenge you to spot opposites—often through negative prefixes or contextual contrast. Together, they form the bedrock upon which all other skills are built.

Moving beyond isolated words, you encounter **Analogies** and **Similes**. These are not merely decorative language tools; they are pure logic puzzles. Analogies require you to identify relationships—function, degree, part-to-whole, or cause-and-effect—and apply that relationship to a new pair. Similes, while less common, test your ability to draw conceptual comparisons. In a timed test, these questions reward candidates who can swiftly map connections without overthinking.

Next comes the structural domain: **Identifying Sentence Errors**, **Idioms and Errors**, and **Prefixes and Suffixes**. Examiners consistently embed grammatical traps—subject-verb disagreements, misplaced modifiers, and incorrect prepositions. Your task is to spot these within seconds. Meanwhile, a strong grasp of Idioms and Errors protects you from collocational pitfalls, and knowledge of Prefixes and Suffixes becomes your secret weapon for decoding unfamiliar vocabulary on the spot, turning anxiety into advantage.

The application of these skills culminates in **Sentence Completion** and **Reading Comprehension**. Sentence Completion tests your ability to use context clues, logical connectors, and tone to fill blanks accurately. It is a direct measure of your analytical reasoning within a single sentence. Reading Comprehension, however, is the ultimate integration of all skills—vocabulary, grammar, inference, and synthesis. In aptitude tests, success here does not come from reading every word, but from strategic skimming, identifying the author's argument, and eliminating distractors with surgical precision.

Finally, a test-ready candidate must go beyond everyday English. **Foreign Words and Phrases** (such as *ad nauseam*, *bona fide*, or *carte blanche*) frequently appear as high-difficulty questions, rewarding candidates with broader cultural and academic exposure. Complementing this is **One Word Substitution**—the ability to replace a lengthy descriptive phrase with a precise single term. This not only tests vocabulary depth but also enhances concise expression, a quality highly valued in aptitude assessments.

In essence, these twelve areas are not separate subjects; they are interconnected weapons in your test-taking arsenal. Your preparation should not be passive reading but active, targeted practice—identifying your weak zones, mastering elimination strategies, and building mental agility. The following notes are structured to guide you through each of these twelve domains with exam-focused shortcuts, common traps, and high-yield practice. Approach them not as a scholar, but as a strategist. Your goal is clarity, speed, and precision.

Sentence Completion

Sentence Completion is a fundamental question type in verbal reasoning and aptitude tests. It presents you with an incomplete sentence containing one or more blanks, and you must select the most appropriate word(s) or phrase(s) from the given options to complete it meaningfully and grammatically.

Sentence completion questions are **not pure vocabulary tests**. They assess three interconnected skills:

Skill	What It Tests
Vocabulary	Do you know the meaning of the words in the options?
Grammar	Does the word fit the sentence structure (tense, agreement, parts of speech)?
Logic	Does the completed sentence make coherent sense in context?

Question Formats

Sentence completion questions appear in three main formats:

1. **Single Blank** – One word is missing; the rest of the sentence provides the context.
2. **Double Blank** – Two words are missing; both must fit together to create a coherent sentence.
3. **Two-Word/Synonym Pairs** – Similar-meaning options are provided; the exact tone of the sentence determines which one fits.

MASTER STRATEGY: The 4-Step Method

The most common mistake test-takers make is looking at the options before fully understanding the sentence.

Follow this systematic approach instead:

Step 1: Read the Sentence Carefully — Look for Clues

Read the entire sentence thoroughly before glancing at the answer choices. Identify:

- The **overall meaning** and tone of the sentence
- **Signal/transition words** that indicate logical relationships
- **Context clues** that hint at what the blank should contain

Step 2: Predict the Answer

Cover the options and fill the blank with **your own word** or phrase. Even a rough synonym is sufficient. This prevents you from being influenced by plausible-but-wrong distractors.

Step 3: Pick the Best Match

Scan all options and select the one closest to your prediction. Make sure to check **every choice** before deciding.

Step 4: Plug In and Verify

Read your selected choice back into the complete sentence. Does it sound natural? Does it maintain the intended meaning? If more than one choice seems possible, eliminate at least one option, guess, and move on.

SIGNAL WORDS: Your Most Powerful Clues

Signal words reveal the **logical relationship** between the blank and the rest of the sentence. Mastering these is the single most important step to solving sentence completion questions accurately.

1. Contrast Indicators

These words signal that the blank should contain something **opposite** to another part of the sentence.

Common Contrast Words

Although, But, Yet, Despite, However, Nevertheless, In spite of, Rather than, Unlike

Example: *Although she was _____, she managed to complete the project on time.*

- **Signal:** "Although" sets up a contrast → completing on time is positive, so the blank must be negative
- **Answer:** exhausted (the only negative option)

2. Support/Reinforcement Indicators

These words signal that the blank should contain something **similar** to another idea in the sentence.

Common Support Words

And, Also, Furthermore, Likewise, Moreover, In addition, For, Similarly

A) advanced; easily

B) slow; quickly

C) average; poorly

D) young; slowly

Q13. The politician's _____ remarks offended many voters, costing him the election.

A) diplomatic

B) inflammatory

C) conciliatory

D) neutral

Q14. She was _____ tired that she could _____ keep her eyes open.

A) so; hardly

B) very; not

C) too; always

D) such; never

Q15. The manager wants the report _____ by Monday, _____ it will delay the project.

A) finished; or

B) finishing; and

C) to finish; but

D) be finished; so

Q16. Despite several _____, the mission succeeded in its attempt to resolve the conflict.

A) setbacks

B) advantages

C) resources

D) victories

Q17. The ancient manuscript was _____ and difficult to _____ without damaging it.

A) fragile; handle

B) sturdy; read

C) valuable; sell

D) heavy; carry

Q18. His _____ behavior at the meeting was _____, making everyone uncomfortable.

A) rude; inappropriate

B) polite; welcome

C) cheerful; delightful

D) quiet; unnoticed

Q19. The new policy was _____ unpopular, yet the management _____ to implement it.

A) widely; decided

B) slightly; refused

C) not; hesitated

D) secretly; planned

Q20. She has a _____ for languages and can speak five _____.

A) gift; fluently

B) problem; poorly

C) desire; rarely

D) fear; nervously

ANSWER KEY WITH EXPLANATIONS

Q	Answer	Explanation
1	A	"Has already become very popular" is the most neutral and logical completion for a new restaurant.
2	D	"Flipped a coin" is the most logical resolution to indecision.
3	A	"Steadily increasing" is the most neutral/positive completion without additional context.
4	B	"With tears in her eyes" provides the most specific and context-rich completion.
5	A	"Due to bad weather" is the most common and logical reason for cancellation.
6	A	"Too long" is the most neutral and logical reason for disliking a movie.
7	A	"Despite the hot weather" shows overcoming adversity, creating meaningful contrast.
8	B	"Complete the assignment by tomorrow" is the most logical and reasonable teacher request.
9	C	"Just in time to catch her flight" is the most logical and complete narrative.
10	A	"Despite" signals contrast—studying should lead to success, so failure is surprising.
11	A	"Brilliance" matches "remarkable intelligence"—positive reinforcement.
12	A	"Advanced...easily" creates a coherent cause-effect relationship.
13	B	"Inflammatory" (provocative/offensive) caused voters to be offended.

9	The traffic was _____, so we arrived much later than expected.	light	smooth	heavy	sparse
10	The proposal was _____ rejected; _____, no one supported it.	narrowly; however	unanimously; in fact	temporarily; hence	partially; nonetheless

SELF-ASSESSMENT TEST 4

Q#	Sentence	A	B	C	D
1	His _____ remarks during the meeting offended several senior members.	diplomatic	inflammatory	conciliatory	prudent
2	The ancient manuscript was written in a _____ script that few could decipher.	legible	obscure	prominent	standard
3	She is known for her _____ wit and quick responses in debates.	dull	sharp	sluggish	tedious
4	The politician's scandal _____ his reputation beyond repair.	enhanced	sustained	tarnished	polished
5	The new drug has the _____ to cure the disease completely.	potential	drawback	risk	limitation
6	He gave a _____ account of the incident, omitting all crucial details.	candid	forthright	evasive	explicit
7	The desert is a _____ landscape with very little vegetation.	lush	fertile	barren	verdant
8	Her _____ attention to detail makes her an excellent editor.	superficial	meticulous	careless	hasty
9	The general's _____ strategy led to a decisive victory.	flawed	reckless	brilliant	outdated
10	The child's _____ behavior was a constant source of annoyance.	endearing	charming	mischievous	disciplined

SELF-ASSESSMENT TEST 5

Q#	Sentence	A	B	C	D
1	The _____ of the old building was _____ by the fire department.	eviction; ordered	demolition; supervised	renovation; delayed	inspection; required
2	She was _____ to find that her proposal had been _____ without discussion.	pleased; accepted	shocked; rejected	happy; approved	relieved; delayed

Analogy Questions

INTRODUCTION

Analogy questions test your ability to recognize and understand **relationships** between pairs of words. You are given a pair of words that have a specific logical connection, and you must select another pair from the options that shares the **same or most similar relationship**.

These questions are not about vocabulary alone—they assess your logical reasoning, pattern recognition, and ability to infer abstract connections. A strong command of word meanings is helpful, but the core skill is identifying the **type of relationship** that exists between the two terms.

Why Analogy Questions Matter

Assessment Area	What It Tests
Vocabulary	Do you understand the meanings of all words in the stem and options?
Logical Reasoning	Can you identify abstract relationships beyond surface-level associations?
Cognitive Flexibility	Can you apply the same relationship structure to a completely different set of words?
Critical Thinking	Can you distinguish between strong, weak, and plausible-but-wrong relationships?

COMMON TYPES OF ANALOGICAL RELATIONSHIPS

Mastering these relationship categories is the key to solving analogies quickly and accurately.

Relationship Type	Description	Example Stem	Correct Analogy
Synonym	Words with similar meanings	HAPPY : JOYFUL	SAD : MELANCHOLY
Antonym	Words with opposite meanings	HOT : COLD	LIGHT : DARK
Part to Whole	One word is a component of the other	FINGER : HAND	PEDAL : BICYCLE
Whole to Part	One word contains the other	BOOK : PAGE	HOUSE : ROOM
Cause and Effect	One word causes or produces the other	RAIN : FLOOD	EXERCISE : FITNESS
Effect to Cause	One word is the result of the other	FEVER : INFECTION	SCORE : PRACTICE
Function	One word describes the purpose/use of the other	KNIFE : CUT	PEN : WRITE
Tool to User	The tool and the person who uses it	BRUSH : PAINTER	SCALPEL : SURGEON
User to Tool	The user and the tool they operate	DOCTOR : STETHOSCOPE	FARMER : PLOW
Characteristic/Quality	One word describes a trait of the other	BRAVE : SOLDIER	WISE : OWL
Degree/Intensity	Different levels of the same quality	WARM : HOT	ANNOYED : FURIOUS
Class/Category	One is a member of the other's category	APPLE : FRUIT	SPARROW : BIRD
Creator to Creation	One creates the other	AUTHOR : NOVEL	COMPOSER : SYMPHONY
Action to Object	One word is an action performed on the other	PLANT : SEED	BAKE : BREAD
Object to Action	The object and the action performed with it	GUITAR : STRUM	PIANO : PLAY

- D) Freezing is a much stronger degree of Cold. ✓
- Refine: All are degrees. Need a parallel in **emotional intensity scale**. Annoyed → Furious are both emotions with increasing intensity. Happy → Ecstatic are also emotions with increasing intensity. Tired and Cold are physical states. Sad → Depressed is also emotional, but "depressed" is often considered a deeper state than just "more sad." However, "furious" is simply an intensified version of annoyed. Similarly, "ecstatic" is an intensified version of happy.
- **Answer:** B) Happy : Ecstatic

Example 8: Creator to Creation

Question: SCULPTOR : STATUE ::

- A) Poet : Poem
- B) Carpenter : Furniture
- C) Chef : Meal
- D) Architect : Blueprint

Solution:

- **Relationship:** A "Sculptor" CREATES a "Statue."
- **Prediction sentence:** "A SCULPTOR creates a STATUE."
- **Test options:**
 - A) Poet creates a Poem. ✓
 - B) Carpenter creates Furniture. ✓
 - C) Chef creates a Meal. ✓
 - D) Architect creates a Blueprint. ✓
- Refine: A sculptor works with three-dimensional materials (stone, clay) to produce an artistic object. A poet produces a literary work. A carpenter produces functional items. Chef produces food. Architect produces a plan/drawing.
- The best parallel is artistic creation: Sculptor creates a Statue (art). Poet creates a Poem (art). Carpenter creates furniture (craft, not fine art). Chef creates meal (culinary). Architect creates blueprint (design, not final product).
- **Answer:** A) Poet : Poem

Example 9: Tool to User

Question: SCALPEL : SURGEON ::

- A) Brush : Painter
- B) Chisel : Mason
- C) Oar : Rower
- D) Pen : Author

Solution:

- **Relationship:** A "Scalpel" is a specialized tool used by a "Surgeon."
- **Prediction sentence:** "A SCALPEL is a tool used by a SURGEON."
- **Test options:** All are tools used by professionals.
- Refine: Scalpel is a precision cutting instrument used in a medical/surgical context. The relationship is professional-specific, high-precision, and essential for the core work. A brush is used by painter (artistic). Chisel by mason (construction). Oar by rower (sports). Pen by author (writing).
- "Scalpel : Surgeon" is a very specific, indispensable tool for that profession. Similarly, "Brush : Painter" is also indispensable. "Chisel : Mason" is also.
- Look for the **exactness** of the pairing: Surgeon performs surgery with a scalpel. Painter paints with a brush. Both are primary tools. But a mason uses many tools; chisel is one of them. An author uses a pen, but also keyboard, etc.
- The most direct and exclusive pairing is "Brush : Painter."
- **Answer:** A) Brush : Painter

Example 10: Gender Relationship

Question: STALLION : MARE ::

- A) Drone : Bee
- B) Buck : Doe

- C) Ram : Ewe
D) Drake : Duck

Solution:

- **Relationship:** "Stallion" is a MALE horse, "Mare" is a FEMALE horse.
- **Prediction sentence:** "A STALLION is a male HORSE, and a MARE is a female HORSE."
- **Test options:**
 - A) Drone is a male bee, but the female is Queen or Worker, not "bee" specifically.
 - B) Buck is a male deer, Doe is a female deer. ✓
 - C) Ram is a male sheep, Ewe is a female sheep. ✓
 - D) Drake is a male duck, but female is just "duck" (or hen). ✓
- **Refine:** The stem uses two specific gendered terms for the same animal species. All options have specific gendered terms.
- The best match is "Buck : Doe" because they are both common, well-known gendered terms for deer, just like stallion/mare for horses. Ram/Ewe is also well-known. Drake/Duck is less commonly distinguished. Drone/Bee is asymmetrical (female is not "bee" specifically).
- **Answer:** B) Buck : Doe

SELF-ASSESSMENT TESTS — ANALOGIES

TEST 1

Q#	Stem Pair	A	B	C	D
1	BIG : LARGE	Small : Tiny	Fast : Slow	Happy : Sad	Bright : Dim
2	UP : DOWN	Over : Under	Left : Right	North : South	All of the above
3	TREE : FOREST	Star : Galaxy	Page : Book	Brick : Wall	Flower : Garden
4	DOCTOR : HOSPITAL	Teacher : School	Lawyer : Court	Pilot : Airport	Chef : Kitchen
5	KNIFE : CUT	Pen : Write	Eraser : Remove	Scissors : Trim	All of the above
6	HONEST : DISHONEST	Brave : Courageous	Truthful : Deceitful	Kind : Gentle	Smart : Intelligent
7	LION : ANIMAL	Rose : Flower	Car : Vehicle	Sparrow : Bird	All of the above
8	HUNGER : EAT	Thirst : Drink	Sleep : Tired	Study : Pass	Work : Earn
9	COMPOSER : SYMPHONY	Author : Novel	Artist : Sculpture	Chef : Meal	All of the above
10	CUB : BEAR	Puppy : Dog	Kitten : Cat	Foal : Horse	All of the above

TEST 2

Q#	Stem Pair	A	B	C	D
1	SAD : MELANCHOLY	Happy : Joyful	Angry : Furious	Tired : Sleepy	Cold : Icy
2	FATHER : MOTHER	Son : Daughter	Brother : Sister	Uncle : Aunt	All of the above
3	WHEEL : CAR	Wing : Bird	Tire : Bicycle	Blade : Fan	Pedal : Boat
4	TEACHER : STUDENT	Doctor : Patient	Lawyer : Client	Pilot : Passenger	All of the above
5	SUN : DAY	Moon : Night	Star : Sky	Cloud : Rain	Light : Bright
6	ACCIDENT : INJURY	Study : Knowledge	Eat : Nourishment	Exercise : Fitness	All of the above

Antonyms

Introduction

Antonym questions present you with a target word (or a sentence containing a highlighted word), and you must select the answer choice that is most nearly **opposite in meaning** to that word. Unlike synonym questions, which require matching similar meanings, antonyms demand a precise understanding of nuance, intensity, and context to identify the true opposite.

These questions are a staple of aptitude tests, vocabulary assessments, and competitive exams. They test not only your vocabulary breadth but also your ability to distinguish between shades of meaning, recognize secondary definitions, and interpret words in context.

What Antonym Questions Test

Assessment Area	What It Tests
Vocabulary Knowledge	Do you know the primary and secondary meanings of the given word?
Contextual Awareness	Can you interpret the word's meaning within a sentence (if provided)?
Understanding of Intensity	Can you distinguish between "mildly opposite" and "directly opposite"?
Nuance and Precision	Can you choose the exact opposite rather than a mere unrelated word?
Root Word Recognition	Can you break down prefixes/suffixes to deduce meaning?

Common Question Formats

Format	Example
Standalone Word	Choose the antonym of "BENEVOLENT."
Sentence-Based	Choose the word that is most opposite in meaning to the underlined word in the sentence: The judge was known for his impartial rulings.
Multiple Opposite Degrees	Four options, where two might be somewhat opposite but only one is the exact opposite.

MASTER STRATEGY: The 4-Step Method

Step 1: Define the Target Word Precisely

Before looking at options, define the target word in your own words. Consider:

- Primary meaning
- Secondary/alternate meanings
- Connotation (positive, negative, neutral)
- Intensity level (mild, moderate, extreme)

Example: "MALEVOLENT" → Primary meaning: having or showing a wish to do evil to others. Connotation: extremely negative. Intensity: strong.

Step 2: Predict the Opposite

Generate your own antonym before reading the options. This prevents you from being swayed by distractors.

Prediction for MALEVOLENT: Kind, benevolent, charitable.

Step 3: Scan All Options and Match

Look at all choices and select the one closest to your prediction. If two seem close, go back to Step 1 and refine.

Step 4: Plug In and Verify

If time permits, substitute your chosen answer into a sentence to ensure it creates a logical contrast. The opposite should create a clear contradiction in meaning.

COMMON TYPES OF ANTONYM RELATIONSHIPS

Type	Description	Example	Opposite
Direct Opposition	Exact opposite meaning	Hot	Cold

Degree/Intensity	Different levels on same scale	Warm (mild) vs. Freezing (extreme) — opposite of Warm might be Cool, but opposite of Scorching might be Freezing	Scorching : Freezing
Privative	Presence vs. Absence	Present	Absent
Reversive	Action vs. reversal of action	Tie	Untie
Complementary	Mutually exclusive	Alive	Dead
Relative	Opposite in relation, not absolute	High (relative to ground) vs. Low	High : Low

SOLVED EXAMPLES

Example 1: Direct Antonym (Standalone)

Question: Choose the antonym of **EPHEMERAL**.

(A) Permanent (B) Brief (C) Fleeting (D) Transient

Solution:

- **Definition:** Ephemeral means lasting for a very short time.
- **Prediction:** Long-lasting, permanent, enduring.
- **Analysis:**
 - A) Permanent — means lasting forever; exact opposite ✓
 - B) Brief — means short (synonym)
 - C) Fleeting — means short (synonym)
 - D) Transient — means short (synonym)

- **Answer:** (A) Permanent

Example 2: Contextual Antonym

Question: The politician's remarks were remarkably **lucid** and easy to follow.

(A) Confusing (B) Clear (C) Brilliant (D) Lengthy

Solution:

- **Definition in Context:** "Lucid" means clear, easy to understand.
- **Prediction:** Confusing, unclear, obscure.
- **Analysis:**
 - A) Confusing — opposite of clear ✓
 - B) Clear — synonym
 - C) Brilliant — related but not opposite
 - D) Lengthy — unrelated

- **Answer:** (A) Confusing

Example 3: Intensity-Based Antonym

Question: Choose the antonym of **SCALDING**.

(A) Warm (B) Boiling (C) Freezing (D) Tepid

Solution:

- **Definition:** Scalding means extremely hot (hot enough to burn).
- **Prediction:** Extremely cold.
- **Analysis:**
 - A) Warm — moderate heat, not opposite of extreme heat
 - B) Boiling — synonym (extreme heat)
 - C) Freezing — extreme cold; direct opposite in intensity ✓
 - D) Tepid — lukewarm (moderate), not opposite of extreme heat

- **Answer:** (C) Freezing

Example 4: Privative Antonym (Presence/Absence)

Question: Choose the antonym of **EXTANT**.

(A) Extinct (B) Existing (C) Living (D) Active



- A) Stubborn — exact match ✓
- B) Flexible — antonym
- C) Indecisive — unrelated
- D) Compliant — antonym

- **Answer:** (A) Stubborn

Example 8: Contextual Nuance in a Sentence

Question: The CEO's **acerbic** comments stunned the employees.

(A) Harsh (B) Gentle (C) Encouraging (D) Diplomatic

Solution:

- **Definition in Context:** Acerbic means sharp, forthright, and sometimes bitter in tone; biting.
- **Prediction:** Sharp, cutting, harsh.
- **Analysis:**
 - A) Harsh — captures the sharp/cutting tone ✓
 - B) Gentle — antonym
 - C) Encouraging — antonym
 - D) Diplomatic — opposite of sharp/blunt

- **Answer:** (A) Harsh

Example 9: Choosing Among Near-Synonyms

Question: Choose the synonym of **PROLIFIC**.

(A) Productive (B) Verbose (C) Fertile (D) Creative

Solution:

- **Definition:** Prolific means producing much fruit, offspring, or work; abundantly productive.
- **Prediction:** Productive, fruitful.
- **Analysis:**
 - A) Productive — exact match ✓
 - B) Verbose — means wordy (relates to too many words, not productivity)
 - C) Fertile — related to producing offspring/plants, but not as broad
 - D) Creative — related but not synonymous (one can be productive without being creative)

- **Answer:** (A) Productive

Example 10: Synonym with Positive/Negative Connotation

Question: Choose the synonym of **PERSEVERANCE**.

(A) Stubbornness (B) Persistence (C) Obstinacy (D) Doggedness

Solution:

- **Definition:** Perseverance means persistence in doing something despite difficulty or delay in achieving success; has a positive connotation.
- **Prediction:** Persistence, determination.
- **Analysis:**
 - A) Stubbornness — negative connotation (refusing to change)
 - B) Persistence — positive/neutral; exact match ✓
 - C) Obstinacy — negative connotation
 - D) Doggedness — can be positive or negative, but "persistence" is the most direct match

- **Answer:** (B) Persistence

SELF-ASSESSMENT TESTS — SYNONYMS

TEST 1

Q#	Target Word	A	B	C	D
1	HAPPY	Joyful	Sad	Angry	Tired
2	BIG	Small	Large	Tiny	Narrow
3	QUICK	Fast	Slow	Sluggish	Lethargic

8	VACILLATING	Hesitating	Decisive	Resolute	Firm
9	WINSOME	Charming	Repulsive	Ugly	Unpleasant
10	XENOPHOBIC	Tolerant	Fearful	Welcoming	Hospitable

TEST 9

Q#	Target Word (with context if needed)	A	B	C	D
1	FLOURISH (as in "The arts flourished")	Wither	Thrive	Decline	Decay
2	MITIGATE (as in "mitigate the risk")	Exacerbate	Alleviate	Worsen	Intensify
3	PERTINENT (as in "pertinent data")	Irrelevant	Relevant	Unrelated	Extraneous
4	SANGUINE (as in "sanguine about the outcome")	Pessimistic	Optimistic	Gloomy	Dismal
5	TORTUOUS (as in "a tortuous argument")	Straight	Winding	Direct	Forthright
6	VENERATE (as in "venerate the ancestors")	Despise	Revere	Disrespect	Mock
7	ABJURE (as in "abjure violence")	Embrace	Renounce	Accept	Welcome
8	CESSATION (as in "cessation of fighting")	Commencement	Halt	Beginning	Start
9	EFFRONTERY (as in "the effrontery to interrupt")	Modesty	Audacity	Shyness	Timidity
10	IMPETUOUS (as in "an impetuous decision")	Cautious	Rash	Deliberate	Prudent

TEST 10

Q#	Target Word	A	B	C	D
1	IMPECUNIOUS	Affluent	Poor	Wealthy	Prosperous
2	OSSIFIED	Hardened	Flexible	Pliable	Supple
3	RECONDITE	Obscure	Obvious	Clear	Apparent
4	SATURNINE	Gloomy	Cheerful	Jovial	Merry
5	INCHOATE	Incomplete	Fully formed	Mature	Developed
6	CELERITY	Swiftness	Slowness	Delay	Lethargy
7	PROTRACTED	Prolonged	Abbreviated	Shortened	Curtailed
8	FACETIOUS	Joking	Serious	Solemn	Grave
9	INEXORABLE	Unyielding	Relenting	Yielding	Flexible
10	PERVICACIOUS	Stubborn	Compliant	Obedient	Submissive

CONSOLIDATED ANSWER KEY FOR ALL TESTS

Test	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
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Reading Comprehension

Introduction

Reading Comprehension (RC) is the most comprehensive and challenging section of verbal reasoning aptitude tests. It presents you with a passage—ranging from 100 to 500+ words—and asks a series of multiple-choice questions based on its content, tone, structure, and underlying assumptions.

Unlike vocabulary-based questions, RC tests your ability to **understand, interpret, analyze, and evaluate** written material. It does not rely solely on memorization; it requires active engagement with the text.

What Reading Comprehension Questions Test

Assessment Area	What It Tests
Literal Understanding	Can you identify facts, details, and explicitly stated information?
Inferential Ability	Can you read between the lines and deduce unstated implications?
Main Idea Identification	Can you distinguish between the central theme and supporting details?
Structural Analysis	Can you understand how the passage is organized and how ideas connect?
Author's Tone & Attitude	Can you detect the author's opinion, bias, or emotional stance?
Vocabulary in Context	Can you deduce the meaning of unfamiliar words from surrounding text?
Critical Reasoning	Can you evaluate arguments, identify assumptions, and assess strengths/weaknesses?

TYPES OF RC PASSAGES

Passage Type	Characteristics	Common Sources
Narrative	Tells a story or recounts events; often personal or historical	Biographies, memoirs, historical accounts
Descriptive	Describes a person, place, object, or phenomenon	Scientific observations, travel writing
Expository	Explains, informs, or presents facts objectively	Encyclopedias, textbooks, research summaries
Argumentative/Persuasive	Presents a viewpoint and attempts to convince the reader	Editorials, opinion pieces, political speeches
Analytical	Breaks down a topic into components and examines relationships	Academic essays, literary criticism, reports
Business/Economic	Discusses markets, management, finance, or business strategy	Case studies, business journals, financial reports

COMMON QUESTION TYPES IN RC

Question Type	Description	Example
Main Idea/Theme	Asks for the primary purpose or central argument	What is the main point of the passage?
Detail/Explicit	Asks about information directly stated in the passage	According to the passage, what happened in 1987?
Inference	Asks for a conclusion drawn from evidence, not directly stated	Which of the following can be inferred from the passage?
Vocabulary in Context	Asks for the meaning of a word as used in the passage	The word "tenuous" most nearly means...
Author's Tone/Attitude	Asks about the author's emotional stance or bias	The author's attitude toward the proposal is best described as...

Identifying Sentence Errors

Introduction

Identifying Sentence Error questions, also known as Error Recognition or Grammar Identification questions, present you with a sentence that may contain a grammatical, syntactical, or usage error. You must identify the part of the sentence that contains the error or select "No Error" if the sentence is completely correct.

Unlike other verbal reasoning questions, these do not test vocabulary or reading comprehension. Instead, they assess your understanding of **English grammar rules, sentence structure, word usage, and standard written English conventions**. These questions are common in aptitude tests, competitive exams, and English proficiency assessments.

What Identifying Sentence Error Questions Test

Assessment Area	What It Tests
Subject-Verb Agreement	Can you match singular/plural subjects with correct verb forms?
Tense Consistency	Can you maintain proper verb tense throughout a sentence?
Pronoun Agreement & Case	Can you match pronouns to their antecedents in number, gender, and case?
Parallel Structure	Can you identify when elements in a list should be grammatically parallel?
Modifiers	Can you place adjectives, adverbs, and phrases correctly?
Prepositions & Idioms	Do you know correct preposition usage and idiomatic expressions?
Word Choice/Usage	Can you distinguish between commonly confused words (affect/effect, lie/lay)?
Sentence Structure	Can you identify fragments, run-ons, and faulty coordination?
Comparisons	Can you make logical and grammatically correct comparisons?
Articles & Determiners	Can you use a/an/the correctly?

Common Question Formats

Format	Example
Underlined Parts	A sentence is divided into parts (usually A, B, C, D). One part contains an error. Select the part with the error.
Underlined & Numbered	Similar to above, each underlined portion is numbered or lettered.
No Error Option	Option E or D is "No Error." You must select this if the sentence is grammatically correct.
Sentence with Highlighted Word	A word/phrase is highlighted; choose the option that best corrects the error.

MASTER STRATEGY: The 6-Step Error Detection Method

Step 1: Read the Entire Sentence — Slowly and Carefully

Read the sentence without focusing on any particular part. Get a general sense of its meaning and structure. Sometimes errors are subtle and only apparent when you understand the intended meaning.

Step 2: Check for Obvious Errors First

Look for common, easy-to-spot errors:

- Subject-verb agreement (singular/plural mismatch)
- Verb tense (incorrect or inconsistent tense)
- Pronoun agreement (pronoun doesn't match its antecedent)

Step 3: Examine Each Underlined Part Systematically

Treat each underlined section as a separate check:

- **A:** Check if it's grammatically correct in isolation AND in context.

Idioms And Phrases

A

1. Above and beyond

Meaning: More than what is required or expected.
Example: The nurse went above and beyond to comfort the frightened child.

2. Above board

Meaning: Open, honest, and legal. **Example:** All financial transactions must be completely above board.

3. An ace up one's sleeve

Meaning: A hidden advantage kept for the right moment. **Example:** The lawyer still had an ace up her sleeve: a decisive witness.

4. Across the board

Meaning: Applying to every person, group, or category. **Example:** The organization announced salary increases across the board.

5. Add fuel to the fire

Meaning: To make a bad or tense situation worse.
Example: His sarcastic remark only added fuel to the fire.

6. Add insult to injury

Meaning: To make a bad situation even worse.
Example: The delayed refund added insult to injury.

7. Against all odds

Meaning: Despite very difficult circumstances or a low chance of success. **Example:** Against all odds, the injured runner completed the race.

8. Ahead of the curve

Meaning: More advanced or innovative than others.
Example: The company stayed ahead of the curve by investing early in renewable energy.

9. Alive and kicking

Meaning: Still active, healthy, or successful.
Example: Despite rumors of closure, the community theater is alive and kicking.

10. All bark and no bite

Meaning: Threatening in words but unlikely to take action. **Example:** The supervisor sounds severe, but he is all bark and no bite.

11. All ears

Meaning: Listening with full attention. **Example:** Tell me what happened; I am all ears.

12. All in a day's work

Meaning: A task considered normal or routine as part of one's job. **Example:** Handling emergencies is all in a day's work for a firefighter.

13. All over the map

Meaning: Disorganized, inconsistent, or covering many unrelated areas. **Example:** His presentation was all over the map and lacked a clear argument.

14. All roads lead to Rome

Meaning: Different methods can lead to the same result. **Example:** You may study alone or in a group; all roads lead to Rome.

15. All that glitters is not gold

Meaning: Appearances can be deceptive, and attractive things are not always valuable. **Example:** The offer looked impressive, but all that glitters is not gold.

16. All the rage

Meaning: Extremely fashionable or popular at a particular time. **Example:** Reusable smart bottles are all the rage among university students.

17. All thumbs

Meaning: Very clumsy, especially with one's hands.
Example: I am all thumbs when it comes to repairing delicate watches.

18. Apple of one's eye

Meaning: A person who is deeply loved and cherished. **Example:** His youngest daughter is the apple of his eye.

19. An arm and a leg

Meaning: A very large amount of money. **Example:** That imported laptop costs an arm and a leg.

20. Around the clock

Meaning: Continuously, day and night. **Example:** Emergency teams worked around the clock.

21. As blind as a bat

Meaning: Unable to see well. **Example:** Without my glasses, I am as blind as a bat.

22. As busy as a bee

Meaning: Very active and occupied with work.
Example: The staff were as busy as bees before the annual conference.

23. As clear as mud

Meaning: Very confusing or difficult to understand.
Example: The new instructions were as clear as mud.

24. As cool as a cucumber

Meaning: Calm and composed, especially under pressure. **Example:** Even during the heated debate, she remained as cool as a cucumber.

25. As fit as a fiddle

Meaning: In excellent health and physical condition.
Example: After months of training, he felt as fit as a fiddle.

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153. By word of mouth

Meaning: Through spoken recommendations rather than advertising. **Example:** The restaurant became popular by word of mouth.

C

154. Call a spade a spade

Meaning: To speak plainly and directly, even about unpleasant matters. **Example:** She calls a spade a spade and never hides poor performance.

155. Call it a day

Meaning: To stop working on something for the present. **Example:** We have completed the main tasks, so let us call it a day.

156. Call the shots

Meaning: To control a situation and make the important decisions. **Example:** As project director, Ayesha calls the shots.

157. The calm before the storm

Meaning: A quiet period before intense activity or trouble. **Example:** The empty office felt like the calm before the storm of registration week.

158. Calm one's nerves

Meaning: To make oneself less anxious. **Example:** She drank water and breathed slowly to calm her nerves.

159. Cannot hold a candle to

Meaning: To be far less good than someone or something else. **Example:** The imitation cannot hold a candle to the original painting.

160. Carry coals to Newcastle

Meaning: To take something to a place where it is already abundant. **Example:** Exporting tea to that famous tea-growing region is like carrying coals to Newcastle.

161. Carry the can

Meaning: To accept blame or responsibility for a mistake. **Example:** The junior officer was unfairly made to carry the can for the failed operation.

162. Carry the day

Meaning: To win support or succeed after a contest or debate. **Example:** Her practical proposal carried the day.

163. Carry weight

Meaning: To have influence, importance, or authority. **Example:** Her recommendation carries considerable weight with the selection committee.

164. A cash cow

Meaning: A business or product that produces steady profit. **Example:** The company's mobile service has become its main cash cow.

165. Cast doubt on

Meaning: To make something seem uncertain or unreliable. **Example:** The missing records cast doubt on the accuracy of the report.

166. Castles in the air

Meaning: Unrealistic hopes or plans. **Example:** Without a business plan, his dreams of rapid expansion are castles in the air.

167. Cat got your tongue?

Meaning: A teasing question asked when someone is unusually silent. **Example:** You were eager to argue earlier; has the cat got your tongue now?

168. A catch-22

Meaning: A situation in which each possible choice creates another problem. **Example:** He needed experience to get a job but needed a job to gain experience, a classic catch-22.

169. Catch on

Meaning: To understand or become popular. **Example:** The students quickly caught on to the new method.

170. Catch one's breath

Meaning: To pause and recover normal breathing or composure. **Example:** After climbing the stairs, he stopped to catch his breath.

171. Catch red-handed

Meaning: To discover someone while they are doing something wrong. **Example:** The guard caught the thief red-handed.

172. Catch someone off guard

Meaning: To surprise someone when they are unprepared. **Example:** The unexpected question caught the candidate off guard.

173. Catch someone's eye

Meaning: To attract someone's attention. **Example:** The bright cover caught my eye in the bookstore.

174. Caught in the crossfire

Meaning: Harmed by a conflict between other people or groups. **Example:** Small businesses were caught in the crossfire of the political dispute.

175. Change gears

Meaning: To shift to a different activity, approach, or speed. **Example:** After discussing theory, the lecturer changed gears and gave examples.

176. Change hands

Meaning: To pass from one owner to another. **Example:** The historic building changed hands twice in one year.

177. A change of heart

Meaning: A complete change in one's attitude, decision, or opinion. **Example:** He had a change of heart and decided to support the proposal.

Foreign Words and Phrases

A

Word/Phrase	Origin	Meaning	Example Sentence
A cappella	Italian	Without instrumental accompaniment	The choir performed a breathtaking a cappella rendition of the Renaissance motet.
A posteriori	Latin	Based on experience or observation	The scientist's conclusions were drawn from a posteriori evidence rather than theoretical assumptions.
A priori	Latin	Based on theory or deduction	The philosopher's a priori argument was compelling but lacked empirical support.
A propos	French	With regard to; concerning	A propos of our earlier discussion, I have prepared a detailed memorandum addressing all your concerns.
Ab initio	Latin	From the beginning	The contract was declared void ab initio due to fraudulent misrepresentation.
Ad hoc	Latin	Created for a specific purpose	The committee formed an ad hoc subcommittee to address the urgent issue.
Ad infinitum	Latin	Without end; endlessly	The debate continued ad infinitum, with neither side willing to concede.
Ad interim	Latin	Temporarily; in the meantime	An ad interim manager was appointed until a permanent replacement was found.
Ad libitum	Latin	At one's pleasure; freely	The musician was allowed to perform ad libitum during the improvisational section.
Ad nauseam	Latin	To the point of nausea; excessively	The politician repeated the same hollow talking points ad nauseam.
Ad valorem	Latin	According to value	The ad valorem tax was calculated as a percentage of the property's assessed worth.
Affaire de coeur	French	A love affair	The novel revolves around a passionate affaire de coeur between two unlikely lovers.
Agent provocateur	French	A person who provokes others to commit illegal acts	The undercover officer acted as an agent provocateur to expose the criminal network.
Aide-mémoire	French	A memory aid; a reminder	The diplomat prepared an aide-mémoire before the crucial negotiation.
Al dente	Italian	Firm to the bite	The pasta was cooked al dente, perfectly textured to complement the sauce.
Al fresco	Italian	In the open air; outdoors	The restaurant offered al fresco dining on its beautiful terrace.
Alma mater	Latin	One's former university	The successful alumnus returned to his alma mater to deliver the commencement address.
Alter ego	Latin	Another self; a second identity	The superhero's mild-mannered alter ego was a journalist named Clark Kent.
Amour propre	French	Self-esteem; self-respect	His amour propre was deeply wounded by the harsh criticism of his life's work.
Ancien régime	French	The old regime before major change	The revolution swept away the remnants of the ancien régime.
Angst	German	Deep anxiety or dread	The existential angst of the protagonist was palpable throughout the novel.
Annus horribilis	Latin	A dreadful year	The monarch described the year of personal tragedies as an annus horribilis.
Annus mirabilis	Latin	A wonderful year	1969 was an annus mirabilis for space exploration.

Ante meridiem	Latin	Before noon (a.m.)	The meeting was scheduled for 9:00 ante meridiem.
Aperçu	French	A brief, insightful summary	He offered a brilliant aperçu of the complex political situation.
Apéritif	French	A pre-meal alcoholic drink	They enjoyed a light apéritif on the terrace before dinner.
Apparatchik	Russian	A member of a political bureaucracy	The old apparatchik was resistant to any reform of the system.
Au courant	French	Up-to-date; fully informed	She is au courant with the latest developments in the technology sector.
Au fait	French	Well-informed; proficient	He is au fait with all the nuances of international trade law.
Au gratin	French	With a browned crust of cheese or breadcrumbs	The au gratin potatoes were the highlight of the meal.
Au naturel	French	In a natural state; unadorned	The salad was served au naturel, without any dressing.
Au pair	French	A young person helping with childcare	The family hosted an au pair from France to help with their children.
Au revoir	French	Goodbye; until we meet again	She waved and said au revoir to her departing guests.
Auteur	French	A filmmaker whose personal vision dominates	The director is considered a true auteur of French cinema.
Autodidact	Greek	A self-taught person	The brilliant autodidact never attended university but became a renowned scholar.

Word/Phrase	Origin	Meaning	Example Sentence
Bête noire	French	A person or thing particularly disliked	Public speaking was his bête noire; he avoided it at all costs.
Billet-doux	French	A love letter	The young poet sent a passionate billet-doux to his beloved.
Bona fide	Latin	Genuine; in good faith	The art dealer confirmed that the painting was a bona fide masterpiece.
Bon appétit	French	Enjoy your meal	The waiter wished them bon appétit as he served the main course.
Bon mot	French	A witty remark	The playwright was famous for his bon mots.
Bon vivant	French	A person who enjoys the good life	The bon vivant was known for his lavish parties and exquisite taste.
Bon voyage	French	Have a safe trip	The entire family gathered to wish them bon voyage.
Bourgeois	French	Middle-class; conventional	His bourgeois values clashed with his bohemian aspirations.
Bric-à-brac	French	Small decorative objects	The antique shop was filled with bric-à-brac from various centuries.
Brouhaha	French	An uproar; commotion	The controversial decision caused a brouhaha in the media.

Word/Phrase	Origin	Meaning	Example Sentence
C'est la vie	French	That is life; such is life	When his plans fell through, he shrugged and said, "C'est la vie."

Opus	Latin	A musical composition	Beethoven's Opus 111 is his final piano sonata.
Orbis terrarum	Latin	The whole world	The Roman Empire dominated the orbis terrarum.
Ordre du jour	French	The order of business; the agenda	The ordre du jour was debated by the committee.
Ostracize	Greek	To exclude from society	He was ostracized for his unpopular views.
Oyez	Anglo-Norman	Hear ye!	The crier shouted "Oyez!" to begin the court session.

Word/Phrase	Origin	Meaning	Example Sentence
Pace	Latin	With due respect to	His argument, pace the distinguished professor, remains unconvincing.
Pandemonium	Greek	Chaos; a wild uproar	Pandemonium erupted in the streets.
Par excellence	French	Pre-eminent; the best example	The restaurant serves French cuisine par excellence.
Par exemple	French	For example	He listed several cities, par exemple, Paris and Rome.
Paradigm	Greek	A model or example	The research established a new paradigm.
Paragon	Greek	A model of perfection	She was considered a paragon of virtue.
Pari passu	Latin	At an equal pace	The two nations developed pari passu.
Pariah	Tamil	An outcast	He was treated as a pariah after the scandal.
Pas de deux	French	A dance for two	The pas de deux was the highlight of the ballet.
Passé	French	Out of date	Her style is now considered passé.
Pathos	Greek	A quality that evokes pity	His speech was full of pathos.
Pax Romana	Latin	The Roman peace	The Pax Romana lasted for two centuries.
Pax vobiscum	Latin	Peace be with you	The priest intoned, "Pax vobiscum."
Penchant	French	A strong preference	He had a penchant for collecting rare books.
Per capita	Latin	For each person	The average per capita income was rising.
Per diem	Latin	Per day; daily allowance	The consultant was paid a generous per diem.
Per se	Latin	In itself; by itself	The policy was not illegal per se.
Persona non grata	Latin	An unacceptable person	She was declared persona non grata.
Petit bourgeois	French	A member of the lower middle class	The family lived a petit bourgeois existence.
Pied-à-terre	French	A small, secondary residence	He kept a pied-à-terre in the city.
Pietà	Italian	A depiction of the Virgin Mary holding Christ	Michelangelo's Pietà is a masterpiece.
Pince-nez	French	Eyeglasses clipped to the nose	The old professor wore pince-nez.

Similes

INTRODUCTION

A **simile** is a figure of speech that makes a direct comparison between two different things using the words "like" or "as." Similes are used to make descriptions more vivid, imaginative, and expressive by linking something unfamiliar to something familiar.

Similes frequently appear in verbal reasoning tests in several ways:

- **Sentence completion** where a simile phrase fits the blank
- **Reading comprehension** where understanding figurative language is essential
- **Analogies** where you must identify the relationship pattern
- **Error detection** where misuse of similes is tested

SIMILE vs. METAPHOR: THE DIFFERENCE

Feature	Simile	Metaphor
Comparison word	Uses "like" or "as"	Does not use "like" or "as"
Example	"She is as brave as a lion."	"She is a lion."
Explicitness	Explicit comparison	Implicit comparison
Usage	More common in everyday speech	More poetic and direct

COMMONLY USED SIMILES — ALPHABETICAL LIST

A

As alike as two peas in a pod

Meaning: Exactly the same in appearance or character.

Example: The twin sisters are as alike as two peas in a pod.

As bald as a coot

Meaning: Completely bald.

Example: At forty, he was already as bald as a coot.

As beautiful as a rose

Meaning: Extremely beautiful.

Example: She looked as beautiful as a rose on her wedding day.

As big as a house

Meaning: Very large.

Example: His new car is as big as a house.

As black as coal

Meaning: Completely black; very dark.

Example: His shoes were as black as coal.

As blind as a bat

Meaning: Having very poor eyesight.

Example: Without his glasses, he is as blind as a bat.

As bold as brass

Meaning: Very bold and confident, often impudently so.

Example: He walked into the meeting as bold as brass and demanded a raise.

As brave as a lion

Meaning: Very courageous.

Example: The soldier was as brave as a lion in battle.

As bright as a button

Meaning: Very intelligent and quick-witted.

Example: The young student is as bright as a button.

As busy as a bee

Meaning: Very busy and industrious.

Example: She has been as busy as a bee preparing for the exhibition.

C

As calm as a millpond

Meaning: Very calm and still, usually referring to water.

Example: The sea was as calm as a millpond.

As cheap as chips

Meaning: Very inexpensive.

Example: The street food was as cheap as chips.

As clean as a whistle

Meaning: Very clean; completely free from guilt or suspicion.

Example: He has a spotless record; he is as clean as a whistle.

As clear as a bell

Meaning: Very clear and distinct.

Example: Her voice was as clear as a bell.

As clear as crystal

Meaning: Completely clear and easy to understand.

Example: The instructions were as clear as crystal.

As clear as mud

Meaning: Not clear at all; confusing.

Example: His explanation was as clear as mud.



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Sock like a boxer

Meaning: To hit hard.

Example: He socked the ball like a boxer.

Soft like butter

Meaning: Very soft.

Example: The dough is soft like butter.

Sorrow like a widow

Meaning: Great sorrow.

Example: He wept sorrow like a widow.

Sound like a drum

Meaning: To be resonant.

Example: His voice sounds like a drum.

Sparkle like a diamond

Meaning: To glitter.

Example: The stars sparkle like diamonds.

Speak like a book

Meaning: To speak formally.

Example: He speaks like a book.

Spell like a wizard

Meaning: To enchant.

Example: Her beauty spells like a wizard.

Spread like wildfire

Meaning: To spread quickly.

Example: The news spread like wildfire.

Spring like a rabbit

Meaning: To jump quickly.

Example: He sprang like a rabbit.

Stagger like a drunk

Meaning: To walk unsteadily.

Example: He staggered like a drunk.

Stand like a rock

Meaning: To be firm.

Example: He stood like a rock.

Stare like an owl

Meaning: To stare fixedly.

Example: He stared like an owl.

Stay like a guest

Meaning: To remain temporarily.

Example: He stayed like a guest.

Steal like a thief

Meaning: To steal secretly.

Example: He stole like a thief.

Stick like a burr

Meaning: To cling firmly.

Example: The reputation stuck like a burr.

Sting like a bee

Meaning: To hurt sharply.

Example: His words stung like a bee.

Stop like a wall

Meaning: To stop suddenly.

Example: The car stopped like a wall.

Storm like a tempest

Meaning: To rage violently.

Example: He stormed like a tempest.

Straight like an arrow

Meaning: Very straight.

Example: The road is straight like an arrow.

Stream like a river

Meaning: To flow continuously.

Example: The tears streamed like a river.

Strike like lightning

Meaning: To hit suddenly.

Example: He struck like lightning.

Strong like an ox

Meaning: Very strong.

Example: He is strong like an ox.

Stubborn like a mule

Meaning: Very stubborn.

Example: She is stubborn like a mule.

Study like a scholar

Meaning: To study seriously.

Example: He studies like a scholar.

Succeed like a king

Meaning: To be successful.

Example: He succeeded like a king.

Suck like a leech

Meaning: To drain.

Example: The project sucked resources like a leech.

Suffer like a dog

Meaning: To suffer greatly.

Example: He suffered like a dog.

Sweat like a pig

Meaning: To sweat heavily.

Example: He sweated like a pig.

Swim like a fish

Meaning: To swim well.

Example: He swims like a fish.

Swing like a pendulum

Meaning: To move back and forth.

Example: The opinions swing like a pendulum.

Swoop like a hawk

Meaning: To descend quickly.

Example: The eagle swooped like a hawk.

T

Talk like a parrot

Meaning: To repeat mindlessly.

Example: He talks like a parrot.

Talk like a politician

Meaning: To speak evasively.

Example: He talks like a politician.

Tall like a giant

Meaning: Very tall.

Example: He is tall like a giant.

Taste like heaven

Meaning: Extremely delicious.

Example: The dish tastes like heaven.

Zeal like a reformer

Meaning: Great enthusiasm.

Example: He worked with zeal like a reformer.

Zest like a child

Meaning: Great enthusiasm.

Example: He approached life with zest like a child.

SELF-ASSESSMENT TESTS — SIMILES

TEST 1: Match the Simile

Instructions: Match the simile in Column A with its correct meaning in Column B.

Q#	Column A	Column B
1	As brave as a lion	A. Very poor
2	As busy as a bee	B. Very cunning
3	As cool as a cucumber	C. Very calm under pressure
4	As poor as a church mouse	D. Very brave
5	As sly as a fox	E. Very busy
6	As stubborn as a mule	F. Very quiet
7	As quiet as a mouse	G. Very proud
8	As proud as a peacock	H. Very strong
9	As strong as an ox	I. Very stupid
10	As dumb as an ox	J. Very obstinate

TEST 2: Complete the Simile

Instructions: Fill in the blank with the correct word to complete the simile.

Q#	Sentence	A	B	C	D
1	He is as blind as a .	bat	bird	bee	fox
2	She sings like an .	angel	owl	lion	ox
3	He ran like .	lightning	snail	water	thunder
4	The news spread like .	fire	wildfire	water	clock
5	They are as different as chalk and .	cheese	bread	milk	butter
6	He is as cunning as a .	fox	lion	ox	sheep
7	She is as gentle as a .	lamb	wolf	lion	tiger
8	The water is as clear as .	crystal	mud	coal	blood
9	He is as stubborn as a .	mule	horse	ox	dog
10	She is as wise as an .	owl	eagle	hawk	crow

TEST 3: Identify the Simile

Instructions: Identify the simile in the sentence and write its meaning.

Q#	Sentence	Simile	Meaning
1	He was as brave as a lion during the crisis.		
2	She felt like a fish out of water at the party.		
3	They are getting along like a house on fire.		
4	The children were as quiet as mice.		
5	He is as strong as an ox.		
6	She is as proud as a peacock.		
7	He is as sly as a fox.		
8	The exam was as easy as pie.		
9	She is as busy as a bee.		
10	He is as stubborn as a mule.		

TEST 4: Multiple Choice — Similes in Context

Instructions: Choose the correct simile to complete each sentence.

Q#	Sentence	A	B	C	D
1	Despite the chaos, the manager remained .	as busy as a bee	as cool as a cucumber	as proud as a peacock	as brave as a lion

Prefixes And Suffixes

Introduction

Prefixes and suffixes are word parts that are added to root words to modify or extend their meanings. A **prefix** is added to the beginning of a root word, while a **suffix** is added to the end. Together, they form the building blocks of thousands of English words. Mastering prefixes and suffixes is one of the most powerful strategies for building vocabulary and decoding unfamiliar words in aptitude tests. By understanding the meaning of common affixes, you can often determine the meaning of an unknown word without needing a dictionary.

PREFIXES — COMPLETE REFERENCE WITH MULTIPLE WORDS

A. NEGATIVE PREFIXES

Prefix	Meaning	Multiple Examples
A-	Not, without	Atypical - Not typical; Amoral - Without morals; Apathy - Lack of feeling; Asymmetrical - Not symmetrical; Atheist - One who does not believe in God; Asexual - Without sex; Atonal - Without tone; Agnostic - One who does not know; Anarchy - Without government; Aphasia - Loss of speech
Ab-	Away from, not	Abnormal - Not normal; Absent - Away from; Abduct - Lead away; Abstract - Drawn away; Abscond - Run away; Abolish - Do away with; Abortive - Failing away; Abominable - Away from good; Abrogate - Repeal away; Abrupt - Broken away
Anti-	Against	Antisocial - Against society; Antibiotic - Against life (bacteria); Antidote - Against poison; Antifreeze - Against freezing; Antipathy - Against feeling; Antithesis - Against placing; Antagonist - Against contender; Antiperspirant - Against sweating; Antiseptic - Against infection; Antigravity - Against gravity
De-	Reverse, remove	Deactivate - Remove activation; Decompose - Break down; Deconstruct - Take apart; Defrost - Remove frost; Degrade - Reduce in rank; Demolish - Destroy; Depopulate - Reduce population; Desiccate - Remove moisture; Devastate - Lay waste; Devalue - Reduce value
Dis-	Not, opposite of	Disagree - Not agree; Disapprove - Not approve; Disbelieve - Not believe; Discomfort - Lack of comfort; Disconnect - Opposite of connect; Discontent - Not content; Disillusion - Opposite of illusion; Disinfect - Remove infection; Dismantle - Take apart; Disobey - Not obey
Il-	Not (before l)	Illegal - Not legal; Illegible - Not legible; Illiterate - Not literate; Illogical - Not logical; Ilimitable - Without limits; Illicit - Not permitted; Illiberal - Not liberal; Illuminable - Capable of being lit; Illusory - Not real
Im-	Not (before b, m, p)	Impossible - Not possible; Immature - Not mature; Immortal - Not mortal; Impatient - Not patient; Imperfect - Not perfect; Impenetrable - Cannot be penetrated; Impolite - Not polite; Impractical - Not practical; Improbable - Not probable; Impure - Not pure
In-	Not	Invisible - Not visible; Incomplete - Not complete; Inadequate - Not adequate; Inappropriate - Not appropriate; Inaudible - Cannot be heard; Incapable - Not capable; Incredible - Not believable; Indefinite - Not definite; Indispensable - Cannot be dispensed with; Inevitable - Cannot be avoided
Ir-	Not (before r)	Irresponsible - Not responsible; Irregular - Not regular; Irreversible - Cannot be reversed; Irrational - Not rational; Irrelevant - Not relevant; Irresistible - Cannot be resisted; Irreparable - Cannot be repaired; Irrevocable - Cannot be revoked; Irreverent - Not reverent; Irritate - Make worse
Mal-	Bad, wrong	Malnutrition - Bad nutrition; Malfunction - Bad function; Malice - Bad intent; Malignant - Bad quality; Malpractice - Bad practice; Malaise - Bad feeling; Malcontent - Bad-tempered; Maladjusted - Poorly adjusted; Malediction - Bad speech; Malfeasance - Wrongdoing
Mis-	Wrong, badly	Misunderstand - Understand wrongly; Misconduct - Wrong conduct; Misinterpret - Interpret wrongly; Mismanage - Manage badly; Misplace - Place wrongly; Mispronounce - Pronounce wrongly; Misquote - Quote wrongly; Misread - Read wrongly; Misrepresent - Represent wrongly; Mistrust - Lack of trust
Non-	Not	Nonstop - Not stopping; Nonviolence - Not using violence; Nonchalant - Not concerned; Nonsense - Not making sense; Nonconformist - Not

		scientist; Physicist - Nature scientist; Physics - Natural science; Physiognomy - Face reading; Physiotherapy - Physical therapy; Physique - Body build
Psycho-	Mind	Psychology - Study of mind; Psychic - Mind-related; Psychosis - Mind condition; Psychotherapy - Mind treatment; Psychoanalysis - Mind analysis; Psychopath - Mind disease; Psychiatry - Mind healing; Psychological - Mind-related; Psychosomatic - Mind-body; Psychotic - Mind-diseased
Socio-	Society	Sociology - Study of society; Social - Society-related; Sociopath - Society-diseased; Socioeconomics - Society-economics; Sociolinguistics - Society-language; Sociology - Society study; Sociability - Socialness; Socialist - Society supporter; Societal - Society-related; Sociobiology - Society-biology
Techno-	Skill, art	Technology - Study of skill; Technocrat - Skill ruler; Technique - Skill; Technical - Skill-related; Technophile - Skill lover; Technologist - Skill specialist; Technocrat - Technical expert; Technophobia - Fear of technology; Technicolor - Color technique; Technobabble - Technical jargon
Theo-	God	Theology - Study of God; Theocracy - Rule by God; Theologian - God scholar; Theism - Belief in God; Atheism - Without God; Theosophy - Divine wisdom; Theanthropic - God-human; Theocentric - God-centered; Theodicy - God-justice; Theonomy - God-law
Therm-	Heat	Thermometer - Heat measure; Thermal - Heat-related; Thermostat - Heat stat; Thermoplastic - Heat-softened; Thermonuclear - Heat nuclear; Thermocline - Heat layer; Thermodynamics - Heat movement; Thermography - Heat writing; Thermometry - Heat measurement; Thermosphere - Heat sphere
Zoo-	Animal	Zoology - Study of animals; Zoo - Animal place; Zoological - Animal-related; Zoologist - Animal scientist; Zooplankton - Animal plankton; Zoosporangium - Animal spore; Zootomy - Animal anatomy; Zoonosis - Animal disease; Zoogeography - Animal geography; Zootoxin - Animal poison

SUFFIXES — COMPLETE REFERENCE WITH MULTIPLE WORDS

A. NOUN SUFFIXES

Suffix	Meaning	Multiple Examples
-acy	State, quality	Accuracy - State of being accurate; Privacy - State of being private; Intimacy - State of intimate; Adequacy - State of being adequate; Supremacy - State of supreme; Legitimacy - State of lawful; Delicacy - State of delicate; Conspiracy - Plotting together; Infancy - State of infant; Vagrancy - State of wandering
-age	Result of, collection	Drainage - Result of draining; Marriage - Act of marrying; Storage - Act of storing; Package - Collection of pack; Mileage - Total miles; Percentage - Result of per cent; Damage - Result of harm; Courage - Quality of brave; Garbage - Waste collection; Heritage - Inheritance
-al	Act of, state	Refusal - Act of refusing; Denial - Act of denying; Approval - Act of approving; Survival - Act of surviving; Withdrawal - Act of withdrawing; Arrival - Act of arriving; Betrayal - Act of betraying; Proposal - Act of proposing; Renewal - Act of renewing; Reversal - Act of reversing
-ance	State, quality	Importance - State of important; Resistance - Quality of resisting; Appearance - Act of appearing; Acceptance - Act of accepting; Assistance - Act of assisting; Performance - Act of performing; Relevance - State of relevant; Significance - State of significant; Tolerance - Quality of tolerant; Variance - State of varying
-ancy	State, quality	Hesitancy - State of hesitating; Constancy - State of constant; Vacancy - State of empty; Pregnancy - State of pregnant; Arrogance - Quality of arrogant; Brilliance - Quality of brilliant; Compliance - State of complying; Elegance - Quality of elegant; Frequency - State of frequent; Piquancy - Quality of stimulating

		mystery; Nervous - Full of nerve; Numerous - Full of number; Religious - Full of religion; Serious - Full of seriousness
-proof	Resistant to	Waterproof - Resistant to water; Fireproof - Resistant to fire; Soundproof - Resistant to sound; Bulletproof - Resistant to bullets; Weatherproof - Resistant to weather; Rustproof - Resistant to rust; Shockproof - Resistant to shock; Shatterproof - Resistant to shattering; Windproof - Resistant to wind; Childproof - Resistant to children
-some	Characterized by	Troublesome - Causing trouble; Awesome - Causing awe; Fearsome - Causing fear; Winsome - Pleasing; Gruesome - Causing horror; Handsome - Good-looking; Loathsome - Causing loathing; Quarrelsome - Inclined to quarrel; Toilsome - Involving toil; Wearisome - Causing weariness
-worthy	Deserving	Trustworthy - Deserving trust; Creditworthy - Deserving credit; Newsworthy - Deserving news; Praiseworthy - Deserving praise; Notable - Deserving note; Dependable - Deserving dependence; Respectable - Deserving respect; Admirable - Deserving admiration; Honorable - Deserving honor; Blameworthy - Deserving blame

D. ADVERB SUFFIXES

Suffix	Meaning	Multiple Examples
-ly	In the manner of	Quickly - In a quick manner; Slowly - In a slow manner; Happily - In a happy manner; Carefully - In a careful manner; Beautifully - In a beautiful manner; Easily - In an easy manner; Gently - In a gentle manner; Honestly - In an honest manner; Quietly - In a quiet manner; Suddenly - In a sudden manner
-ward	In the direction of	Homeward - In direction of home; Forward - In direction of front; Backward - In direction of back; Downward - In direction of down; Upward - In direction of up; Inward - In direction of inside; Outward - In direction of outside; Toward - In direction of; Heavenward - In direction of heaven; Seaward - In direction of sea
-wise	In the manner of	Clockwise - In manner of clock; Lengthwise - In manner of length; Likewise - Similar manner; Otherwise - Different manner; Anticlockwise - Opposite of clock; Crosswise - In cross manner; Endwise - In end manner; Sidewise - In side manner; Slantwise - In slant manner; Stepwise - In step manner
-ways	In the direction of	Sideways - Toward side; Lengthways - Toward length; Endways - Toward end; Broadways - Toward broad; Crankways - Toward crank; Directways - Direct; Flatways - Flat; Inways - Inward; Outways - Outward; Straightways - Straight

PUBLICATIONS

LET'S MAKE IT HAPPEN

SELF-ASSESSMENT TESTS — PREFIXES AND SUFFIXES

TEST 1: Identifying Prefix Meanings

Instructions: Choose the correct meaning of the prefix in each word.

Q#	Word	A	B	C	D
1	Antiseptic	Against	Before	After	Together
2	Biweekly	One	Two	Three	Many
3	Incredible	Not	Together	Before	Through
4	Subordinate	Above	Below	Beyond	Across
5	Postnatal	Before	After	Around	Against
6	Multifaceted	One	Two	Many	Half
7	Precaution	Before	After	Around	Against
8	Exhale	In	Out	Through	Across
9	Interpersonal	Between	Within	Among	Together
10	Illogical	Not	Very	Too	Always

TEST 2: Identifying Suffix Meanings

Instructions: Choose the correct meaning of the suffix in each word.

Test 1	A	B	A	B	B	C	A	B	A	A
Test 2	A	B	C	C	A	A	A	A	A	A
Test 3	A	A	A	A	A	A	A	A	A	A
Test 4	A	A	A	A	A	A	A	A	A	A
Test 5	See detailed explanations below									
Test 6	A	A	B	A	A	A	A	A	A	A
Test 7	A	A	A	A	A	A	A	A	A	A
Test 8	See detailed explanations below									
Test 9	A	C	A	A	A	C	A	A	A	A
Test 10	A	C	D	A	D	C	A	A	A	C

Test 5 — Detailed Explanations

Q#	Word	Prefix	Root	Suffix	Meaning
1	Unpredictable	Un-	Predict	-able	Not capable of being predicted
2	Misunderstanding	Mis-	Understand	-ing	The act of understanding wrongly
3	International	Inter-	Nation	-al	Relating to between nations
4	Rehabilitation	Re-	Habilit	-ation	Act of restoring/rebuilding
5	Irresponsible	Ir-	Responsible	-ible	Not responsible
6	Nonconformist	Non-	Conform	-ist	One who does not conform
7	Antidote	Anti-	Dote	(none)	Against poison
8	Superimpose	Super-	Impose	(none)	To place above/upon
9	Circumnavigation	Circum-	Navigat(e)	-ion	The act of sailing around
10	Biotechnology	Bio-	Techno	-logy	Study of technology in life

TEST 8 — Detailed Explanations

Q#	Formed Word	Prefix & Meaning	Root & Meaning	Suffix & Meaning	Overall Meaning / Explanation
1	Unhappiness	Un- = Not	Happy = Feeling pleasure or joy	-ness = State or quality of	The state of not being happy . *Un-* negates "happy," and -ness turns the adjective into a noun meaning "the quality/state of being unhappy."
2	Disagreement	Dis- = Opposite of, not	Agree = To have the same opinion	-ment = Action or result of	The result or act of not agreeing . Dis- reverses "agree," and -ment turns the verb into a noun meaning "the action or result of disagreeing."
3	Misunderstanding	Mis- = Wrongly, badly	Understand = To grasp the meaning	-ing = Action or process	The act of understanding wrongly . Mis- modifies "understand" to mean "understand"

One-Word Substitution

Introduction

One-word substitution is the art of expressing a complex idea, phrase, or group of words in a single word. This is a critical topic in verbal reasoning and aptitude tests because it tests your vocabulary depth, precision of expression, and ability to recognize concise language equivalents.

Mastery of one-word substitutions demonstrates advanced language proficiency and the ability to communicate with clarity and efficiency.

WHY ONE-WORD SUBSTITUTION MATTERS IN APTITUDE TESTS

Assessment Area	Why One-Word Substitution Is Tested
Vocabulary Precision	Tests your knowledge of exact word meanings
Sentence Completion	The correct word may be a precise substitute for a phrase
Synonyms/Antonyms	Directly related to understanding word meanings
Reading Comprehension	Helps you decode complex ideas quickly
Writing Skills	Concise expression is a mark of good writing

MASTER STRATEGY

Step	Action
1	Read the phrase carefully and understand its core meaning
2	Identify the key concept (person, action, quality, state, etc.)
3	Recall the specific word that represents that exact concept
4	Use process of elimination if multiple options seem similar
5	Ensure the word fits grammatically in the context

ONE-WORD SUBSTITUTIONS — CATEGORIZED LIST

A. PERSONALITY AND CHARACTER

Phrase	One Word
One who is present everywhere	Omnipresent
One who is all-powerful	Omnipotent
One who knows everything	Omniscient
One who eats everything	Omnivorous
One who loves mankind	Philanthropist
One who hates mankind	Misanthrope
One who loves women	Philogynist
One who hates women	Misogynist
One who loves books	Bibliophile
One who hates books	Bibliophobe
One who collects stamps	Philatelist
One who collects coins	Numismatist
One who collects rare books	Bibliomaniac
One who travels from place to place	Itinerant
One who settles in another country	Immigrant
One who leaves his own country	Emigrant
One who wanders aimlessly	Vagabond
One who lives alone	Recluse
One who is self-centered	Egoist
One who is selfless	Altruist
One who is easily deceived	Gullible
One who is hard to please	Fastidious
One who is very careful	Meticulous
One who is very stubborn	Obstinate
One who is very lazy	Indolent
One who is very talkative	Garrulous
One who is very silent	Taciturn
One who is very brave	Intrepid



Marriage by music	Musical marriage
Marriage by art	Artistic marriage
Marriage by literature	Literary marriage
Marriage by poetry	Poetic marriage
Marriage by prose	Prosaic marriage
Marriage by drama	Dramatic marriage
Marriage by comedy	Comedic marriage
Marriage by tragedy	Tragic marriage
Marriage by romance	Romantic marriage
Marriage by passion	Passionate marriage
Marriage by friendship	Friendly marriage
Marriage by partnership	Partnered marriage
Marriage by equality	Egalitarian marriage
Marriage by patriarchy	Patriarchal marriage
Marriage by matriarchy	Matriarchal marriage
Marriage by democracy	Democratic marriage
Marriage by dictatorship	Dictatorial marriage
Marriage by consensus	Consensual marriage
Marriage by compromise	Compromise marriage
Marriage by cooperation	Cooperative marriage
Marriage by collaboration	Collaborative marriage
Marriage by communication	Communicative marriage
Marriage by understanding	Understanding marriage
Marriage by forgiveness	Forgiving marriage
Marriage by patience	Patient marriage
Marriage by kindness	Kind marriage
Marriage by generosity	Generous marriage
Marriage by gratitude	Grateful marriage
Marriage by joy	Joyful marriage
Marriage by hope	Hopeful marriage
Marriage by faith	Faithful marriage
Marriage by love	Loving marriage
Marriage by peace	Peaceful marriage
Marriage by harmony	Harmonious marriage
Marriage by happiness	Happy marriage
Marriage by health	Healthy marriage
Marriage by wealth	Wealthy marriage
Marriage by wisdom	Wise marriage
Marriage by courage	Courageous marriage
Marriage by strength	Strong marriage
Marriage by endurance	Enduring marriage
Marriage by commitment	Committed marriage
Marriage by loyalty	Loyal marriage
Marriage by trust	Trusting marriage
Marriage by honesty	Honest marriage
Marriage by transparency	Transparent marriage
Marriage by openness	Open marriage
Marriage by adventure	Adventurous marriage
Marriage by creativity	Creative marriage
Marriage by beauty	Beautiful marriage
Marriage by grace	Gracious marriage
Marriage by elegance	Elegant marriage



Analytical Reasoning



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Analytical Reasoning

Analytical Reasoning means the ability to understand information, analyze conditions, find logical relationships, and reach a correct conclusion.

This section tests whether a student can:

- Understand rules and conditions
- Arrange information logically
- Draw valid conclusions
- Identify assumptions
- Strengthen or weaken arguments
- Solve grouping and ordering problems
- Recognize cause-effect relationships
- Find what must be true, could be true, or cannot be true

Main Areas of Analytical Reasoning

1. Logic Basics
2. Conditions and Rules
3. Linear Arrangement
4. Ranking and Sequencing
5. Grouping Problems
6. Conditional Reasoning
7. Assumptions
8. Strengthen and Weaken Arguments
9. Inference and Conclusion
10. Cause, Explanation, and Paradox
11. Map Coloring and Relation Problems





- Fact: *The store is closed on Sundays.*
- Fact: *Triangle ABC has three sides.*

2. Premise

A fact or reason offered in support of a conclusion.

Examples:

- Premise: *The road is flooded.*
- Premise: *The bridge is closed.*
- Premise: *Rain causes traffic delays.*
- Premise: *All humans are mortal.*
- Premise: *Socrates is a human.*

Distinguishing Facts from Premises:

- Fact: *The ground is wet.*
Premise: *The ground is wet, therefore it must have rained.*
- Fact: *The car won't start.*
Premise: *The car won't start, so the battery must be dead.*

3. Conclusion

The claim that the argument asks the reader to accept.

Examples:

- Conclusion: *Therefore, the northern route cannot be used today.*
- Conclusion: *Thus, it will rain tomorrow.*
- Conclusion: *Hence, John will not attend the party.*
- Conclusion: *So, the building must be evacuated.*

4. Assumption

An unstated proposition on which the reasoning depends.

Detailed Examples:

Example 1:

- Premise: *Ali cannot reach the office because he left his keys at home.*
- Conclusion: *Ali is locked out of his office.*
- Assumption: *Ali does not have a spare key or anyone else to open the door.*

Example 2:

- Premise: *The train is delayed by 30 minutes.*
- Premise: *My meeting starts in 20 minutes.*
- Conclusion: *I will be late for the meeting.*
- Assumption: *I have no way to get to the meeting faster than the train.*

Example 3:

- Premise: *The restaurant serves vegetarian food.*
- Premise: *Sara is vegetarian.*
- Conclusion: *Sara can eat at this restaurant.*
- Assumptions: *The restaurant is open when Sara wants to eat there; the restaurant's definition of "vegetarian food" meets Sara's dietary needs.*

5. Inference

A statement derived from one or more facts.

Examples:

- Fact 1: *Zain is before Umar.*
Fact 2: *Umar is before Waqas.*
Inference: *Zain is before Waqas.*
- Fact 1: *It rained yesterday.*
Fact 2: *The ground is dry today.*
Inference: *The sun came out after the rain.*
- Fact 1: *All teachers are educated.*
Fact 2: *Ahmed is a teacher.*
Inference: *Ahmed is educated.*



- B. Farah in Room 2
- C. Farah in Room 3
- D. Farah not assigned to Room 3

Solution:

- Rule: All Team X members are excluded from Room 3.
- Since Farah is in Team X, Farah cannot be in Room 3.
- Rooms 1 and 2 are not forbidden (though not guaranteed).
- Option C directly violates the rule.

Answer: C

7. DETAILED PRACTICE SET WITH EXPLANATIONS

Question 1

Given: *All engineers are trained. Adeel is an engineer.*

What must be true?

- A. Adeel is trained.
- B. Every trained person is an engineer.
- C. Adeel trains engineers.
- D. No engineer is trained.

Solution: $\text{Engineers} \subseteq \text{Trained}$; $\text{Adeel} \in \text{Engineers} \rightarrow \text{Adeel} \in \text{Trained}$. Answer: A. (B reverses the subset; C uses outside knowledge; D contradicts the premise.)

Question 2

Given: *Some books are expensive. All expensive items are insured.*

What follows?

- A. All books are insured.
- B. Some books are insured.
- C. No book is insured.
- D. All insured items are books.

Solution: The intersection of Books and Expensive is non-empty. Since $\text{Expensive} \subseteq \text{Insured}$, that same intersection is also inside Insured. So $\text{Books} \cap \text{Insured} \neq \emptyset \rightarrow$ some books are insured. Answer: B.

Question 3

Given: *No poets are careless. Some teachers are poets.*

Which must be true?

- A. Some teachers are not careless.
- B. All teachers are careful.
- C. No teacher is careless.
- D. Some careless people are poets.

Solution: $\text{Poets} \cap \text{Careless} = \emptyset$. $\text{Teachers} \cap \text{Poets} \neq \emptyset$. The teachers who are poets cannot be careless. Hence at least one teacher is not careless. Answer: A. (B is too strong – other teachers might be careless; C contradicts the possible existence of careless non-poet teachers; D contradicts the disjointness.)

Question 4

Given: *A is older than B, and C is older than A.*

Which cannot be true?

- A. C is older than B.
- B. B is older than C.
- C. A is younger than C.
- D. B is younger than A.

Solution: Chain: $C > A > B$. Therefore $C > B$ (A is true); $A < C$ (C is true); $B < A$ (D is true). $B > C$ would mean $B > C > A > B$ – an impossible cycle. Answer: B.

Question 5

Given: *All red files are urgent. File K is not urgent.*

Which conclusion follows?

- A. K is red.
- B. K is not red.

9	All P are Q. Some Q are R. Which statement could be false ?	Some P are Q.	Some Q are P.	All P are R.	Some Q are not P.
10	M is older than N. O is older than M. Which statement cannot be true?	O is older than N.	N is older than O.	M is younger than O.	N is younger than M.

Answer Key and Explanations

Q#	Answer	Explanation
1	C	The premise directly states that all professors are scholars. The overlap between scholars and researchers does not force any relationship between professors and researchers.
2	B	The chain is Ahmad > Bilal > Usman. By transitivity, Ahmad > Usman (A), Bilal > Usman (C), and Ahmad > Bilal (D) are true. Usman > Ahmad would reverse the chain, making it impossible.
3	B	Some students are athletes, and all athletes are fit. Therefore those students who are athletes are also fit – at least one student is fit. Option A overstates, C contradicts, D reverses.
4	A	Snakes are a subset of reptiles, and reptiles are disjoint from mammals. Hence snakes cannot be mammals.
5	B	From $W < X < Y < Z$, transitivity gives $W < Z$. Options A, C, and D make unstated claims about ends or adjacency.
6	B	Having a badge is necessary for employment, but not sufficient. Sara could be an employee or not; we cannot conclude either way.
7	B	Some fruits are sweet, and sweet things are tasty, so those fruits are tasty. Option A overstates, C contradicts, D reverses.
8	A	Teachers and students are disjoint. Some adults are teachers, so those adults cannot be students. Thus at least one adult is not a student.
9	C	P is a subset of Q, and some Q are R. The overlap $Q \cap R$ could lie entirely outside P, so “All P are R” could be false. A and B follow if P exists; D is possible but not guaranteed.
10	B	Chain $O > M > N$. Therefore $O > N$ (A), $M < O$ (C), $N < M$ (D). $N > O$ would create an impossible cycle, so B cannot be true.

SELF-ASSESSMENT TEST 2 – FOUNDATIONS OF LOGIC

Instructions

Read each question carefully. Choose the best answer from the options provided. Do not use outside knowledge—only reason from the information given. Time suggested: 15 minutes for 10 questions.

Q#	Question	A	B	C	D
1	All doctors are educated. Some educated people are artists. Which statement must be true?	All doctors are artists.	Some artists are doctors.	All doctors are educated.	No doctor is an artist.
2	A is heavier than B. B is heavier than C. Which statement cannot be true?	A is heavier than C.	C is heavier than A.	B is heavier than C.	A is heavier than B.
3	Some birds are swimmers. All swimmers are animals. Which statement is best supported ?	All birds are animals.	Some birds are animals.	No bird is an animal.	All animals are birds.
4	No flowers are trees. All roses are flowers. Which statement must be true?	No roses are trees.	Some roses are trees.	All trees are flowers.	Some flowers are not roses.
5	P is left of Q. Q is left of R. S is left of P. ($S < P < Q < R$) Which statement must be true?	R is at the far right.	S is left of Q.	P is immediately left of Q.	Q is immediately left of R.

Conditions And Rule Translation

Turning Verbal Restrictions into Exact Operational Rules

Learning Outcomes

- Classify rules as fixed, positive, negative, conditional, numerical or exclusive.
- Translate rule language into concise symbols without changing its meaning.
- Distinguish inclusive “or” from exclusive “either-or.”
- Combine rules to produce deductions before attempting questions.
- Recognize invalid reversals and over-strong interpretations.

1. WHY RULE TRANSLATION MATTERS

Most analytical reasoning problems are difficult because the information is presented in **sentences** rather than **diagrams**. The first task is therefore **translation**. A correct translation reduces reading load and exposes interactions among rules; an incorrect translation contaminates every later step.

The solver should preserve **four features** of each rule:

Feature	What it asks	Example
Direction	Does A control B, or does B control A?	If A is selected, B is selected $\rightarrow$ A controls B.
Strength	Is the relationship mandatory, permitted or prohibited?	Must, may, cannot.
Scope	Does the rule apply to all cases, one group, one day, or one position?	All members, only on Tuesday, only in Room 3.
Timing	Is the rule permanent, or activated only when a condition occurs?	Always, or only if something else happens.

2. MAJOR RULE FAMILIES (TABLE)

Rule Family	Typical Wording	Compact Representation	Example Translation
Fixed placement	K is third; M is in Group 2	$K = 3; M \in G2$	“The workshop is on Friday” $\rightarrow$ Workshop = Friday.
Positive relation	A is with B; P is adjacent to Q	AB block; $P-Q$	“The twins sit together” $\rightarrow$ Twins form a block.
Negative relation	A is not with B; P is not adjacent to Q	$A \neq B; P \nparallel Q$	“Ali and Bilal are not in the same row” $\rightarrow$ Ali $\neq$ Bilal.
Ordering	R is earlier than S	$R < S$	“The meeting is before lunch” $\rightarrow$ Meeting $<$ Lunch.
Conditional	If A is selected, B is selected	$A \rightarrow B$	“If it rains, the match is cancelled” $\rightarrow$ Rain $\rightarrow$ Cancel.
Capacity	Exactly three members are in Team X	$ X = 3$	“The committee has five people” $\rightarrow$ committee = 5.
Inclusive or	A or B, or both	$A \vee B$	“Tea or coffee is served” (may have both).
Exclusive or	Either A or B, but not both	$A \oplus B$	“Exactly one of R and S is chosen” $\rightarrow$ $R \oplus S$.
At least / at most	At least two; no more than four	$\geq 2; \leq 4$	“No fewer than 3” $\rightarrow \geq 3$; “At most 2” $\rightarrow \leq 2$.

3. THE DIFFERENCE BETWEEN “ONLY,” “ONLY IF,” AND “IF”

Small words can completely reverse the logic of a rule. Use these guidelines:

- **“If A, then B”** $\rightarrow$ A is **sufficient** for B; B is **necessary** for A.
Symbol: $A \rightarrow B$.
Example: *If you study, you pass.* $\rightarrow$ Study $\rightarrow$ Pass.
- **“A only if B”** $\rightarrow$ A is **sufficient** for B; B is **necessary** for A.
Symbol: $A \rightarrow B$ (same direction as “if A then B”).
Example: *You pass only if you study.* $\rightarrow$ Pass $\rightarrow$ Study.
Notice: “only if” places the condition after the arrow.

Ranking And Sequencing

Comparing People, Objects and Events Without Forcing Unsupported Order

Learning Outcomes

- Create comparison chains for height, age, marks, speed, weight and seniority.
- Distinguish total order from partial order.
- Calculate positions from opposite ends.
- Handle ties, gaps and "between" relationships.
- Determine when the oldest/highest/earliest item cannot be uniquely identified.

1. WHY RANKING AND SEQUENCING MATTERS

Ranking and sequencing questions are among the most common in aptitude tests. They appear in various forms:

- **Ranking:** Comparing people or items by a single attribute (height, age, marks, speed, weight, seniority).
- **Sequencing:** Ordering events or steps in a process (prerequisites, schedules, timelines).

The key challenge is to **avoid assuming connections that are not stated**. Unlike purely conditional logic, ranking problems often involve **partial information** where some comparisons remain unknown. A disciplined solver learns to identify what is **definitely known** versus what is **uncertain**.

Example of the Danger:

- Statement: *A is taller than B. C is taller than B.*
- Invalid assumption: *A and C can be compared.*
- Reality: A and C are both taller than B, but their relative heights are unknown. A could be taller than C, or C could be taller than A, or they could be equal.

2. RANKING AS AN ORDER RELATION

Ranking questions compare items according to a single attribute. The attribute may be:

- **Quantitative:** Marks, height, weight, speed, temperature, salary.
- **Temporal:** Age, seniority, date of birth, time of arrival.
- **Positional:** Position in a queue, rank in a competition, seat in a row.

Direction Discipline

The first discipline is to **define the direction of the symbol consistently**. If ">" means "taller than," do not later use the same symbol to mean "younger than." Write a label above the chain when several attributes appear in one set.

Attribute	Symbol	Meaning	Example
Height	$A > B$	A is taller than B	Ali > Bilal
Age	$C > D$	C is older than D	Grandfather > Grandson
Marks	$P > Q$	P scored higher than Q	85% > 70%
Speed	$X > Y$	X is faster than Y	Cheetah > Horse
Weight	$M > N$	M is heavier than N	Elephant > Tiger
Seniority	$S > T$	S is more senior than T	Manager > Trainee

Example Chain with Label:

- Taller: Ali > Bilal > Danish
- Therefore: Ali is tallest, Danish is shortest, and Bilal is between them.
- The chain says nothing about their ages or marks.

3. TOTAL AND PARTIAL ORDERS

Definitions

Term	Definition	Example
Total Order	Every pair of items is compared	$A > B > C > D$ (all relationships known)
Partial Order	One or more pairs remain unresolved	$A > B$ and $C > B$ (A and C not compared)

Common Relationship Patterns

Given Information	Definite Result	Unknown Relationship
$A > B > C$	$A > C$	None among A, B, C
$A > B$ and $C > B$	A and C both exceed B	A versus C
$A > B$ and $A > C$	A exceeds both	B versus C
$A > B$; $C > D$	Two separate chains	Any cross-chain comparison
$A > B > C$ and $D > B$	B is below A and D; B is above C	A versus D; C versus D



Grouping And Selection

Distributing Items into Teams, Committees, Rooms and Categories

Learning Outcomes

- Represent group capacity and membership restrictions accurately.
- Use fixed placements, incompatibilities and conditional membership.
- Distinguish selection games from distribution games.
- Apply complements and leftover-member deductions.
- Construct complete groups when testing could-be-true options.

1. SELECTION VERSUS DISTRIBUTION

Understanding the difference between selection and distribution is fundamental to solving grouping problems correctly.

Feature	Selection Games	Distribution Games
Definition	Some items are chosen, others are left out	Every item is assigned to one of several groups
Absence Meaning	"A is not selected" → A is left out entirely	"A is not in Group X" → A must be in another group
Example	Choosing a committee of 3 from 5 candidates	Assigning 6 people to 2 teams of 3 each
Key Question	Which items are included?	Which items go where?
Universe Status	Selected items = included; Unselected = excluded	All items are used exactly once

Key Point: Always state the universe and whether all members must be used.

Comparison Table

Aspect	Selection	Distribution
Total items used	Variable (some chosen, some not)	Fixed (all items used)
Empty groups allowed?	Yes (if no items chosen for a category)	Sometimes (depending on rules)
Complement logic	Known excluded → Known included	Known in one group → Known in other group(s)

Example of the Difference:

- **Selection:** "A committee of 3 is chosen from 5 people." → 2 people are left out entirely.
- **Distribution:** "5 people are assigned to 2 committees, one with 3 members and one with 2." → All 5 are used; the groups partition the set.

2. GROUP CAPACITY

Capacity rules convert broad possibilities into forced placements.

Capacity Concepts

Rule Type	Example	Implication
Fixed capacity	Group has exactly 3 members	Filling 3 slots completes the group
Range capacity	Group has at least 2, at most 4	Minimum and maximum constraints apply
Equal capacity	Two groups of equal size	Filling one determines the other's composition
Total capacity	7 people divided into groups of 3 and 4	Filling one group determines the other

Visual Representation

Always record capacities visibly beside each group box.

Example:

text

Group 1 (3): ____ Group 2 (4): ____

When Capacity Forces Placement:

- If a group has exactly 3 members and 2 are already placed, the 3rd is forced.
- If a group has exactly 2 members and A and B must be together, placing A in that group makes B the second member.
- If a block of 3 must be together and a group has capacity 2, that placement is impossible.

3. COMMON MEMBERSHIP RULES

Conditional Reasoning

Mastering Implication, Necessary Conditions and Logical Equivalence

Learning Outcomes

- Interpret sufficient and necessary conditions.
- Form the contrapositive correctly.
- Avoid reversal and negation fallacies.
- Translate "only if," "unless," "whenever," "without" and related expressions.
- Build multi-step conditional chains and identify valid conclusions.

1. ANATOMY OF AN IF-THEN STATEMENT

In the conditional statement $A \rightarrow B$, A is the **sufficient condition** and B is the **necessary condition**.

Core Principles:

- The occurrence of A guarantees B under the rule.
- The absence of B guarantees the absence of A.
- B may occur for another reason without A.
- A may be absent while B is still present.

A conditional therefore licenses exactly two standard forms: the original implication and its contrapositive.

Conditional Forms Table

Form	Symbol	Validity
Original	$A \rightarrow B$	Valid
Contrapositive	$\neg B \rightarrow \neg A$	Valid and logically equivalent
Converse / Reversal	$B \rightarrow A$	Not licensed unless separately stated
Inverse / Negation	$\neg A \rightarrow \neg B$	Not licensed unless separately stated

Examples of Each Form

Original: If it rains, the ground is wet. ($\text{Rain} \rightarrow \text{Wet}$)

- Valid deduction: It rains $\rightarrow$ ground is wet.

Contrapositive: If the ground is not wet, it did not rain. ($\neg \text{Wet} \rightarrow \neg \text{Rain}$)

- Valid deduction: Ground is dry $\rightarrow$ no rain.

Converse (Invalid): If the ground is wet, it rained. ($\text{Wet} \rightarrow \text{Rain}$)

- Invalid: Ground could be wet from sprinkler, spilled water, etc.

Inverse (Invalid): If it does not rain, the ground is not wet. ($\neg \text{Rain} \rightarrow \neg \text{Wet}$)

- Invalid: Ground could be wet from other sources.

2. NECESSARY VERSUS SUFFICIENT

A **sufficient condition** is enough to produce the result. A **necessary condition** is required but may not be enough.

Examples Table

Statement	Sufficient Condition	Necessary Condition	Explanation
"Being a square is sufficient for being a rectangle"	Square	Rectangle	Every square is a rectangle
"Being a rectangle is necessary for being a square"	Square	Rectangle	A square must be a rectangle
"To be president, you must be a citizen"	President	Citizen	Every president is a citizen

Key Insight

"Being a square $\rightarrow$ being a rectangle" and "Being a rectangle is necessary for being a square" express the **same direction**.

Yet being a rectangle is **not sufficient** for being a square because non-square rectangles exist.

Visualizing Necessity vs Sufficiency

Relationship	Meaning	Example
A is sufficient for B	$A \rightarrow B$	$\text{Rain} \rightarrow \text{Wet}$
B is necessary for A	$A \rightarrow B$ (same)	$\text{Rain} \rightarrow \text{Wet}$ (Wet is necessary for Rain)
A is sufficient and necessary for B	$A \leftrightarrow B$	$\text{Triangle} \leftrightarrow \text{Three-sided polygon}$

Test Yourself:

- "Having fuel is necessary for starting a car." $\rightarrow$ Start $\rightarrow$ Fuel



Assumptions

Finding the Unstated Proposition an Argument Must Rely Upon

Learning Outcomes

- Identify evidence, conclusion and the gap between them.
- Distinguish required assumptions from helpful background facts.
- Apply the negation test accurately.
- Recognize causal, comparison, plan and recommendation assumptions.
- Control scope and avoid extreme answer choices.

1. THE ROLE OF AN ASSUMPTION

An assumption is not merely something the author believes. It is an **unstated proposition required for the reasoning to work**.

Key Insight: Evidence and conclusion are often separated by a logical gap. The required assumption bridges that gap. If the bridge is removed, the evidence no longer supports the conclusion in the intended way.

Argument Core: Evidence, Conclusion, Gap

Step	Action	Example
1	Identify the conclusion by asking what the author is trying to establish or recommend	"The school should introduce online classes."
2	Identify the evidence offered in support of that conclusion	"Many students own smartphones."
3	Describe the gap as a question	"What must connect smartphone ownership to online classes?"
4	Predict the type of assumption before reading the options	"Students can use smartphones for learning."
5	Use the negation test on close contenders	"Students cannot use smartphones for learning."

Example of the Gap

Argument: The school should introduce online classes because many students own smartphones.

Element	Statement
Evidence	Many students own smartphones.
Conclusion	The school should introduce online classes.
Gap	Why would smartphone ownership justify online classes?
Required Assumption	Students can use their smartphones for online learning.

2. DISTINGUISHING ASSUMPTIONS FROM STRENGTHENERS

Feature	Required Assumption	Strengtheners
Definition	Must be true for argument to work	Increases confidence but not essential
Necessity	Absolutely required	Helpful but not necessary
Negation Test	Negation destroys the argument	Negation weakens but doesn't destroy
Scope	Modest and targeted	Can be broader

Example Comparison

Argument: A training program should be implemented because it improved accuracy at Company X.

Statement	Type	Why
The reported improvement was caused by the program	Required Assumption	Without this, the evidence is irrelevant
The program is inexpensive	Strengtheners	Helpful but argument could still work if expensive
All employees will participate	Too Strong	Not required; partial participation might still help

3. THE NEGATION TEST

The negation test is the most reliable method for identifying required assumptions.

How to Apply the Negation Test

1. Identify the candidate assumption.



	customers use social media. Which assumption is required?				
2	A medicine worked for one patient, so it will work for another. Required assumption?	The patients are relevantly similar medically	All medicines work equally	The second patient is younger	Doctors never make mistakes
3	A sample of 50 volunteers is used to estimate national opinion. Required assumption?	The volunteers are reasonably representative	The nation has only 50 people	Every volunteer tells the truth about everything	No one has a neutral opinion
4	Sales rose after a price reduction; therefore, the reduction caused the rise. Required assumption?	No stronger concurrent factor explains the rise	Prices never affect sales	All buyers know the old price	Sales can only rise once
5	The school should buy tablets to improve learning. Required assumption?	Tablets can be integrated into effective learning activities	Every book should be discarded	All students already own tablets	Teachers dislike paper
6	A past trend is projected into next year. What is commonly assumed?	Relevant conditions will not change drastically	The trend is mathematically perfect	No exceptions ever occurred	The future is identical to the past in every detail
7	Which statement best describes a required assumption?	A fact that makes the conclusion interesting	An unstated proposition necessary for the reasoning	Any background fact mentioned in the passage	The same statement as the conclusion
8	In the negation test, a good assumption is one whose negation:	Strengthens the conclusion	Leaves the argument unchanged	Undermines the argument's support	Repeats the evidence
9	A plan assumes funds are available. Negating this means:	Funds are unlimited	Necessary funds are not available	Some funds are expensive	Funding is popular
10	An option says "Every citizen will benefit," but the argument needs only that many commuters benefit. The option is likely:	Too strong	Required	A direct premise	A contradiction



Which statement most weakens the argument?

- A. People who lost weight were more likely to report their results.
- B. The app is available on multiple platforms.
- C. Users downloaded the app voluntarily.
- D. The app tracks food intake.

Answer: A

Solution:

- Conclusion: App causes weight loss.
- Evidence: 90% of users lost weight.
- Gap: Self-reporting bias may inflate results.
- Weakening: Option A reveals reporting bias—people who lost weight were more likely to respond.

10. PRACTICE SET

Questions Table

Q#	Question	A	B	C	D
1	A training course is claimed to improve accuracy. Which strengthens the claim?	A controlled group taking the course improves more than a similar group that does not	The course uses printed handouts	The instructor has an office	Accuracy is important
2	Sales rose after a celebrity endorsement. Which weakens the claim that the endorsement caused the rise?	A major competitor simultaneously stopped selling the product	The celebrity is well known	Sales were measured monthly	The product has packaging
3	A city plans bicycle lanes to reduce car use. Which strengthens?	A large share of commuters say safety is the main reason they do not cycle	Bicycles have two wheels	Some streets have shops	Cars use fuel
4	A survey of website visitors finds 90% favor online services. Which weakens generalization to all citizens?	People who visit the website are more likely to prefer online services	The website is updated weekly	The survey has ten questions	Citizens use many services
5	A school extends study hours to raise scores. Which weakens?	Students are already exhausted, and the added hours reduce concentration	The school has a library	Tests use multiple choice	Teachers mark papers
6	Which option is most likely irrelevant to whether a medicine works?	Bottle color	Controlled trial results	Side-effect rate	Recovery difference versus placebo
7	A correlation is strengthened as causal when:	The cause consistently precedes the effect and alternatives are controlled	The variables share similar names	The sample is described emotionally	One anecdote is repeated
8	Which most weakens a prediction based on a five-year trend?	A new law will fundamentally change the relevant market next year	The trend was shown in a graph	The report uses percentages	The past years had twelve months each

1	All librarians are readers. Which must be true?	Every librarian is a reader	Every reader is a librarian	Some librarian exists	No reader is a librarian
2	Some cars are electric. Which follows?	All cars are electric	At least one electric car exists	No electric item is a car	Every electric vehicle is a car
3	The report says a policy "could improve access." Which paraphrase is safe?	The policy guarantees universal access	The policy has the potential to improve access	Access is already perfect	The policy will remove every barrier
4	A study covers teachers in one province. Which conclusion is too broad?	The surveyed teachers reported high workload	All teachers in every country have the same workload	The study concerns one province	The result may motivate further research
5	No A are B. X is A. Which cannot be true?	X is not B	X is B	X is A	At least one A exists
6	Some P are Q and all Q are R. Which must be true?	Some P are R	All P are R	No P are R	All R are Q
7	A passage reports correlation only. Which conclusion is unsafe?	The variables are associated	One variable definitely causes the other	The relationship deserves investigation	The data show co-variation
8	If all selected files are signed and File K is selected, what follows?	K is signed	Every signed file is selected	K is the only selected file	No file is signed
9	Which answer is usually best in inference questions?	The broadest possible claim	The most cautious claim fully supported by the evidence	The most emotional claim	The claim requiring outside knowledge
10	Some students are athletes; some students are artists. Which is certain?	Some athletes are artists	Students exist	No artist is an athlete	All students are athletes
11	A is before B and B before C. Which cannot be true?	A before C	C before A	B after A	C after B
12	An inference changes "many" into "all." This is usually:	A justified paraphrase	An overstatement	A necessary contradiction	A definition

Answer Explanations Table

Q#	Answer	Explanation
1	A	Direct universal inclusion: Librarians $\subseteq$ Readers.
2	B	"Some" establishes at least one instance exists.
3	B	Preserves modal strength ("could" $\rightarrow$ "potential").



Cause, Explanation and Paradox

Explaining Surprising Facts While Distinguishing Cause from Coincidence

Learning Outcomes

- Identify the expected outcome and the surprising observation.
- Resolve apparent contradictions by introducing a compatible distinction.
- Evaluate causal hypotheses and rival explanations.
- Recognize selection effects, hidden subgroups, measurement change and behavioral response.
- Choose explanations that account for both sides of a paradox.

1. WHAT MAKES A PARADOX QUESTION

A paradox question presents facts that appear inconsistent but are intended to be **jointly true**. The correct answer does not deny either fact. Instead, it supplies a distinction, mechanism or missing condition that allows both to coexist.

Key Characteristics

Element	Description	Example
Expected outcome	What should happen based on the first fact	More roads should reduce congestion
Surprising observation	What actually happened	Congestion got worse
Resolution	Explains how both can be true	More roads encouraged more driving

Two-Direction Relevance

A good resolution has **two-direction relevance**: it explains the expected tendency AND the surprising result.

Feature	Explanation
Explains the expected tendency	Why the first fact would normally produce the expected outcome
Explains the surprising result	Why the expected outcome didn't occur
Reconciles both	Shows how both facts can coexist

2. COMMON RESOLUTION PATTERNS

Pattern	How It Resolves the Puzzle	Example
Different subgroups	The overall result combines populations that behave differently	Average rises while most salaries stay same (executives joined)
Behavioral response	People change behavior in reaction to the policy or condition	More roads → more driving
Hidden time lag	The effect occurs later than the observation period	Policy judged too early
Measurement change	The method of counting changed, creating an apparent difference	New screening detects more cases
Selection effect	The observed group is not comparable with the original group	Survey only reaches certain people
Offsetting factor	A second force cancels or reverses the expected effect	Safety warning offsets price reduction
Capacity or saturation	Additional input no longer produces proportional output	More computers but more students

Detailed Pattern Explanations

Different Subgroups:

- Average salary rises while most workers receive no raise.
- Explanation: A small number of highly paid executives joined the firm.
- The average can rise even when most stay the same.

Behavioral Response:

- More roads built, but congestion gets worse.
- Explanation: More road capacity encouraged more people to drive.
- People change behavior in response to the policy.

Hidden Time Lag:

- Policy shows no effect after one month but would after two years.



	but would show benefit after three years.					
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Answer Key and Explanations Table

Q#	Answer	Explanation
1	A	Training creates a temporary offset.
2	D	A competitor opening next door is an offsetting factor.
3	A	Measurement/reporting changed.
4	A	Different subgroups—removing low scores raises the average.
5	A	Behavioral response—more production due to lower costs.
6	A	Behavioral response—more parking spaces encourage more drivers.
7	A	Detection effect—more people tested, more diagnosed.
8	A	Enrollment grew faster than the number of teachers.
9	A	Restatement provides no mechanism.
10	A	Time lag resolution.

SELF-ASSESSMENT TEST 2 – CAUSE, EXPLANATION AND PARADOX

Instructions

Read each scenario carefully. Choose the explanation that best resolves the paradox or explains the surprising result. Do not use outside knowledge—only reason from the information given. Time suggested: 15 minutes for 10 questions.

Questions Table

Q#	Scenario	Question	A	B	C	D
1	A company invested in new technology to improve efficiency, but productivity decreased.	Which best explains this?	Employees require time to learn the new technology	Technology uses electricity	The company has employees	Productivity is measured
2	A restaurant expanded its menu, but overall sales decreased.	Which explains this?	The expanded menu increased preparation time, leading to longer waits	Food is served hot	The restaurant has tables	Customers pay with cards
3	A city installed new streetlights to reduce crime, but property crime increased.	Which resolves the paradox?	The new lights made it easier for residents to see and report crime	Streetlights are bright	Crimes occur at night	Residents lock doors
4	A company's average employee age decreased, but most employees did not get younger.	Which explains this?	A group of older workers retired and were replaced by younger workers	Employees have birthdays	The company has departments	Salary increases
5	A more fuel-efficient plane led to more fuel consumption for the airline.	Which explains this?	Lower fuel cost per mile led to more flights	Planes use fuel	The airline has pilots	Flights are scheduled
6	A hospital added more	Which best resolves this?	More beds attracted more	The hospital has doctors	Patients need beds	The hospital is large

Map Coloring and Relation Problems

Using Networks and Matching Grids to Manage Adjacency and Assignments

Learning Outcomes

- Represent adjacency as a graph of nodes and edges.
- Apply the rule that adjacent regions must differ in color.
- Distinguish direct adjacency from indirect connection.
- Construct relation grids using ticks, crosses and one-to-one constraints.
- Combine adjacency or matching rules to derive forced assignments.

1. MAP COLORING AS A NETWORK PROBLEM

The geographical shape of a map is often less important than its **adjacency network**. Represent each region as a **node** and each shared border as an **edge**. Adjacent nodes must receive different colors. Regions connected only through another region are not adjacent and may share a color unless another rule prevents it.

Core Principle

Concept	Description	Example
Node	Represents a region	A, B, C, D
Edge	Represents a shared border	A—B means A shares border with B
Adjacent	Connected by an edge	Must have different colors
Non-adjacent	No direct edge	May share a color

Adjacency Notation

If A shares a border with B and C, write edges A—B and A—C. Do not infer B—C unless B and C also share a direct border.

Statement	Correct Inference	Incorrect Inference
A—B and A—C	A is adjacent to B and C	B is adjacent to C
B—C and C—D	B and C are adjacent; C and D are adjacent	B is adjacent to D
A—B and B—C and C—D	A—B—C—D is a path	A is adjacent to C or D

2. HIGH-DEGREE REGIONS

A region adjacent to many others has a **high degree** and should usually be colored or analyzed first. Its color restricts many neighbors simultaneously.

Concept	Description	Example
Degree	Number of edges from a node	Region A touches 4 others → degree 4
High-degree region	Adjacent to many others	Analyze first for constraints
Triangle	Three mutually adjacent regions	Require three distinct colors

Structural Deduction

If two neighbors are also adjacent to each other, they form a **triangle** with the central region and require three distinct colors.

Example:

- A is adjacent to B and C.
- B is adjacent to C.
- A, B, C form a triangle → 3 colors required.

Configuration	Colors Required	Reasoning
Path A—B—C	2	A and C can share a color
Triangle A—B—C—A	3	All three must differ
Central region with 4 non-adjacent neighbors	2	Center one color, all neighbors another

3. SAME COLOR AND DIFFERENT COLOR QUESTIONS

Rule	Explanation	Example
Directly adjacent pairs must differ	Shared border → different colors	A—B → A ≠ B
Non-adjacent pairs may share a color	"May" is not "must"	A and C (non-adjacent) could share color

9	Which pair definitely differs in color?	A pair with a stated shared border	Any two regions on the map	Any two non-adjacent regions	Any pair with similar names
10	Corner contact counts as adjacency only when:	The problem's definition says it does	It always counts	It never counts	The colors are red and blue
11	In a matching problem, "Bilal does not study Chemistry" should be marked as:	A cross at Bilal–Chemistry	A tick at Bilal–Chemistry	A tick in every Bilal cell	No mark
12	A complete could-be-true matching answer requires:	A full consistent assignment	Only one legal cell	Ignoring unused categories	Every option to be true

Answer Explanations Table

Q#	Answer	Explanation
1	B	Adjacent regions must differ in color.
2	B	Adjacency is not transitive. A and C may or may not be adjacent.
3	C	A triangle requires three distinct colors.
4	B	Non-adjacency permits but does not force equality.
5	A	In one-to-one matching, a tick eliminates all others in its row and column.
6	A	Only one candidate remains for that row.
7	A	Confirmed category links propagate.
8	A	They are mutually non-adjacent, so they can share a color.
9	A	Direct adjacency is decisive for color difference.
10	A	Use the stated definition of adjacency.
11	A	A negative relation eliminates that cell.
12	A	A possibility must extend to a complete model.

SELF-ASSESSMENT TEST 1 – MAP COLORING AND RELATION PROBLEMS

Instructions

Read each question carefully. Choose the best answer from the options provided. Do not use outside knowledge—only reason from the information given. Time suggested: 15 minutes for 10 questions.

Questions Table

Q#	Scenario	Question	A	B	C	D
1	A map has regions A, B, C with edges A—B and B—C.	Which pair must have different colors?	A and B	A and C	B and C	A and B only
2	A map has regions X, Y, Z with edges X—Y, Y—Z, and X—Z.	Minimum colors required?	1	2	3	4
3	P is adjacent to Q and R. Q and R are not adjacent to each other.	Which pair may share a color?	P and Q	P and R	Q and R	P only
4	A matching problem has three people (A, B, C) assigned to three subjects	What must be true?	B cannot be Math	C cannot be Math	Both B and C cannot be Math	Neither B nor C can be English



Quantitative Reasoning



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ARITHMETICS AND NUMBER SYSTEM

Numbers

Numbers are fundamental concepts in mathematics that represent quantities, measurements, or values. They form the basis for arithmetic, algebra, and more advanced mathematical fields. Numbers can be classified into various types based on their properties, such as whether they include negative values, fractions, or non-repeating decimals. Understanding these types helps in solving problems across disciplines like science, engineering, and finance.

Types of Numbers

Numbers are categorized into several sets, each building upon or extending the previous ones. These sets include natural numbers, whole numbers, integers, rational numbers, irrational numbers, and real numbers.

Natural Numbers

Definition:

Natural numbers are the positive counting numbers starting from 1 and extending infinitely. They are used for counting objects and ordering. Note: Some definitions include 0 as a natural number, but traditionally (especially in set theory), natural numbers start from 1.

Properties:

- Closed under addition and multiplication (i.e., adding or multiplying two natural numbers results in another natural number).
- Not closed under subtraction or division (e.g., $3 - 5 = -2$, which is not natural).
- They are infinite and have no upper bound.
- The smallest natural number is 1.
- They are all positive and have no fractional or decimal parts.

Examples:

- 1, 2, 3, 4, 5, ...
- Counting apples: If you have 5 apples and add 3 more, you get 8 apples (addition).
- Ordering: First (1), second (2), etc.

Non-Examples:

- 0 (if excluding it), -1 , $1/2$, $\sqrt{2}$.

Set Notation:

Natural numbers are denoted by $\mathbb{N}$ or N . $N = \{1, 2, 3, 4, \dots\}$

Applications:

Natural numbers are used in everyday counting, indexing in computer science (e.g., array positions starting from 1 in some languages), and in number theory for studying primes.

Whole Numbers

Definition: Whole numbers are natural numbers including 0. They extend natural numbers to include the concept of "nothing" or zero. This set is useful when counting can include absence.

Properties:

- Closed under addition and multiplication.
- Not closed under subtraction (e.g., $2 - 3 = -1$, not whole) or division.
- Infinite, starting from 0 with no upper bound.
- All non-negative integers without fractions.

Examples:

- 0, 1, 2, 3, 4, ...
- Bank balance: If you have \$0, it's a whole number representing no money.
- Temperature in Kelvin: Always non-negative, like 0 K (absolute zero).

Non-Examples:

- -5 , 3.14 , $\sqrt{3}$.

Set Notation:

Whole numbers are often denoted by W or $\mathbb{N}_0$ (natural numbers including 0). $W = \{0, 1, 2, 3, \dots\}$

Relationship to Natural Numbers:

Whole numbers = Natural numbers $\cup \{0\}$. All natural numbers are whole numbers, but 0 is a whole number that is not natural (if natural starts from 1).

Applications:

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Practice Problems of NUMBERS

Problem 1

Find the sum of first 20 natural numbers.

Solution

Formula: $S = n(n + 1) / 2$

$$S = (20 \times 21) / 2 = 210$$

Answer: 210

Problem 2

Find the 10th natural number.

Solution

Natural numbers start from 1.

10th natural number = 10

Answer: 10

Problem 3

How many natural numbers are there between 15 and 30?

Solution

Numbers = 16 to 29

$$\text{Count} = 29 - 16 + 1 = 14$$

Answer: 14 numbers

Problem 4

Is 0 a natural number?

Solution

No, because natural numbers start from 1.

0 is a whole number, not a natural number.

Problem 5

Find the smallest whole number.

Solution

Whole numbers start from 0.

Answer: 0

Problem 6

Find the value: $-7 + 12$

Solution

$$-7 + 12 = 5$$

Answer: 5

Problem 7

Evaluate: $-15 - (-8)$

Solution

Subtracting a negative means adding:

$$-15 + 8 = -7$$

Answer: -7

Problem 8

Which is greater: -3 or -7?

Solution

On a number line, -3 lies to the right of -7.

Answer: -3 is greater

Problem 9

Is 245 even or odd?

Solution

Last digit = 5, which is odd.

Answer: Odd

Problem 10

Find the sum of the first 10 even numbers.

Solution

First 10 even numbers: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20

Sum formula: $S = n(n + 1)$

$$S = 10 \times 11 = 110$$

Answer: 110

Problem 11

Find the sum of the first 15 odd numbers.

Solution

Formula: $S = n^2$

$$S = 15^2 = 225$$

Answer: 225

Problem 12

Is -5 a natural number, whole number, or integer?

Solution

Natural? No.

Whole? No.

Integer? Yes.

Answer: Integer only

Problem 13

How many integers are between -10 and 5?

Solution

Numbers: -9 to 4

$$\text{Count: } 4 - (-9) + 1 = 14$$

Answer: 14 integers

Problem 14

Find the additive inverse of -18.

Solution

Additive inverse is the number that makes the sum zero.

$$-18 + 18 = 0$$

Answer: 18

Problem 15

Find: $(-4) \times (-6)$

Solution

Negative $\times$ Negative = Positive

$$\text{Result} = 24$$

Answer: 24

Problem 16

Simplify: $8 - 12 + 5$

Solution

$$8 - 12 = -4$$

$$-4 + 5 = 1$$

Answer: 1

Problem 17

Find the greatest integer less than 3.7.

Solution

The greatest integer less than or equal to 3.7 is 3.

Answer: 3

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Exponentiation

Definition: Repeated multiplication: $a^b = a \times a \times \dots$ (b times).

Properties:

- $a^0 = 1$ ($a \neq 0$).
- $a^1 = a$.
- Negative exponents: $a^{(-b)} = 1 / a^b$.
- Fractional: $a^{(1/b)} = b$ -th root of a .

Examples:

- $2^3 = 8$.
- $(-3)^2 = 9$.
- $4^{(1/2)} = \sqrt{4} = 2$.
- $e^1 \approx 2.718$.

Roots ($\sqrt{\quad}$ or n th root)

Definition: Inverse of exponentiation: $\sqrt[b]{a} = b$ where $b^2 = a$.

Examples:

- $\sqrt{9} = 3$.
- $\sqrt[3]{8} = 2$.
- $\sqrt{2} \approx 1.414$ (irrational).

Order of Operations (PEMDAS/BODMAS)

- Parentheses/Brackets.
- Exponents/Orders.
- Multiplication/Division (left to right).
- Addition/Subtraction (left to right). Example: $2 + 3 \times 4^2 - 1 = 2 + 3 \times 16 - 1 = 2 + 48 - 1 = 49$.

Properties Across Number Types

Operation	Natural/Whole	Integers	Rational	Irrational	Real
Addition	Closed	Closed	Closed	Closed	Closed
Subtraction	Not Closed	Closed	Closed	Closed	Closed
Multiplication	Closed	Closed	Closed	Closed	Closed
Division	Not Closed	Not Closed	Closed ($\neq 0$)	Closed ($\neq 0$)	Closed ($\neq 0$)

These operations form the core of arithmetic. For advanced topics, see algebraic structures like fields (reals under + and $\times$).

Practice Problems - OPERATIONS ON NUMBERS

1. ADDITION

Problem 1

Find: $345 + 678$

Solution

$$345 + 678 = 1023$$

Answer: 1023

Problem 2

Add: $-15 + 28$

Solution

$$-15 + 28 = 13$$

Answer: 13

Problem 3

Find: $900 - 457$

Solution

$$900 - 457 = 443$$

Answer: 443

Problem 4

Subtract: $-8 - (-12)$

Solution

Subtracting a negative equals addition:

$$-8 + 12 = 4$$

Answer: 4

Problem 5

Multiply: 24×15

Solution

$$24 \times 15 = 360$$

Answer: 360

Problem 6

Find: -6×7

Solution

Negative $\times$ Positive = Negative
 $= -42$

Answer: -42

Problem 7

Find: -9×-4

Solution

Negative $\times$ Negative = Positive
 $= 36$



- In 7,892: Face value of 8 is 8, regardless of its position.
- Real-life: In a phone number like 123-4567, each digit's face value is just itself (no positional meaning).
- Edge Case: In 0.5, face value of 5 is 5 (decimal part).

Non-Examples:

- The value 40 in 456 is not the face value of 4; that's place value influence.

Applications: Face value is used in digit recognition, such as in optical character recognition (OCR) for scanning documents or in basic counting where position doesn't matter.

Place Value

Definition: The place value of a digit is its value based on its position in the number. In the decimal system, positions are powers of 10: units (10^0), tens (10^1), hundreds (10^2), etc., from right to left for whole numbers, and tenths (10^{-1}), hundredths (10^{-2}), etc., for decimals. It determines how much the digit contributes to the total number.

Properties:

- Dependent on position: Multiplied by the base raised to the power of the position.
- For whole numbers: Rightmost is units (1), then tens (10), hundreds (100), etc.
- For decimals: Left of decimal is whole, right is fractions (0.1, 0.01, etc.).
- Enables representation of large or small numbers efficiently.
- In other bases (e.g., base-2: binary places are 1, 2, 4, 8,...).

Examples:

- In 456:
 - Place value of 4 is hundreds ($4 \times 100 = 400$).
 - Place value of 5 is tens ($5 \times 10 = 50$).
 - Place value of 6 is units ($6 \times 1 = 6$).
 - Total: $400 + 50 + 6 = 456$.
- In 7,892: Place value of 8 is tens ($8 \times 10 = 80$).
- Decimal Example: In 3.14:
 - 3: units ($3 \times 1 = 3$).
 - 1: tenths ($1 \times 0.1 = 0.1$).
 - 4: hundredths ($4 \times 0.01 = 0.04$).
- Real-life: In \$1,234, place value of 2 is hundreds (\$200).

Non-Examples:

- Just the digit 5 without context; that's face value only.

Applications: Essential for addition/subtraction with carrying/borrowing, understanding scientific notation (e.g., 1.23×10^3), and in computing (e.g., binary place values in bits).

Key Differences: Place Value vs. Face Value

Aspect	Face Value	Place Value
Definition	The digit itself (0-9)	Digit $\times$ position power (e.g., 10^n)
Dependency	Independent of position	Dependent on position
Value Range	Always 0-9	Can be any multiple (e.g., 400)
Role in Number	Basic identity of digit	Contribution to total value
Example (Digit 7 in 7,000)	7	$7 \times 1,000 = 7,000$
Changes With	Never changes	Changes with position

Practice Problems

Question 1

Find the **face value** of 7 in the number 5734.

Solution:

Face value of a digit is the digit itself.

Face value of 7 = 7

Question 2

Find the **place value** of 5 in 5734.

Solution:

5 is in the thousands place.

Place value = $5 \times 1000 = 5000$

Question 3

In the number 4082, find the **face value** and **place value** of digit 8.

Solution:

Face value = 8

8 is in the tens place.

Place value = $8 \times 10 = 80$

Question 4

**Solution:**

Last digit is 5, which is odd.

So it is not divisible by 2.

Therefore, 2,145 is not divisible by 6.

Question 11

Check whether 7,264 is divisible by 8.

Solution:

A number is divisible by 8 if its last three digits are divisible by 8.

Last three digits = 264

$$264 \div 8 = 33$$

Therefore, 7,264 is divisible by 8.

Question 12

Is 5,918 divisible by 8?

Solution:

Last three digits = 918

$918 \div 8$ is not a whole number.

Therefore, 5,918 is not divisible by 8.

Question 13

Check whether 6,543 is divisible by 9.

Solution:

Sum of digits = $6 + 5 + 4 + 3 = 18$

18 is divisible by 9.

Therefore, 6,543 is divisible by 9.

Question 14

Is 8,172 divisible by 9?

Solution:

Sum of digits = $8 + 1 + 7 + 2 = 18$

Least Common Multiple (LCM)**1. Introduction to LCM**

The **Least Common Multiple (LCM)** of two or more numbers is the smallest multiple that is divisible by each number without a remainder.

Example: LCM of 4 and 5 is 20.

2. Methods to Find LCM**A. Listing Multiples Method**

1. List multiples of each number.
2. Identify common multiples.
3. Smallest common multiple is the LCM.

Example 1: Find LCM of 4 and 6.

- Multiples of 4: 4, 8, 12, 16, 20, 24, ...
- Multiples of 6: 6, 12, 18, 24, 30, ...
- Common multiples: 12, 24, ...
- **LCM = 12**

B. Prime Factorization Method

1. Prime factorize each number.
2. Take highest power of each prime factor.
3. Multiply these powers.

Example 2: Find LCM of 12 and 15.

- $12 = 2^2 \times 3^1$
- $15 = 3^1 \times 5^1$
- Highest powers: $2^2, 3^1, 5^1$
- $\text{LCM} = 2^2 \times 3 \times 5 = 4 \times 3 \times 5 = 60$

C. Division Method (Ladder Method)

18 is divisible by 9.

Therefore, 8,172 is divisible by 9.

Question 15

Check whether 4,820 is divisible by 10.

Solution:

A number is divisible by 10 if it ends in 0.

Last digit is 0.

Therefore, 4,820 is divisible by 10.

Question 16

Check whether 3,960 is divisible by 2, 3, 4, and 5.

Solution:

Divisible by 2: Last digit is 0, yes

Divisible by 3: Sum of digits = $3 + 9 + 6 + 0 = 18$, yes

Divisible by 4: Last two digits = 60, divisible by 4, yes

Divisible by 5: Last digit is 0, yes

So, 3,960 is divisible by 2, 3, 4, and 5.

Question 17

Find the **smallest number** that must be added to 248 to make it divisible by 9.

Solution:

Sum of digits of 248 = $2 + 4 + 8 = 14$

Next multiple of 9 after 14 is 18

Difference = $18 - 14 = 4$

So, smallest number to be added = 4



For 3: 3^1 (from 15)

For 5: 5^2 (from 25)

- **Step 3: Multiply the Highest Powers**

$$\text{LCM} = 2^2 \times 3^1 \times 5^2 = 4 \times 3 \times 25 = 300$$

Answer: LCM of 15, 20, and 25 is **300**.

3. Two bells toll at intervals of 6 and 8 seconds, respectively. How often will they toll together?

Solution:

- **Step 1: List the Multiples**
Multiples of 6: 6, 12, 18, 24, 30, 36, ...
Multiples of 8: 8, 16, 24, 32, 40, ...
- **Step 2: Identify Common Multiples**
Common multiples: 24, 48, 72, ...
- **Step 3: Find the Least Common Multiple**
The smallest common multiple is 24 seconds.

Answer: The bells will toll together every **24 seconds**.

4. Find the LCM of 5, 7, and 10.

Solution:

- **Step 1: Prime Factorization**
 $5 = 5^1$
 $7 = 7^1$
 $10 = 2^1 \times 5^1$
- **Step 2: Take the Highest Powers of Each Prime Factor**
For 2: 2^1 (from 10)
For 5: 5^1 (from 5 and 10)
For 7: 7^1 (from 7)
- **Step 3: Multiply the Highest Powers**
 $\text{LCM} = 2^1 \times 5^1 \times 7^1 = 2 \times 5 \times 7 = 70$

Answer: LCM of 5, 7, and 10 is **70**.

5. Find the LCM of 9, 12, and 15.

Solution:

- **Step 1: Prime Factorization**
 $9 = 3^2$
 $12 = 2^2 \times 3^1$
 $15 = 3^1 \times 5^1$
- **Step 2: Take the Highest Powers of Each Prime Factor**
For 2: 2^2 (from 12)
For 3: 3^2 (from 9)
For 5: 5^1 (from 15)
- **Step 3: Multiply the Highest Powers**
 $\text{LCM} = 2^2 \times 3^2 \times 5^1 = 4 \times 9 \times 5 = 180$

Answer: LCM of 9, 12, and 15 is **180**.

6. Find the LCM of 14 and 18.

Solution:

- **Step 1: Prime Factorization**
 $14 = 2^1 \times 7^1$
 $18 = 2^1 \times 3^2$
- **Step 2: Take the Highest Powers of Each Prime Factor**
For 2: 2^1 (common)
For 3: 3^2 (from 18)
For 7: 7^1 (from 14)
- **Step 3: Multiply the Highest Powers**
 $\text{LCM} = 2^1 \times 3^2 \times 7^1 = 2 \times 9 \times 7 = 126$

Answer: LCM of 14 and 18 is **126**.

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Question 13

The LCM of two numbers is always greater than both numbers.

Solution:

Example: LCM of 6 and 12 is 12, which is equal to one of the numbers.

Word Problems

1. Question: A bell rings every 12 minutes, and another bell rings every 18 minutes. If they ring together at 9:00 AM, what time will they next ring together?

Solution: Find the LCM of 12 and 18. Prime factors: $12 = 2^2 \times 3$, $18 = 2 \times 3^2$. $LCM = 2^2 \times 3^2 = 36$ minutes. $9:00 \text{ AM} + 36 \text{ min} = 9:36 \text{ AM}$.

2. Question: Two traffic lights turn green at intervals of 24 seconds and 36 seconds. If they both turn green at 8:00 AM, after how many seconds will they turn green simultaneously again?

Solution: LCM of 24 and 36. $24 = 2^3 \times 3$, $36 = 2^2 \times 3^2$. $LCM = 2^3 \times 3^2 = 72$ seconds.

3. Question: A bakery packages muffins in boxes of 15 or 20. What is the smallest number of muffins that can be packed exactly into either size of box?

Solution: LCM of 15 and 20. $15 = 3 \times 5$, $20 = 2^2 \times 5$. $LCM = 2^2 \times 3 \times 5 = 60$ muffins.

4. Question: Sarah goes to the gym every 6 days, and her friend goes every 10 days. If they both went today, after how many days will they both go to the gym on the same day again?

Solution: LCM of 6 and 10. $6 = 2 \times 3$, $10 = 2 \times 5$. $LCM = 2 \times 3 \times 5 = 30$ days.

5. Question: Three runners start a lap around a track at the same time. Runner A takes 4 minutes, Runner B takes 6 minutes, and Runner C takes 9 minutes to complete one lap. After how many minutes will they all meet again at the starting point?

Solution: LCM of 4, 6, and 9. $4 = 2^2$, $6 = 2 \times 3$, $9 = 3^2$. $LCM = 2^2 \times 3^2 = 36$ minutes.

6. Question: A school has two different classes. One class has 24 students and the other has 30 students. If they want to split into groups with the same number of students per group and no student left out, what is the smallest total number of students from both classes that could be rearranged into equal groups (assuming a combined event)?

Solution: This asks for the smallest common multiple. LCM of 24 and 30. $24 = 2^3 \times 3$, $30 = 2 \times 3 \times 5$. $LCM = 2^3 \times 3 \times 5 = 120$ students.

7. Question: A machine produces a part every 8 minutes, and another machine produces a part every 14 minutes. If both start production at the same time, after how many minutes will they produce a part simultaneously again?

Solution: LCM of 8 and 14. $8 = 2^3$, $14 = 2 \times 7$. $LCM = 2^3 \times 7 = 56$ minutes.

8. Question: A gardener plants flowers in rows of 9 or 12 flowers per row. What is the minimum number of flowers needed so that they can be planted in either row arrangement perfectly?

Solution: LCM of 9 and 12. $9 = 3^2$, $12 = 2^2 \times 3$. $LCM = 2^2 \times 3^2 = 36$ flowers.

9. Question: Two planets revolve around a star. Planet X takes 15 years, and Planet Y takes 25 years. If they align today, in how many years will they align again?

Solution: LCM of 15 and 25. $15 = 3 \times 5$, $25 = 5^2$. $LCM = 3 \times 5^2 = 75$ years.

10. Question: A radio station plays a song at 5-minute intervals and a commercial break at 7-minute intervals. If they start together at 12:00 PM, at what time will they both occur at the same time again?

Solution: LCM of 5 and 7 (both prime). $LCM = 5 \times 7 = 35$ minutes. $12:00 \text{ PM} + 35 \text{ min} = 12:35 \text{ PM}$.

11. Question: A librarian shelves books on carts. One cart holds 18 books, another holds 24 books. What is the smallest number of books that can be divided equally onto either cart without leftovers?

Solution: LCM of 18 and 24. $18 = 2 \times 3^2$, $24 = 2^3 \times 3$. $LCM = 2^3 \times 3^2 = 72$ books.

12. Question: Four cyclists start a race together. Their lap times are 3, 4, 6, and 8 minutes. After how many minutes will all four cyclists pass the starting line at the same time?

Solution: LCM of 3, 4, 6, and 8. $3=3$, $4=2^2$, $6=2 \times 3$, $8=2^3$. $LCM = 2^3 \times 3 = 24$ minutes.

13. Question: A vending machine restocks chips every 20 days and candy every 28 days. If both were restocked today, in how many days will both be restocked on the same day again?

Solution: LCM of 20 and 28. $20 = 2^2 \times 5$, $28 = 2^2 \times 7$. $LCM = 2^2 \times 5 \times 7 = 140$ days.

14. Question: Two countdown timers are set. Timer A beeps every 16 seconds, Timer B beeps every 20 seconds. If they start together, after how many seconds will they beep together for the first time?

Solution: LCM of 16 and 20. $16 = 2^4$, $20 = 2^2 \times 5$. $LCM = 2^4 \times 5 = 80$ seconds.

15. Question: A factory produces nails in packs of 60 and screws in packs of 80. What is the smallest quantity of nails and screws combined (equal number of each) that can be bought so that you have the same number of nails and screws?

Solution: LCM of 60 and 80. $60 = 2^2 \times 3 \times 5$, $80 = 2^4 \times 5$. $LCM = 2^4 \times 3 \times 5 = 240$. You need 240 of each.

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Solution:

- **Step 1: Prime Factorization**
 - $63 = 3^2 \times 7$
 - $84 = 2^2 \times 3 \times 7$
 - $120 = 2^3 \times 3 \times 5$
- **Step 2: Common Prime Factors**
 - Common factors: 3 and 7
 - Lowest power of 3: 3^1
 - Lowest power of 7: 7^1
- **Step 3: Multiply Common Factors**
 - $HCF = 3^1 \times 7^1 = 3 \times 7 = 21$

Answer: HCF of 63, 84, and 120 is 21.

Word Problems:

1. Question: A rope is 42 meters long and another is 56 meters long. What is the longest possible length of a piece that can cut both ropes into equal lengths without any leftover?

Solution: Find the HCF of 42 and 56. Factors of 42: 1, 2, 3, 6, 7, 14, 21, 42. Factors of 56: 1, 2, 4, 7, 8, 14, 28, 56. Common factors: 1, 2, 7, 14. HCF = 14 meters.

2. Question: A shopkeeper has 24 red pens and 36 blue pens. He wants to pack them into identical boxes, each containing the same number of pens of the same color. What is the greatest number of pens he can put in each box?

Solution: HCF of 24 and 36. $24 = 2^3 \times 3$, $36 = 2^2 \times 3^2$. HCF = $2^2 \times 3 = 12$ pens per box.

3. Question: Two strings of lengths 72 cm and 90 cm are to be cut into pieces of equal length. What is the maximum possible length of each piece?

Solution: HCF of 72 and 90. $72 = 2^3 \times 3^2$, $90 = 2 \times 3^2 \times 5$. HCF = $2 \times 3^2 = 18$ cm.

4. Question: A gardener has 45 rose bushes and 60 daisy plants. She wants to plant them in rows such that each row has the same number of plants and each row contains only one type of flower. What is the greatest number of plants she can place in each row?

Solution: HCF of 45 and 60. $45 = 3^2 \times 5$, $60 = 2^2 \times 3 \times 5$. HCF = $3 \times 5 = 15$ plants per row.

5. Question: There are 28 boys and 35 girls in a school. The principal wants to divide them into teams with the same number of students, where each team has only boys or only girls. What is the largest possible number of students in each team?

Solution: HCF of 28 and 35. $28 = 2^2 \times 7$, $35 = 5 \times 7$. HCF = 7 students per team.

6. Question: Two tankers contain 850 liters and 680 liters of water. What is the maximum capacity of a container that can exactly measure the water in both tankers a whole number of times?

Solution: HCF of 850 and 680. $850 = 2 \times 5^2 \times 17$, $680 = 2^3 \times 5 \times 17$. HCF = $2 \times 5 \times 17 = 170$ liters.

7. Question: A rectangular floor is 24 meters long and 16 meters wide. What is the largest square tile size (side length in whole meters) that can be used to cover the floor exactly without cutting any tiles?

Solution: HCF of 24 and 16. $24 = 2^3 \times 3$, $16 = 2^4$. HCF = $2^3 = 8$ meters. (Tile side = 8m).

8. Question: A baker has 144 chocolate chips and 180 walnuts. He wants to make identical cookies, each containing the same number of chips and the same number of walnuts, using all ingredients. What is the greatest number of cookies he can make?

Solution: HCF of 144 and 180. $144 = 2^4 \times 3^2$, $180 = 2^2 \times 3^2 \times 5$. HCF = $2^2 \times 3^2 = 36$ cookies.

9. Question: Three pieces of wood are 12 cm, 18 cm, and 30 cm long. They need to be cut into equal-sized pieces. What is the longest possible length of each piece?

Solution: HCF of 12, 18, and 30. $12 = 2^2 \times 3$, $18 = 2 \times 3^2$, $30 = 2 \times 3 \times 5$. HCF = $2 \times 3 = 6$ cm.

10. Question: A juice seller has three types of juice: 120 liters of orange, 180 liters of apple, and 240 liters of mango. He wants to fill identical bottles, each containing the same type of juice, without mixing. What is the greatest capacity of each bottle?

Solution: HCF of 120, 180, and 240. $120 = 2^3 \times 3 \times 5$, $180 = 2^2 \times 3^2 \times 5$, $240 = 2^4 \times 3 \times 5$. HCF = $2^2 \times 3 \times 5 = 60$ liters.

11. Question: A school has 60 students in Grade 5, 84 in Grade 6, and 108 in Grade 7. They are to be seated in rows with the same number of students per row and each row having students from only one grade. What is the greatest

**Problem 3**

Find the smallest number which is exactly divisible by 9, 12, and 18.

Solution:

$$9 = 3^2$$

$$12 = 2^2 \times 3$$

$$18 = 2 \times 3^2$$

$$\text{LCM} = 2^2 \times 3^2 = 36$$

Smallest required number = 36

Problem 4

Three bells ring at intervals of 15 minutes, 20 minutes, and 30 minutes. If they ring together at 9:00 AM, when will they ring together again?

Solution:

$$15 = 3 \times 5$$

$$20 = 2^2 \times 5$$

$$30 = 2 \times 3 \times 5$$

$$\text{LCM} = 2^2 \times 3 \times 5 = 60 \text{ minutes}$$

They will ring together again at 10:00 AM.

Problem 5

What is the least number which when divided by 5, 6, and 8 leaves no remainder?

Solution:

$$5 = 5$$

$$6 = 2 \times 3$$

$$8 = 2^3$$

$$\text{LCM} = 2^3 \times 3 \times 5 = 120$$

Required number = 120

Problem 6

Find the smallest number which when divided by 12, 15, and 20 leaves a remainder 2 in each case.

Solution:

First find LCM of 12, 15, and 20.

$$12 = 2^2 \times 3$$

$$15 = 3 \times 5$$

$$20 = 2^2 \times 5$$

$$\text{LCM} = 2^2 \times 3 \times 5 = 60$$

$$\text{Required number} = \text{LCM} + \text{remainder} = 60 + 2 = 62$$

Problem 7

A school has bells for period changes ringing after 35 minutes and 45 minutes. If they ring together at the start of school, after how many minutes will they ring together again?

Solution:

$$35 = 5 \times 7$$

$$45 = 3^2 \times 5$$

$$\text{LCM} = 3^2 \times 5 \times 7 = 315 \text{ minutes}$$

They will ring together after 315 minutes.

Problem 8

Three buses leave a station at intervals of 24 minutes, 36 minutes, and 48 minutes. If they leave together at 7:00 AM, when will they leave together again?

Solution:

$$24 = 2^3 \times 3$$

$$36 = 2^2 \times 3^2$$

$$48 = 2^4 \times 3$$

$$\text{LCM} = 2^4 \times 3^2 = 144 \text{ minutes}$$

$$144 \text{ minutes} = 2 \text{ hours } 24 \text{ minutes}$$

They will leave together again at 9:24 AM.

Problem 9

Find the smallest number of chocolates that can be distributed equally among 6, 9, and 12 children.

Solution:

$$6 = 2 \times 3$$

$$9 = 3^2$$

$$12 = 2^2 \times 3$$

$$\text{LCM} = 2^2 \times 3^2 = 36$$

Minimum chocolates = 36

Problem 10

Three machines can complete a task in cycles of 10 days, 15 days, and 20 days. After how many days will they complete the task together again?

Solution:

$$10 = 2 \times 5$$

$$15 = 3 \times 5$$

$$20 = 2^2 \times 5$$

$$\text{LCM} = 2^2 \times 3 \times 5 = 60 \text{ days}$$

They will complete the task together after 60 days.

Problem 11

Find the largest number that divides 36 and 60 exactly.

Solution:

Prime factorization:

$$36 = 2^2 \times 3^2$$

$$60 = 2^2 \times 3 \times 5$$

Common factors with lowest powers: $2^2 \times 3 = 12$

Largest number = 12

Problem 12

Three numbers are 24, 36, and 48. Find the greatest number that divides all of them exactly.

Solution:

Prime factorization:

$$24 = 2^3 \times 3$$

$$36 = 2^2 \times 3^2$$

$$48 = 2^4 \times 3$$

Common factors: $2^2 \times 3 = 12$

Answer = 12

Problem 13

Two ropes are 84 m and 126 m long. Find the maximum length of rope that can be cut from both ropes without any remainder.

Solution:

Prime factorization:

$$84 = 2^2 \times 3 \times 7$$

$$126 = 2 \times 3^2 \times 7$$

Common factors: $2 \times 3 \times 7 = 42$

Maximum length = 42 m

Definition

An arithmetic series is a number series in which the **difference between consecutive terms is constant**.

General Form

$a, a + d, a + 2d, a + 3d, \dots$

where

a = first term

d = common difference

Examples

Example 1:

2, 4, 6, 8, 10, ...

Pattern: Add 2 each time

Example 2:

15, 12, 9, 6, 3, ...

Pattern: Subtract 3 each time

Find the Missing Term

Example:

5, 10, __, 20, 25

Difference = +5

Missing term = 15

3. Geometric Number Series (Multiplication or Division Pattern)

Definition

A geometric series is a number series where each term is obtained by **multiplying or dividing by a fixed number**.

4. Number Patterns Based on Operations

These series involve **more than one operation** such as addition, subtraction, multiplication, or division.

Example 1: Alternating Operations

2, 6, 7, 21, 22, 66, ...

Pattern:

$\times 3, +1, \times 3, +1, \dots$

Example 2: Increasing Difference

1, 4, 9, 16, 25, ...

Pattern:

$+3, +5, +7, +9$

(or square numbers: $1^2, 2^2, 3^2, 4^2, 5^2$)

5. Special Number Series

a) Square Numbers

Series of perfect squares.

1, 4, 9, 16, 25, 36, ...

Pattern:

$1^2, 2^2, 3^2, 4^2, 5^2, \dots$

b) Cube Numbers

Series of perfect cubes.

1, 8, 27, 64, 125, ...

Pattern:

$1^3, 2^3, 3^3, 4^3, 5^3, \dots$

c) Even Numbers

2, 4, 6, 8, 10, ...

Pattern: Add 2

d) Odd Numbers

1, 3, 5, 7, 9, ...

Pattern: Add 2

7. Steps to Solve Number Series Questions

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General Form

$a, ar, ar^2, ar^3, \dots$

where

a = first term

r = common ratio

Examples

Example 1:

2, 4, 8, 16, 32, ...

Pattern: Multiply by 2

Example 2:

81, 27, 9, 3, 1, ...

Pattern: Divide by 3

Find the Missing Term

Example:

3, 6, __, 24

Pattern: $\times 2$

Missing term = 12

e) Prime Numbers

2, 3, 5, 7, 11, 13, 17, ...

Pattern: Numbers with exactly two factors (1 and itself)

f) Fibonacci Series

Each term is the **sum of the previous two terms**.

0, 1, 1, 2, 3, 5, 8, 13, 21, ...

Pattern:

$0 + 1 = 1$

$1 + 1 = 2$

$1 + 2 = 3$

6. Mixed and Complex Number Series

These series combine **multiple rules** and require careful observation.

Example 1: Two-Series Pattern

1, 4, 9, 16, 25, ...

Square numbers

Example 2: Alternating Series

2, 4, 8, 3, 6, 12, 4, 8, 16, ...

Odd positions: $\times 2$

Even positions: $\times 2$ (starting from 3)

Example 3: Position-Based Pattern

1, 3, 6, 10, 15, ...

Pattern:

$+2, +3, +4, +5$

(Triangular numbers)



Fractions, Decimals & Percentages

1. Fractions

Definition

A **fraction** represents a part of a whole and is written in the form:

a/b

where

a = numerator (top number)

b = denominator (bottom number), $b \neq 0$

Types of Fractions

Proper Fraction:

Numerator < Denominator

Example: $3/5$, $7/9$

Improper Fraction:

Numerator $\geq$ Denominator

Example: $7/4$, $9/3$

Mixed Fraction:

Combination of a whole number and a proper fraction

Example: $1\frac{3}{4}$, $2\frac{5}{6}$

Equivalent Fractions:

Fractions with different forms but same value

Example:

$1/2 = 2/4 = 3/6$

2. Operations with Fractions

A. Addition of Fractions

Case 1: Same Denominator

Add the numerators, keep the denominator same.

Example:

$3/7 + 2/7 = (3 + 2)/7 = 5/7$

Case 2: Different Denominators

Steps:

1. Find LCM of denominators
2. Convert to equivalent fractions
3. Add numerators

Example:

$1/4 + 1/6$

LCM of 4 and 6 = 12

$1/4 = 3/12$

$1/6 = 2/12$

Sum = $3/12 + 2/12 = 5/12$

B. Subtraction of Fractions

Example:

$5/6 - 1/4$

LCM of 6 and 4 = 12

$5/6 = 10/12$

$1/4 = 3/12$

Difference = $10/12 - 3/12 = 7/12$

C. Multiplication of Fractions

Multiply numerators and denominators directly.

Example:

$2/3 \times 5/7$

$= (2 \times 5) / (3 \times 7)$

$= 10/21$

D. Division of Fractions

To divide fractions, **multiply by the reciprocal**.

Example:

$4/5 \div 2/3$

$= 4/5 \times 3/2$

$= 12/10$

$= 6/5$ or $1\frac{1}{5}$

3. Decimals

Definition

A **decimal** is another way of writing fractions using a decimal point.

Example:

$1/10 = 0.1$

$1/100 = 0.01$

Types of Decimals

Terminating Decimals:

Decimals that end

Example: 0.5, 2.75

Recurring (Repeating) Decimals:

Decimals that repeat

Example: 0.333..., 1.666...

4. Operations with Decimals

A. Addition of Decimals

Steps:

1. Write numbers in columns
2. Align decimal points
3. Add normally

Example:

$2.45 + 1.7 = 4.15$

B. Subtraction of Decimals

Example:

$5.6 - 2.38$

Write as:

$5.60 - 2.38 = 3.22$

C. Multiplication of Decimals

Steps:

1. Multiply ignoring decimal points
2. Count total decimal places
3. Place decimal in answer

Example:

0.4×0.6

$4 \times 6 = 24$

Total decimal places = 2

Answer = 0.24

D. Division of Decimals

Ratio and Proportion

1. Introduction to Ratio and Proportion

What is a Ratio?

A ratio is a relationship between two quantities, indicating how many times the first number contains the second. It is expressed in the form:

$$\text{Ratio} = a/b = a : b$$

Where:

- a and b are two quantities
- The ratio $a : b$ represents how many times a is compared to b

Example of Ratio:

If there are 6 boys and 4 girls in a class, the ratio of boys to girls is:

$$6/4 = 6 : 4 \text{ or } 3 : 2$$

This means that for every 3 boys, there are 2 girls.

2. Types of Ratios

- **Simple Ratios:** Involves only two quantities
- **Compound Ratios:** Involves more than two quantities, e.g., the ratio of $a : b$ and $c : d$ is $a : b : c : d$

3. Proportion

A proportion is an equation that expresses the equality of two ratios. If two ratios are equal, they are said to be in proportion.

Formula for Proportion:

$$a/b = c/d$$

This means that the ratio of a to b is equal to the ratio of c to d. The quantities a, b, c, and d are said to be in proportion.

Example of Proportion:

If the ratio of boys to girls in two classes is the same, such as:

$$6/4 = 9/6$$

This is a proportion, as both ratios are equal, i.e., $3 : 2 = 3 : 2$.

4. Types of Proportion

A. Direct Proportion

In direct proportion, as one quantity increases, the other also increases, or as one decreases, the other decreases. In other words, the quantities change in the same direction.

Formula for Direct Proportion:

$$a/b = c/d$$

Where:

- a, b, c, d are in direct proportion if a increases as b increases and a decreases as b decreases

Example of Direct Proportion:

If a car travels 60 kilometers in 1 hour, how far will it travel in 4 hours?

Since distance and time are in direct proportion:

$$60/1 = x/4$$

Cross-multiply to find x:

$$60 \times 4 = x \times 1 \Rightarrow x = 240$$

So, the car will travel 240 kilometers in 4 hours.

B. Inverse Proportion

In inverse proportion, as one quantity increases, the other decreases, and vice versa. They change in opposite directions.

Formula for Inverse Proportion:

$$a/b = d/c$$

Where:

- a and b are in inverse proportion to c and d if a increases as b decreases, and a decreases as b increases

Example of Inverse Proportion:

If 5 workers can complete a task in 10 days, how long will it take for 10 workers to complete the same task?

Since the number of workers and time are in inverse proportion, we use the formula:

$$5 \times 10 = 10 \times x$$

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- Laboratory solution preparation
- C. Agriculture**

- Fertilizers and pesticides: precise chemical ratios
- Soil treatment mixtures

Practice Problems

1. Cost Mixing Problem

Problem:

A merchant wants to mix two types of cloth, one costing Rs. 200 per meter and the other costing Rs. 250 per meter, to make 100 meters of fabric worth Rs. 225 per meter. How much of each cloth should he use?

Solution:

Let x = amount of cloth at Rs. 200/meter

Let y = amount of cloth at Rs. 250/meter

We know: $x + y = 100$ (Equation 1)

Using allegation method:

$$(250 - 225) / (225 - 200) = 25/25 = 1$$

Thus, ratio = 1:1

Since ratio is 1:1 and $x + y = 100$:

$$x = y$$

$$x + x = 100$$

$$2x = 100$$

$$x = 50$$

$$y = 50$$

Answer:

- 50 meters of cloth at Rs. 200/meter
- 50 meters of cloth at Rs. 250/meter

2. Strength Mixing Problem

Problem:

A pharmacy has two medicine solutions: 30% concentration and 60% concentration. How many liters of each to make 40 liters of 50% concentration?

Solution:

Let x = liters of 30% solution

Let y = liters of 60% solution

We know: $x + y = 40$ (Equation 1)

Using allegation method:

$$(60 - 50) / (50 - 30) = 10/20 = 1/2$$

Thus, ratio = 1:2

Since total = 40 liters:

$$x = (1/3) \times 40 = 13.33 \text{ liters}$$

$$y = (2/3) \times 40 = 26.67 \text{ liters}$$

Answer:

- 13.33 liters of 30% solution
- 26.67 liters of 60% solution

3. Water and Milk Problem

Problem:

A milkman mixes 6 liters of milk with 4 liters of water. How much of this mixture should be used to make 15 liters of a mixture with 70% milk?

Solution:

Original mixture: 6 liters milk + 4 liters water = 10 liters total

$$\text{Milk percentage} = (6/10) \times 100 = 60\%$$

Final mixture: 15 liters with 70% milk

$$\text{Milk needed} = 70\% \text{ of } 15 = (70/100) \times 15 = 10.5 \text{ liters}$$

Let x = liters of original mixture needed

$$\text{Milk in } x \text{ liters} = 60\% \text{ of } x = 0.6x$$

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$$A = 1000 \times (1.1)^3$$

$$A = 1000 \times 1.331 = 1331$$

Answer: Rs. 1,331

Problem 12

A sum amounts to Rs. 2,420 in 2 years at 10% compound interest. Find the principal.

Solution:

$$P = A / (1 + R/100)^T$$

$$P = 2420 / (1 + 10/100)^2$$

$$P = 2420 / (1.1)^2$$

$$P = 2420 / 1.21 = 2000$$

Answer: Rs. 2,000

Percentage Applications in Banking and Finance

1. Introduction

Percentages are fundamental in finance, used for:

- Interest and loan calculations
- Investment returns and profit
- Taxes, fees, and discounts

Understanding percentages helps in making informed financial decisions.

2. Interest Rate Applications

A. Simple Interest in Loans and Investments

Calculated only on the principal amount.

Formula: Simple Interest (SI) = $(P \times R \times T) / 100$

Example 1:

Loan: Rs. 10,000 at 12% annual simple interest for 3 years.

$$SI = (10,000 \times 12 \times 3) / 100 = \text{Rs. } 3,600$$

Answer: Total interest = Rs. 3,600

B. Compound Interest in Savings and Investments

Calculated on principal plus accumulated interest.

Formula: Amount (A) = $P \times (1 + R/100)^T$

Example 2:

Investment: Rs. 5,000 at 6% p.a. for 4 years, compounded annually.

$$A = 5,000 \times (1 + 6/100)^4 = 5,000 \times 1.2625 = \text{Rs. } 6,312.50$$

Answer: Total amount = Rs. 6,312.50

3. Loan and Mortgage Payments

Equated Monthly Installment (EMI)

Fixed monthly payment for repaying a loan.

Formula (simplified version):

$$EMI = [P \times R \times (1+R)^T] / [(1+R)^T - 1]$$

Where R = monthly interest rate, T = tenure in months

Example 3:

Loan: Rs. 100,000 at 10% p.a. for 2 years.

$$\text{Monthly rate } R = 10 / (12 \times 100) = 0.00833$$

$$\text{Tenure } T = 2 \times 12 = 24 \text{ months}$$

Using the formula (with calculation):

$$EMI \approx \text{Rs. } 4,830.07$$

Answer: Monthly EMI $\approx$ Rs. 4,830

4. Investment Returns and Profit Calculations

Rate of Return (RoR)

Percentage gain or loss on an investment.

Formula: RoR = $(\text{Profit} / \text{Initial Investment}) \times 100$

Example 4:

Invest Rs. 50,000 in stock, value after 1 year = Rs. 60,000.

$$\text{Profit} = 60,000 - 50,000 = \text{Rs. } 10,000$$

ALGEBRA

Algebraic Expressions and Identities

1. Introduction to Algebraic Expressions

An **algebraic expression** is a combination of numbers, variables, and arithmetic operations (addition, subtraction, multiplication, division, etc.). It does not have an equality sign.

Example:

$2x + 3$, $4a^2 - 5a + 6$, and $3y^2 - 7y + 2$ are algebraic expressions.

Components of an Algebraic Expression:

- **Variables:** Letters representing unknown quantities (e.g., x , y , a).
- **Coefficients:** Numbers multiplying the variables (e.g., in $2x$, the coefficient is 2).
- **Constants:** Numbers that do not change (e.g., in $2x + 3$, the constant is 3).
- **Operators:** Mathematical operations ($+$, $-$, $\times$, $\div$).

2. Types of Algebraic Expressions

A. Monomial – One term.

Example: $4x$, $7y^2$, $-3a$.

B. Binomial – Two terms.

Example: $2x + 3$, $5a - 4b$, $x^2 + y^2$.

C. Trinomial – Three terms.

Example: $x^2 + 2x + 1$, $3a^2 + 5a + 7$.

D. Polynomial – More than one term.

Example: $2x^3 + 3x^2 - 5x + 6$.

3. Basic Operations on Algebraic Expressions

A. Addition of Algebraic Expressions

Combine like terms (terms with the same variables raised to the same powers).

Example 1: Add $3x + 5$ and $2x - 4$.

$$(3x + 5) + (2x - 4) = (3x + 2x) + (5 - 4) = 5x + 1$$

B. Subtraction of Algebraic Expressions

Subtract like terms.

Example 2: Subtract $4x + 7$ from $6x - 3$.

$$(6x - 3) - (4x + 7) = (6x - 4x) + (-3 - 7) = 2x - 10$$

C. Multiplication of Algebraic Expressions

Multiply each term in the first expression by each term in the second expression.

Example 3: Multiply $(2x + 3)$ and $(x - 4)$.

$$(2x + 3)(x - 4) = 2x(x) + 2x(-4) + 3(x) + 3(-4) \\ = 2x^2 - 8x + 3x - 12 = 2x^2 - 5x - 12$$

D. Division of Algebraic Expressions

Divide each term in the numerator by the denominator.

Example 4: Divide $4x^2 + 6x$ by $2x$.

$$(4x^2 + 6x) \div (2x) = (4x^2)/(2x) + (6x)/(2x) = 2x + 3$$

4. Algebraic Identities

Algebraic identities are equations that hold true for all values of the variables.

A. Square of a Binomial

$$(a + b)^2 = a^2 + 2ab + b^2$$

Example 5: Expand $(x + 3)^2$.

$$(x + 3)^2 = x^2 + 2(x)(3) + 3^2 = x^2 + 6x + 9$$

B. Difference of Squares

$$a^2 - b^2 = (a + b)(a - b)$$

Example 6: Factor $x^2 - 16$.

$$x^2 - 16 = (x + 4)(x - 4)$$

C. Square of a Binomial (Negative Sign)

$$(a - b)^2 = a^2 - 2ab + b^2$$

Example 7: Expand $(x - 4)^2$.

$$(x - 4)^2 = x^2 - 2(x)(4) + 4^2 = x^2 - 8x + 16$$

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Algebra Word Problems

1. Age Problems

Age problems are a common type of algebra word problem where relationships between the ages of two or more people are given, and you are asked to find their ages at different points in time (present, past, or future). These problems require setting up equations based on the given relationships.

General Steps to Solve Age Problems:

1. **Define variables:** Assign variables for the unknowns (usually ages). For example, if finding the current age of two people, let x represent the age of person A, and y represent the age of person B.
2. **Translate the information into equations:** Use the relationships in the problem to form algebraic equations. This may involve relationships like "in 5 years," "10 years ago," or "three times as old."
3. **Solve the system of equations:** Use algebraic methods such as substitution or elimination.
4. **Check the solution:** Verify that the found ages satisfy all conditions in the problem.

Types of Age Problems:

1.1 Simple Age Difference

These problems involve a simple difference in the ages of two people.

- **Example:** John is 5 years older than Jane. If Jane's current age is x , express John's age in terms of x .
- **Solution:** Let Jane's age be x . John's age is $x + 5$.

1.2 Age Difference at a Given Time

These problems give the relationship between ages at a specific point in the past or future.

- **Example:** John is currently 5 years older than Jane. In 10 years, John will be twice as old as Jane. How old are they now?
- **Solution:**
 - Let Jane's current age be x .
 - John's current age is $x + 5$.
 - In 10 years: Jane's age = $x + 10$, John's age = $(x + 5) + 10 = x + 15$.
 - Equation for 10 years in the future: $x + 15 = 2(x + 10)$.
 - Solve:

$$\begin{aligned} x + 15 &= 2x + 20 \\ 15 - 20 &= 2x - x \\ -5 &= x \end{aligned}$$

- Result: $x = -5$ (This set of conditions yields no valid age).

1.3 Sum of Ages

These problems involve the sum of the ages of two or more people.

- **Example:** The sum of the ages of John and Jane is 60. John is 10 years older than Jane. What are their ages?
- **Solution:**
 - Let Jane's age be x .
 - John's age is $x + 10$.
 - Equation for the sum: $x + (x + 10) = 60$.
 - Solve:

$$\begin{aligned} 2x + 10 &= 60 \\ 2x &= 50 \\ x &= 25 \end{aligned}$$

- Result: Jane is 25, John is $25 + 10 = 35$.

1.4 Age Multiplication (One Age is a Multiple of Another)

These problems state that one person's age is a multiple of another's, often in the past or future.

- **Example:** Five years ago, Peter was three times as old as Paul. Now, Peter is 10 years older than Paul. How old are they now?
- **Solution:**
 - Let Paul's current age be x .
 - Peter's current age is $x + 10$.
 - Five years ago: Paul's age = $x - 5$, Peter's age = $(x + 10) - 5 = x + 5$.
 - Equation for five years ago: $x + 5 = 3(x - 5)$.

Function

1. Introduction to Functions

A **function** is a relationship or mapping between two sets, such that each element in the first set (called the **domain**) is related to **exactly one** element in the second set (called the **codomain**). In other words, a function assigns a unique output to each input from the domain.

Notation: A function f from set A (domain) to set B (codomain) is written as:

$$f: A \rightarrow B$$

If $x \in A$ is mapped to $y \in B$, we write $f(x) = y$.

2. Components of a Function

- **Domain:** The set of all possible **inputs** for the function.
- **Codomain:** The set of all possible **outputs** the function can produce.
- **Range:** The set of all **actual outputs** produced by the function. The range is a **subset** of the codomain.
- **Mapping:** The rule or relationship that connects each element of the domain to an element in the codomain.

3. Types of Functions

3.1. One-to-One Function (Injective Function)

A function $f: A \rightarrow B$ is **one-to-one** (or **injective**) if **different elements** of the domain A map to **different elements** in the codomain B .

Formally: If $f(x_1) = f(x_2)$, then $x_1 = x_2$.

Example: $f(x) = 2x$ is injective because different inputs yield different outputs.

3.2. Onto Function (Surjective Function)

A function $f: A \rightarrow B$ is **onto** (or **surjective**) if **every element** in the codomain B is the image of at least one element in the domain A . The **range equals the codomain**.

Example: $f(x) = x^2$ from $A = \{1, 2, 3\}$ to $B = \{1, 4, 9\}$ is surjective.

3.3. One-to-One Correspondence (Bijective Function)

A function is **bijective** if it is **both injective and surjective**. There is a perfect "pairing" between the elements of the domain and the codomain.

Example: $f(x) = x + 1$ from $A = \{1, 2, 3\}$ to $B = \{2, 3, 4\}$ is bijective.

3.4. Constant Function

A **constant function** always produces the **same output**, regardless of the input.

Example: $f(x) = 5$ for all x .

3.5. Identity Function

The **identity function** maps every element of the domain to **itself**.

Notation: **I** or **id_A**. Formally: $I(x) = x$ for all $x \in A$.

Example: $I: \mathbb{R} \rightarrow \mathbb{R}, I(x) = x$.

4. Function Operations

4.1. Function Composition

Combines two functions to form a new function. If $f: A \rightarrow B$ and $g: B \rightarrow C$, the composition $g \circ f$ is defined as:

$$(g \circ f)(x) = g(f(x))$$

Example: If $f(x) = 2x$ and $g(x) = x + 1$, then $(g \circ f)(x) = g(f(x)) = g(2x) = 2x + 1$.

4.2. Arithmetic Operations on Functions

For functions $f(x)$ and $g(x)$ with compatible domains:

- **Addition:** $(f + g)(x) = f(x) + g(x)$
- **Subtraction:** $(f - g)(x) = f(x) - g(x)$
- **Multiplication:** $(f \cdot g)(x) = f(x) \cdot g(x)$
- **Division:** $(f / g)(x) = f(x) / g(x)$, provided $g(x) \neq 0$

5. Domain and Range of a Function

- **Domain:** The set of all possible **input** values (x) for which the function is defined.
Example: For $f(x) = 1/x$, the domain is $\mathbb{R} \setminus \{0\}$ (all real numbers except 0).
- **Range:** The set of all possible **output** values ($f(x)$).
Example: For $f(x) = x^2$, the range is $[0, \infty)$ (all non-negative real numbers).

6. Inverse Functions

GEOMETRY

A. Plane Geometry

• Lines and Angles (Properties, Theorems)

1. Basic Definitions

- **Point:** A location in space with no dimensions (no length, width, or height).
- **Line:** A straight one-dimensional figure that extends infinitely in both directions. It has no width or thickness but has length.
- **Line Segment:** A part of a line that has two distinct endpoints.
- **Ray:** A part of a line that starts at a point (called the origin) and extends infinitely in one direction.
- **Angle:** The figure formed by two rays (called the sides of the angle) sharing a common endpoint (called the vertex).
- **Collinear Points:** Points that lie on the same straight line.
- **Coplanar Points:** Points that lie on the same plane.

1. Point



A location in space with no dimensions (no length, width, or height).

2. Line



A straight one-dimensional figure that extends infinitely in both directions. It has no width or thickness but has length.

3. Line Segment



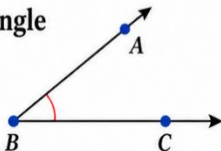
A part of a line that has two distinct endpoints.

4. Ray



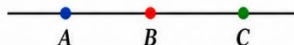
A part of a line that starts at a point (called the origin) and extends infinitely in one direction.

5. Angle



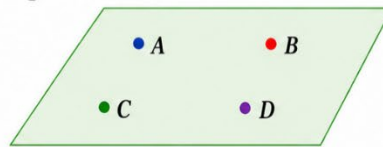
The figure formed by two rays (called the sides of the angle) sharing a common endpoint (called the vertex).

6. Collinear Points



Points that lie on the same straight line.

7. Coplanar Points



Points that lie on the same plane.

Length, Congruence, Midpoints, and Bisectors

The distance between A and B is a non-negative number denoted by AB . The segment itself is an object, while AB commonly denotes its numerical length. Two segments are **congruent** when they have equal lengths.

Segment Addition Postulate: If B lies between A and C, then

$$AB + BC = AC.$$

A **midpoint** divides a segment into two congruent segments. If M is the midpoint of AB , then $AM = MB$ and each equals $AB/2$. A **segment bisector** is any point, line, ray, segment, or plane that passes through the midpoint of a segment.

Solved Example 1: Segment Addition

Problem. B lies between A and C. If $AB = 3x - 2$, $BC = x + 6$, and $AC = 24$, find x , AB , and BC .

Solution.

1. Apply segment addition: $AB + BC = AC$.
2. Substitute: $(3x - 2) + (x + 6) = 24$.
3. Simplify: $4x + 4 = 24$, hence $x = 5$.
4. $AB = 3(5) - 2 = 13$ and $BC = 5 + 6 = 11$.
5. Check: $13 + 11 = 24$.

Answer: $x = 5$, $AB = 13$ units, $BC = 11$ units.

Solved Example 2: Midpoint Algebra

Problem. M is the midpoint of PQ . $PM = 4y - 7$ and $MQ = 2y + 5$. Find y and PQ .



Solution:

1. **Semi-perimeter (s)** $= (a + b + c)/2 = (7 + 8 + 9)/2 = 12 \text{ cm}$
2. **Heron's Formula:** $\text{Area} = \sqrt{[s(s - a)(s - b)(s - c)]}$
 $= \sqrt{[12 \times (12 - 7) \times (12 - 8) \times (12 - 9)]}$
 $= \sqrt{[12 \times 5 \times 4 \times 3]}$
 $= \sqrt{(720)} \approx 26.83 \text{ cm}^2$

Answer:

The area is approximately **26.83 cm²**.

Problem 7: Triangle Perimeter

Question:

Find the perimeter of an equilateral triangle with a side length of 12 cm.

Solution:

Perimeter of an equilateral triangle $= 3 \times \text{side length}$
 $= 3 \times 12 \text{ cm}$
 $= 36 \text{ cm}$

Answer:

The perimeter is **36 cm**.

Problem 8: Triangle Congruence - SAS Criterion

Question:

In two triangles $\triangle PQR$ and $\triangle XYZ$, the following information is given:

$PQ = XY = 7 \text{ cm}$,
 $QR = YZ = 10 \text{ cm}$,
 $\angle Q = \angle Y = 60^\circ$.

Are the two triangles congruent? Justify your answer using the SAS criterion.

Solution:

The side $PQ = XY = 7 \text{ cm}$ and $QR = YZ = 10 \text{ cm}$ are equal.

The included angle $\angle Q = \angle Y = 60^\circ$ is the same.

Since **two sides and the included angle are equal**, by the **SAS (Side-Angle-Side) Congruence Criterion**, the triangles are congruent.

Answer:

Yes, $\triangle PQR \cong \triangle XYZ$ by **SAS Congruence**.

Problem 9: Similarity of Triangles - SSS Criterion

Question:

Two triangles $\triangle ABC$ and $\triangle DEF$ have the following side lengths:

$AB = 6 \text{ cm}$, $BC = 8 \text{ cm}$, $AC = 10 \text{ cm}$,
 $DE = 9 \text{ cm}$, $EF = 12 \text{ cm}$, $DF = 15 \text{ cm}$.

Are the triangles similar? Justify your answer.

Solution:

Check if corresponding sides are proportional:

$AB/DE = 6/9 = 2/3$,
 $BC/EF = 8/12 = 2/3$,
 $AC/DF = 10/15 = 2/3$.

Since all ratios are equal, the corresponding sides are proportional.

By the **SSS (Side-Side-Side) Similarity Criterion**, the triangles are similar.

Answer:

Yes, $\triangle ABC \sim \triangle DEF$ by **SSS Similarity**.

Problem 10: Pythagoras Theorem - Find the Hypotenuse

Question:

In a right-angled triangle, one leg is 15 cm, and the other leg is 20 cm. Find the length of the hypotenuse.

Solution:

Using the **Pythagoras Theorem**: $c^2 = a^2 + b^2$, where $a = 15 \text{ cm}$, $b = 20 \text{ cm}$.

$c^2 = 15^2 + 20^2 = 225 + 400 = 625$

$c = \sqrt{625} = 25 \text{ cm}$.

Quadrilaterals

A **quadrilateral** is a polygon with four sides, four vertices, and four angles. The sum of the interior angles of any quadrilateral is 360° .

Properties of Quadrilaterals

General Properties of Quadrilaterals:

- Four sides and four angles.
- Sum of interior angles = 360° .
- Opposite sides may or may not be parallel.
- Diagonals may or may not bisect each other at right angles.

Types of Quadrilaterals:

1. **Square:**
 - All sides are equal.
 - All angles are 90° .
 - Opposite sides are parallel.
 - Diagonals are equal in length and bisect each other at 90° .
2. **Rectangle:**
 - Opposite sides are equal.
 - All angles are 90° .
 - Opposite sides are parallel.
 - Diagonals are equal in length and bisect each other.
3. **Rhombus:**
 - All sides are equal.
 - Opposite angles are equal.
 - Opposite sides are parallel.
 - Diagonals bisect each other at right angles but are **not equal** in length.
4. **Parallelogram:**
 - Opposite sides are equal and parallel.
 - Opposite angles are equal.
 - Diagonals bisect each other.
 - Adjacent angles are supplementary (sum to 180°).
5. **Trapezium (Trapezoid in the US):**
 - Only **one pair** of opposite sides is parallel.
 - The non-parallel sides are called legs.
 - The angles between each leg and the parallel sides are supplementary.
6. **Kite:**
 - Two distinct pairs of **adjacent sides** are equal.
 - The diagonals intersect at right angles.
 - One diagonal bisects the other.
 - One pair of opposite angles is equal (the angles between the unequal sides).

Special Properties of Diagonals:

- In **square, rectangle, and parallelogram**, diagonals bisect each other.
- In a **kite**, one diagonal bisects the other at right angles.
- In a **rhombus**, diagonals bisect at right angles and are not equal in length.
- In a **trapezium**, diagonals are not necessarily equal and may intersect at an oblique angle.

Area Formulas for Quadrilaterals

Shape	Area Formula	Perimeter Formula
Square	Area = a^2 where a is the side length.	Perimeter = $4a$
Rectangle	Area = $l \times b$ where l is length and b is breadth.	Perimeter = $2(l + b)$
Rhombus	Area = $(1/2) \times d_1 \times d_2$ where d_1 and d_2 are the diagonals.	Perimeter = $4a$ where a is the side length.

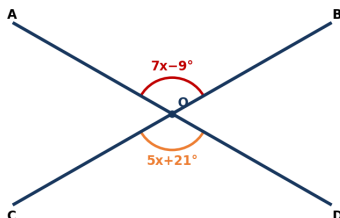
3. $8x + 4 = 180$, so $8x = 176$ and $x = 22$.

4. $\angle AOC = 3(22) + 15 = 81^\circ$; $\angle COB = 5(22) - 11 = 99^\circ$.

Final answer: $x = 22$; angles 81° and 99°

Problem 2. Vertically opposite angles

Question. Two straight lines intersect at O. The vertically opposite angles are labeled $7x - 9^\circ$ and $5x + 21^\circ$. Find x and the four angles around O.



Complete solution

1. Vertically opposite angles are equal.

2. $7x - 9 = 5x + 21$

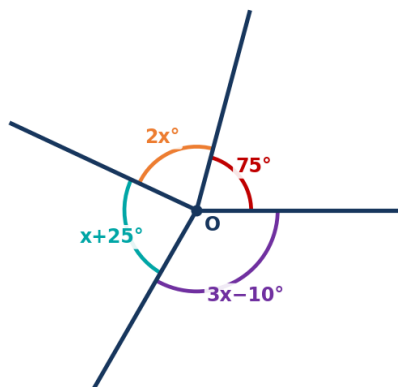
3. $2x = 30$, so $x = 15$.

4. Each labeled angle is 96° . Each adjacent angle is $180^\circ - 96^\circ = 84^\circ$.

Final answer: $x = 15$; angles alternate $96^\circ, 84^\circ, 96^\circ, 84^\circ$

Problem 3. Angles around a point

Question. Four angles around O are 75° , $2x^\circ$, $(x + 25)^\circ$, and $(3x - 10)^\circ$. Find x and all unknown angles.



Complete solution

1. Angles around a point total 360° .

2. $75 + 2x + (x + 25) + (3x - 10) = 360$

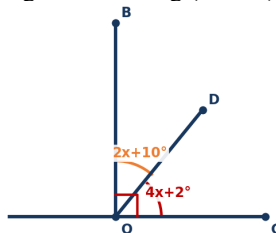
3. $6x + 90 = 360$, so $x = 45$.

4. The angles are 75° , 90° , 70° , and 125° .

Final answer: $x = 45$; unknown angles $90^\circ, 70^\circ, 125^\circ$

Problem 4. Complementary angles inside a right angle

Question. A right angle is divided into two angles measuring $(4x + 2)^\circ$ and $(2x + 10)^\circ$. Find x and the two angles.



Complete solution

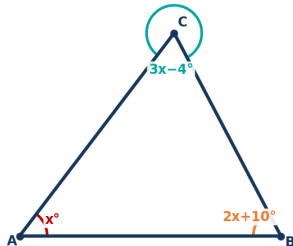
1. The two angles are complementary, so their sum is 90° .

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Problem 20. Algebraic triangle angles

Question. The three angles of a triangle are x° , $(2x + 10)^\circ$, and $(3x - 4)^\circ$. Find x and all angles.



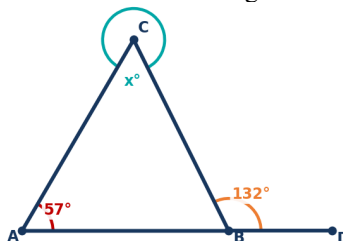
Complete solution

- $x + (2x + 10) + (3x - 4) = 180$
- $6x + 6 = 180$, so $x = 29$.
- Angles: 29° , 68° , and 83° .

Final answer: $x = 29$; angles 29° , 68° , 83°

Problem 21. Exterior angle theorem

Question. An exterior angle at B is 132° , and the remote interior angle at A is 57° . Find $\angle C$.



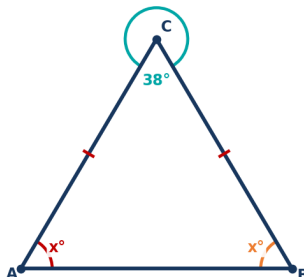
Complete solution

- Exterior angle = sum of the two remote interior angles.
- $132 = 57 + \angle C$
- $\angle C = 75^\circ$.

Final answer: 75°

Problem 22. Isosceles base angles

Question. In isosceles triangle ABC, $AC = BC$ and $\angle C = 38^\circ$. Find $\angle A$ and $\angle B$.



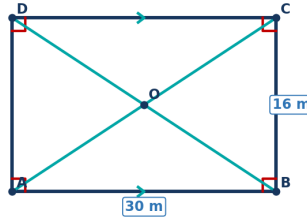
Complete solution

- Equal sides have equal opposite angles, so $\angle A = \angle B$.
- $\angle A + \angle B = 180^\circ - 38^\circ = 142^\circ$.
- Each base angle is 71° .

Final answer: $\angle A = \angle B = 71^\circ$

Problem 42. Distance across a rectangular field

Question. A rectangular field is 30 m long and 16 m wide. Find the straight-line distance from one corner to the opposite corner.



Complete solution

- $d^2 = 30^2 + 16^2 = 900 + 256 = 1156$
- $d = 34$ m.

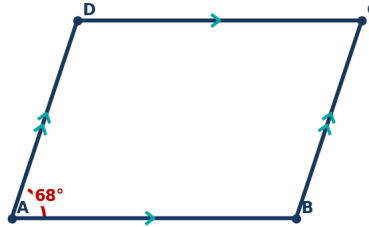
Final answer: 34 m

Section 5 — Quadrilaterals and Polygon Drawings

Use the named figure as information. A parallelogram, rectangle, rhombus, kite, trapezoid, or regular polygon carries built-in properties even when they are not written beside the diagram.

Problem 43. Opposite angles in a parallelogram

Question. In parallelogram ABCD, $\angle A = 68^\circ$. Find $\angle B$, $\angle C$, and $\angle D$.



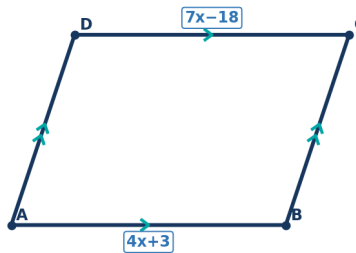
Complete solution

- Opposite angles are equal: $\angle C = 68^\circ$.
- Adjacent angles are supplementary: $\angle B = \angle D = 180^\circ - 68^\circ = 112^\circ$.

Final answer: $\angle B = 112^\circ$, $\angle C = 68^\circ$, $\angle D = 112^\circ$

Problem 44. Algebraic opposite sides

Question. In a parallelogram, $AB = 4x + 3$ and $CD = 7x - 18$. Find x and the common length.



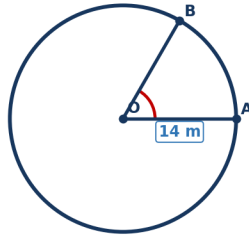
Complete solution

- Opposite sides of a parallelogram are equal.
- $4x + 3 = 7x - 18$
- $3x = 21$, $x = 7$.
- Length = 31 units.

Final answer: $x = 7$; $AB = CD = 31$ units

Problem 64. Circumference from diameter

Question. A circular track has diameter 28 m. Find its circumference using $\pi=22/7$.



Complete solution

1. $C = \pi d = (22/7) \times 28 = 88$ m.

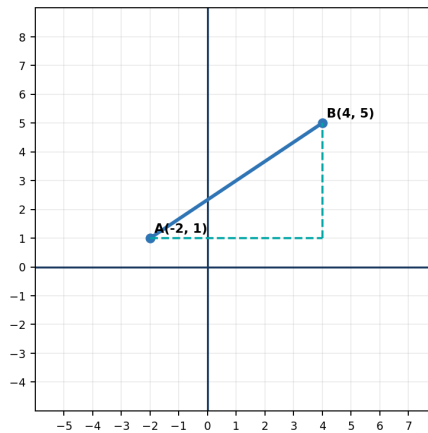
Final answer: 88 m

Section 7 — Coordinate Drawings and Transformations

Coordinate diagrams convert geometric structure into numerical changes in x and y. Use the grid to verify signs, direction, scale, and orientation.

Problem 65. Distance between two plotted points

Question. Find the distance between A(-2,1) and B(4,5).



Complete solution

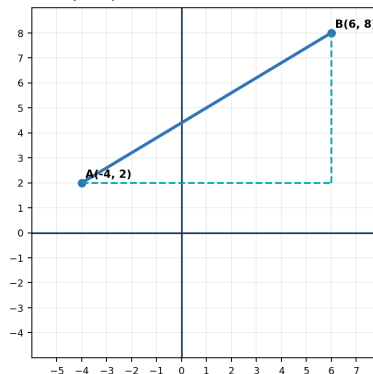
1. Horizontal change=6 and vertical change=4.

2. Distance = $\sqrt{6^2 + 4^2} = \sqrt{52} = 2\sqrt{13}$.

Final answer: $2\sqrt{13}$ units

Problem 66. Midpoint of a segment

Question. Find the midpoint of A(-4,2) and B(6,8).



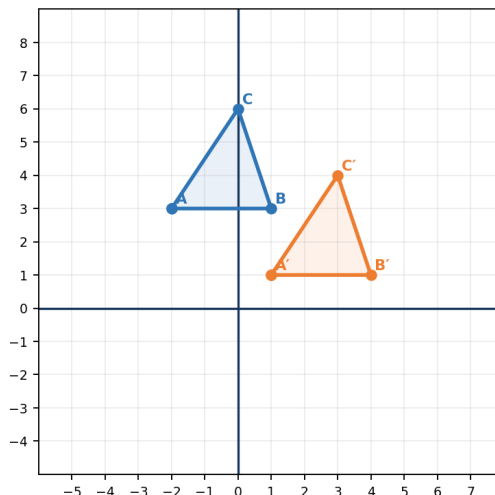
Complete solution

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Problem 71. Translation of a polygon

Question. Translate triangle ABC by vector $(3, -2)$, where $A(-2, 3)$, $B(1, 3)$, $C(0, 6)$.



Complete solution

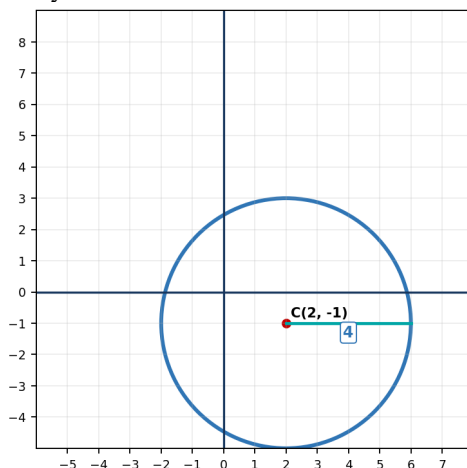
1. Add 3 to each x-coordinate and subtract 2 from each y-coordinate.

2. $A'=(1, 1)$, $B'=(4, 1)$, $C'=(3, 4)$.

Final answer: $A'(1, 1)$, $B'(4, 1)$, $C'(3, 4)$

Problem 72. Center and radius from circle equation

Question. For $(x-2)^2+(y+1)^2=16$, identify the center and radius.



Complete solution

1. Standard form is $(x-h)^2+(y-k)^2=r^2$.

2. $h=2$, $k=-1$, and $r=4$.

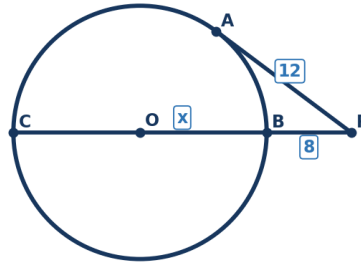
Final answer: Center $(2, -1)$; radius 4

Section 8 — Composite Drawings, Mensuration and Solid Structures

For composite figures, split the diagram into familiar components. For solids, identify which dimensions control volume and which surfaces contribute to total area.

Problem 91. Challenge: tangent-secant power

Question. A tangent from P has length 12. A secant from P has external part 8 and total length x. Find x.



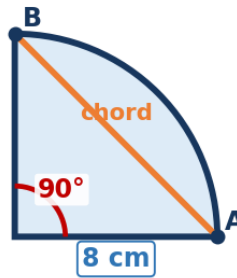
Complete solution

1. Power theorem: $\text{tangent}^2 = \text{external secant} \times \text{whole secant}$.
2. $12^2 = 8x$
3. $144 = 8x$, $x = 18$.

Final answer: 18 units

Problem 92. Challenge: sector minus triangle

Question. A 90° sector has radius 8 cm. A right isosceles triangle is formed by the two radii and chord. Find the area between the arc and chord.



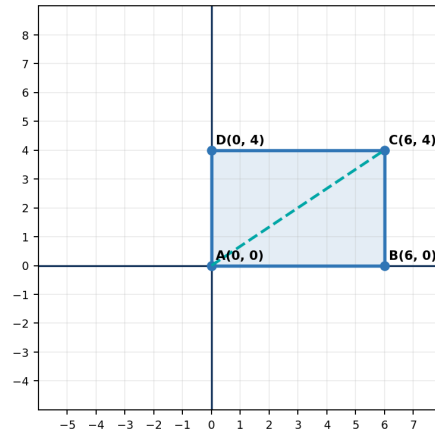
Complete solution

1. Sector area $= \frac{90}{360} \times \pi \times 8^2 = 16\pi$.
2. Triangle area $= \frac{1}{2} \times 8 \times 8 = 32$.
3. Segment area $= 16\pi - 32 \text{ cm}^2$.

Final answer: $16\pi - 32 \text{ cm}^2$

Problem 93. Challenge: coordinate diagonal classification

Question. Quadrilateral vertices are A(0,0), B(6,0), C(6,4), D(0,4). Use the drawing to classify the quadrilateral and find diagonal AC.



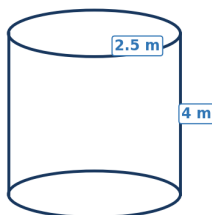
Complete solution

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Problem 100. Challenge: cylinder capacity

Question. A cylindrical water tank has radius 2.5 m and height 4 m. Find its capacity in cubic meters and liters.



Complete solution

1. $V = \pi r^2 h = \pi (2.5^2)(4) = 25\pi \text{ m}^3$.

2. Since $1 \text{ m}^3 = 1000 \text{ L}$, capacity $= 25,000\pi \text{ L} \approx 78,540 \text{ L}$.

Final answer: $25\pi \text{ m}^3$; $25,000\pi \text{ L}$ ($\approx 78,540 \text{ L}$)

Formulas to Remember

Concept	Formula
Triangle angle sum	$A+B+C=180^\circ$
Polygon interior sum	$(n-2) \times 180^\circ$
Regular exterior angle	$360^\circ/n$
Pythagoras	$a^2+b^2=c^2$
Triangle area	$1/2 bh$
Trapezoid area	$1/2(a+b)h$
Circle circumference	$2\pi r = \pi d$
Circle area	πr^2
Arc length	$(\theta/360^\circ) \times 2\pi r$
Sector area	$(\theta/360^\circ) \times \pi r^2$
Distance formula	$\sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$
Midpoint	$((x_1+x_2)/2, (y_1+y_2)/2)$
Slope	$(y_2-y_1)/(x_2-x_1)$
Cuboid volume	lwh
Cylinder volume	$\pi r^2 h$

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$$\begin{aligned}\sin(\theta/2) &= \pm\sqrt{(1 - \cos \theta)/2} \\ \cos(\theta/2) &= \pm\sqrt{(1 + \cos \theta)/2} \\ \tan(\theta/2) &= \pm\sqrt{(1 - \cos \theta)/(1 + \cos \theta)} \\ &= \sin \theta / (1 + \cos \theta) \\ &= (1 - \cos \theta) / \sin \theta\end{aligned}$$

6. Sum and Difference Identities

Sum Identities:

$$\begin{aligned}\sin(A + B) &= \sin A \cos B + \cos A \sin B \\ \cos(A + B) &= \cos A \cos B - \sin A \sin B \\ \tan(A + B) &= (\tan A + \tan B) / (1 - \tan A \tan B)\end{aligned}$$

Difference Identities:

$$\begin{aligned}\sin(A - B) &= \sin A \cos B - \cos A \sin B \\ \cos(A - B) &= \cos A \cos B + \sin A \sin B \\ \tan(A - B) &= (\tan A - \tan B) / (1 + \tan A \tan B)\end{aligned}$$

7. Values of Trigonometric Ratios for Standard Angles

Angle (θ)	$\sin \theta$	$\cos \theta$	$\tan \theta$	$\csc \theta$	$\sec \theta$	$\cot \theta$
0°	0	1	0	∞	1	∞
30°	$1/2$	$\sqrt{3}/2$	$1/\sqrt{3}$	2	$2/\sqrt{3}$	$\sqrt{3}$
45°	$\sqrt{2}/2$	$\sqrt{2}/2$	1	$\sqrt{2}$	$\sqrt{2}$	1
60°	$\sqrt{3}/2$	$1/2$	$\sqrt{3}$	$2/\sqrt{3}$	2	$1/\sqrt{3}$
90°	1	0	∞	1	∞	0

Note: ∞ denotes undefined (approaches infinity).

B. Applications of Trigonometry

Trigonometry has a wide range of applications, from real-world problems involving heights and distances to solving equations. Below, we will discuss some of the key applications of trigonometry, such as solving height and distance problems and working with simple trigonometric equations.

1. Height and Distance Problems

Height and distance problems involve finding the height of an object or the distance between two points using angles and lengths in right-angled triangles. These problems are common in surveying, navigation, and architecture.

Key Concepts

- **Line of Sight:** The straight line from an observer's eye to an object.
- **Angle of Elevation:** The angle between the horizontal line of sight and the line of sight to an object **above** the observer.
- **Angle of Depression:** The angle between the horizontal line of sight and the line of sight to an object **below** the observer.

Typical Problem Setup

A right-angled triangle is formed where:

- The angle of elevation or depression is given.
- One side (height or distance) is known.
- The other side is to be found.

Formulae for Solving Height and Distance Problems

To Find	Formula
Height	Height = Distance $\times$ $\tan \theta$
Distance	Distance = Height / $\tan \theta$
Angle	$\theta = \tan^{-1}(\text{Height} / \text{Distance})$

(θ is the angle of elevation or depression)

Example Problem

A person is standing 50 m away from the base of a tower. The angle of elevation to the top of the tower is 30° . Find the height of the tower.

Solution:

Given: Distance = 50 m, $\theta = 30^\circ$

Height = $50 \times \tan 30^\circ$

$$= 50 \times (1/\sqrt{3})$$

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Statistics

Statistics is a branch of mathematics that deals with **collecting, analyzing, interpreting, presenting, and organizing data**. It helps us understand **trends and patterns** in data. Three important concepts in statistics are the **Mean, Median, and Mode**. Let's break these down in more detail to understand them clearly.

1. Mean (Arithmetic Mean)

Definition:

The **mean**, often called the **average**, is one of the most commonly used **measures of central tendency**. It gives us a summary of the data by telling us where the **center** of the data is.

To calculate the mean, we **add up all the numbers** in the data set and **divide the sum** by the **total number of numbers** in the set.

Formula:

$$\text{Mean} = (\Sigma x_i) / n$$

Where:

x_i = individual data points

n = total number of data points in the set

How to Calculate:

1. **Add** all the numbers in the data set.
2. **Divide** the sum by the **number of data points**.

Example 1:

For the data set {10, 12, 14, 16, 18}:

• Add the numbers: $10 + 12 + 14 + 16 + 18 = 70$

• There are **5** numbers, so divide the sum by 5: $70 / 5 = 14$

Thus, the **mean is 14**.

Properties of Mean:

- **Sensitive to outliers:** The mean can be heavily affected by very large or very small numbers (**outliers**) in the data.
- **Useful for normal (bell-shaped) distributions:** The mean is a good measure for data that is evenly spread out.

2. Median

Definition:

The **median** is the **middle number** in a data set when the numbers are arranged in **order from smallest to largest** (or largest to smallest). If there is an **odd** number of data points, the median is the middle one. If there is an **even** number, the median is the **average of the two middle numbers**.

The median is **less affected by extreme values or outliers** compared to the mean.

How to Calculate:

1. **Arrange the data** in increasing (ascending) or decreasing (descending) order.
2. If the number of data points is **odd**, the median is the **middle number**.
3. If the number of data points is **even**, the median is the **average of the two middle numbers**.

Example 2:

For the data set {7, 3, 9, 2, 4}:

• Arrange in order: {2, 3, 4, 7, 9}

• The middle number (3rd number) is **4**, so the **median is 4**.

For the data set {1, 2, 3, 4, 5, 6}:

• Arrange in order: {1, 2, 3, 4, 5, 6}

• The two middle numbers are **3 and 4**.

• The median is the average: $(3 + 4) / 2 = 3.5$.

Properties of Median:

- **Less affected by outliers:** Extreme values do not affect the median as much as the mean.
- **Works well for skewed data:** The median gives a better central value when data is not evenly distributed.

3. Mode

Definition:

The **mode** is the value that appears **most frequently** in a data set. A data set can have:

- **One mode (unimodal)**
- **Two modes (bimodal)**

Data interpretation involves extracting meaningful information from various forms of data presentation, such as **tables**, **bar graphs**, **pie charts**, and **line graphs**. These methods are essential for visualizing data, making it easier to understand patterns, trends, and comparisons.

1. Tables

A **table** organizes data in rows and columns, making it easy to view and compare different categories or variables.

How to Interpret a Table:

- **Look at the headings:** Rows represent one variable, and columns represent another. Each cell contains a specific data point.
- **Compare values:** Look for patterns, trends, or anomalies. For example, identify the highest or lowest value, or compare values across different categories or time periods.

Example Table:

Month	Sales (in thousands)	Profit (in thousands)
January	50	10
February	60	15
March	70	20
April	80	25
May	90	30

Interpretation:

- Sales increase every month from January to May.
- Profit also increases, indicating that the company is improving its profitability as sales rise.
- The relationship between sales and profit is directly proportional.

2. Bar Graphs

A **bar graph** (or bar chart) uses rectangular bars to represent data. The length or height of the bar is proportional to the value it represents.

How to Interpret a Bar Graph:

- **Identify the variables:** The x-axis typically shows categories (e.g., months, products), and the y-axis shows the values (e.g., sales, revenue).
- **Compare the bars:** The longer the bar, the higher the value. Bar graphs are useful for comparing quantities across different categories.
- **Look for trends:** Identify patterns, such as which category has the highest or lowest value.

Example Bar Graph:

(Imagine a bar graph with months on the x-axis and sales on the y-axis. Bars for January to May show increasing heights.)

Interpretation:

- The tallest bar represents May, which has the highest sales, while January has the shortest bar (lowest sales).
- The graph clearly shows the monthly progression of sales.

3. Pie Charts

A **pie chart** is a circular chart divided into slices, where each slice represents a category's proportion of the total.

How to Interpret a Pie Chart:

- **Look at the slices:** Each slice represents a different category, and the size of the slice is proportional to its percentage of the total.
- **Identify the largest and smallest slices:** The largest slice indicates the most significant category, while the smallest slice represents the least significant.
- **Compare percentages:** Add up the percentages to check for consistency (they should sum up to 100%).

Example Pie Chart:

(Imagine a pie chart with four slices: Product A = 40%, Product B = 30%, Product C = 25%, Product D = 5%.)

Interpretation:

- The chart shows that 40% of total sales come from Product A, while Product D contributes only 5%.
- The chart helps understand the distribution of sales across different products.

4. Line Graphs

$$S_n = n \cdot a$$

Example 2:

Find the **6th term** and the **sum of the first 6 terms** of a GP where $a = 2$ and $r = 3$.

Solution:

- 6th term:

$$T_6 = 2 \cdot 3^{6-1} = 2 \cdot 3^5 = 2 \cdot 243 = 486$$
- Sum of first 6 terms:

$$S_6 = 2 \cdot (1 - 3^6) / (1 - 3) = 2 \cdot (1 - 729) / (-2) = 2 \cdot (-728) / (-2) = 728$$

3. Summary of Key Concepts

Concept	Formula	When to Use
Arithmetic Progression (AP)	$T_n = a + (n - 1) \cdot d$	Sequences with constant difference between terms
Sum of AP	$S_n = (n/2) \cdot [2a + (n - 1) \cdot d]$	Sum of the first n terms of an AP
Geometric Progression (GP)	$T_n = a \cdot r^{n-1}$	Sequences with constant ratio between terms
Sum of GP ($r \neq 1$)	$S_n = a \cdot (1 - r^n) / (1 - r)$	Sum of the first n terms of a GP (when $r \neq 1$)
Sum of GP ($r = 1$)	$S_n = n \cdot a$	Sum when the common ratio is 1
Common Ratio of GP	$r = T_{n+1} / T_n$	Finding the common ratio from consecutive terms

Sequence and Series Practice Problems

Problem 1: AP – Find the 15th Term and Sum of the First 15 Terms

Given: First term $a = 7$, common difference $d = 5$, number of terms $n = 15$.

Solution:

- 15th term:

$$T_n = a + (n-1)d$$

$$T_{15} = 7 + (15-1) \times 5 = 7 + 14 \times 5 = 7 + 70 = 77$$
- Sum of first 15 terms:

$$S_n = (n/2)[2a + (n-1)d]$$

$$S_{15} = (15/2)[2 \times 7 + (15-1) \times 5] = (15/2)[14 + 70] = (15/2) \times 84 = 15 \times 42 = 630$$

Answer:

- 15th term = 77
- Sum of first 15 terms = 630

Problem 2: AP – Total Pages Read After 12 Days

Given: Pages read on day 1 = 10, increase of 10 pages each day.

Thus, first term $a = 10$, common difference $d = 10$, number of days $n = 12$.

Solution:

Find the sum of the arithmetic series over 12 days:

$$S_n = (n/2)[2a + (n-1)d]$$

$$S_{12} = (12/2)[2 \times 10 + (12-1) \times 10] = 6[20 + 110] = 6 \times 130 = 780$$

Answer:

Total pages read after 12 days = 780

Problem 3: GP – Find the 10th Term and Sum of the First 10 Terms

Given: First term $a = 3$, common ratio $r = 2$, number of terms $n = 10$.

Solution:

- 10th term:

$$T_n = a \cdot r^{n-1}$$

$$T_{10} = 3 \times 2^{10-1} = 3 \times 2^9 = 3 \times 512 = 1536$$
- Sum of first 10 terms (since $r \neq 1$):

$$S_n = a(1 - r^n) / (1 - r)$$

$$S_{10} = 3(1 - 2^{10}) / (1 - 2) = 3(1 - 1024) / (-1) = 3(-1023) / (-1) = 3 \times 1023 = 3069$$

Formula Sheets

Geometric Formulas

Here's a concise list of key geometric formulas that are commonly used in mathematics:

1. Area of Basic Shapes

1. Square

Area:

$$A = s^2$$

where s is the side length.

Perimeter:

$$P = 4s$$

where s is the side length.

2. Rectangle

Area:

$$A = l \times w$$

where l is the length and w is the width.

Perimeter:

$$P = 2(l + w)$$

3. Triangle

Area:

$$A = \frac{1}{2} \times b \times h$$

where b is the base and h is the height.

Perimeter:

$$P = a + b + c$$

where a , b , and c are the sides of the triangle.

4. Parallelogram

Area:

$$A = b \times h$$

where b is the base and h is the height.

Perimeter:

$$P = 2(a + b)$$

where a and b are the adjacent sides.

5. Rhombus

Area:

$$A = \frac{1}{2} \times d_1 \times d_2$$

where d_1 and d_2 are the diagonals.

Perimeter:

$$P = 4s$$

where s is the side length.

6. Trapezoid (Trapezium)

Area:

$$A = \frac{1}{2} \times (b_1 + b_2) \times h$$

where b_1 and b_2 are the lengths of the parallel sides and h is the height.

Perimeter:

$$P = a + b_1 + b_2 + c$$

where a , b_1 , b_2 , and c are the sides.

2. Circle

1. Circle Formulas

Area:

$$A = \pi r^2$$

where r is the radius.

Circumference (Perimeter):

$$C = 2\pi r$$

where r is the radius.

Diameter:

$$D = 2r$$

where r is the radius.

3. Polygonal Formulas

1. Regular Polygon (n sides)

Area (using side length s and apothem a):

$$A = \frac{1}{2} \times n \times s \times a$$

where n is the number of sides, s is the side length, and a is the apothem.

Perimeter:

$$P = n \times s$$

where n is the number of sides and s is the side length.

4. 3D Geometric Formulas

1. Cube

Volume:

$$V = s^3$$

where s is the side length.

Surface Area:

$$A = 6s^2$$

where s is the side length.

2. Rectangular Prism (Cuboid)

Volume:

$$V = l \times w \times h$$

where l is the length, w is the width, and h is the height.

Surface Area:

$$A = 2lw + 2lh + 2wh$$

where l is the length, w is the width, and h is the height.

3. Sphere

Volume:

$$V = \frac{4}{3}\pi r^3$$

where r is the radius.

Surface Area:

$$A = 4\pi r^2$$

where r is the radius.

4. Cylinder

Volume:

$$V = \pi r^2 h$$

where r is the radius and h is the height.

Surface Area:

$$A = 2\pi r^2 + 2\pi r h$$

where r is the radius and h is the height.

5. Cone



Reasoning Aptitude Test



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REASONING APTITUDE TEST (GAT/HAT) - 1

100 MULTIPLE-CHOICE QUESTIONS

Section I: Verbal Reasoning (40 MCQs)

Section II: Analytical Reasoning (20 MCQs)

Section III: Quantitative Reasoning (40 MCQs)

Instructions

- Choose the best answer for each question.
- Use only the information supplied in analytical-reasoning questions.
- The answer key and detailed explanations are provided after Question 100.

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SECTION I — VERBAL REASONING

1. Although the committee initially dismissed the proposal as impractical, the pilot results were so _____ that the members agreed to reconsider it.

- A) discouraging
- B) compelling
- C) ambiguous
- D) routine

2. The witness gave such a _____ account that investigators could not determine what had actually occurred.

- A) coherent
- B) meticulous
- C) contradictory
- D) candid

3. Because the instructions were _____, even experienced users found the procedure _____.

- A) explicit; simple
- B) ambiguous; confusing
- C) concise; effortless
- D) redundant; transparent

4. The scientist remained _____ in her conclusions, refusing to claim more than the evidence supported.

- A) reckless
- B) cautious
- C) dogmatic
- D) indifferent

5. Far from being a _____ speaker, Nadia was lively and persuasive.

- A) monotonous
- B) articulate
- C) eloquent
- D) forceful

6. The roads were flooded; _____, the match was postponed.

- A) nevertheless
- B) therefore
- C) similarly
- D) meanwhile

7. The manager's apology sounded _____ because it was followed by no attempt to _____ the damage.

- A) sincere; repair
- B) hollow; remedy
- C) gracious; ignore
- D) candid; exaggerate

8. A good summary should be brief but not _____; it must retain the central ideas.

- A) accurate
- B) superficial
- C) coherent



- B) fourth
- C) fifth
- D) sixth

50. Which statement cannot be true?

- A) J is fourth.
- B) H is fourth.
- C) L is fourth.
- D) G is fourth.

Questions 51–53 are based on the following grouping problem.

Eight students—A, B, C, D, E, F, G, and H—are divided into Team X and Team Y, with four students in each team. A is in Team X. D is in Team Y. B and C are in different teams. If E is in Team X, F is also in Team X. G and H are in different teams.

51. Which of the following could be Team X?

- A) A, B, D, E
- B) A, B, F, G
- C) A, C, E, G
- D) A, B, C, F

52. Which member must be in Team X?

- A) B
- B) C
- C) E
- D) F

53. If B is in Team X, which member must be in Team Y?

- A) C
- B) G
- C) H
- D) F

54. Most residents own smartphones. Therefore, an emergency alert sent only through the city's mobile app will reach most residents. Which assumption is required?

- A) Most smartphone-owning residents can receive the city's app alerts.
- B) All residents prefer written notices.
- C) The city has never issued an emergency alert before.
- D) Smartphones are less expensive than radios.

55. A tutoring program improved examination scores at School A. Therefore, introducing the same program at School B will improve scores there. Which assumption is required?

- A) School B has more students than School A.
- B) Relevant conditions at the two schools are sufficiently similar for the program to have a comparable effect.
- C) Every student at School A liked the program.
- D) School B has never used any tutoring program.

56. A company introduced flexible working hours, and output increased the next month. The company concludes that flexible hours caused the increase. Which fact most strengthens the conclusion?

- A) The company's logo was redesigned that month.
- B) No major changes in workforce, equipment, or demand occurred during the period.
- C) Several employees prefer working from home.
- D) Output had increased once three years earlier.

57. A survey of online shoppers found that 90% prefer cashless payment. The researcher concludes that 90% of all citizens prefer cashless payment. Which fact most weakens the conclusion?

- A) The survey participants were members of a cashless-payment application.
- B) Cashless payments can be completed quickly.
- C) Some stores accept both cash and cards.
- D) The survey contained ten questions.

58. Some poets are teachers. No teachers are careless. Which statement must be true?

- A) Some poets are not careless.
- B) All poets are careful.

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100. How many distinct arrangements can be made from the letters of the word LEVEL?

- A) 20
- B) 24
- C) 30
- D) 60

ANSWER KEY AND EXPLANATIONS

Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.
1	B	21	A	41	B	61	C	81	C
2	C	22	C	42	B	62	C	82	C
3	B	23	B	43	C	63	C	83	B
4	B	24	B	44	A	64	C	84	C
5	A	25	C	45	B	65	B	85	A
6	B	26	B	46	A	66	C	86	C
7	B	27	B	47	C	67	C	87	C
8	B	28	A	48	A	68	C	88	B
9	A	29	B	49	D	69	C	89	C
10	B	30	B	50	D	70	B	90	C
11	A	31	B	51	B	71	C	91	B
12	C	32	B	52	D	72	C	92	B
13	A	33	A	53	A	73	B	93	C
14	B	34	B	54	A	74	B	94	B
15	A	35	B	55	B	75	B	95	B
16	C	36	B	56	B	76	A	96	B
17	B	37	B	57	A	77	C	97	C
18	A	38	A	58	A	78	B	98	C
19	C	39	B	59	A	79	D	99	B
20	C	40	B	60	B	80	A	100	C

Detailed Explanations

Section I — Verbal Reasoning

1. Answer: B

Explanation: “Although” signals a contrast. The proposal was initially rejected, but strong and convincing results caused reconsideration; therefore, “compelling” is the best fit.

2. Answer: C

Explanation: An account that prevents investigators from determining the facts is internally inconsistent or contradictory.

3. Answer: B

Explanation: Unclear or ambiguous instructions naturally make a procedure confusing. The two words form a logical cause-and-effect pair.

4. Answer: B

Explanation: Refusing to go beyond the evidence shows caution and intellectual restraint.

5. Answer: A

Explanation: “Far from” introduces an opposite. A lively and persuasive speaker is not monotonous.

6. Answer: B

Explanation: The postponement resulted from the flooding, so the cause-and-effect connector “therefore” is required.

7. Answer: B

Explanation: An apology unsupported by corrective action sounds hollow, and “remedy the damage” means to correct or repair it.

8. Answer: B

Explanation: A summary may be concise, but it should not be shallow or superficial because it must preserve the main ideas.

9. Answer: A

Explanation: A scalpel is a tool used by a surgeon; similarly, a gavel is a tool associated with and used by a judge.

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10. Answer: B

Explanation: A sapling is the young form of a tree; a foal is the young form of a horse.

11. Answer: A

Explanation: A whisper is a low-intensity form of speaking; a stroll is a low-intensity or leisurely form of walking.

12. Answer: C

Explanation: An archipelago is a group of islands; a constellation is a recognized group of stars.

13. Answer: A

Explanation: Inoculation protects against disease; insurance protects against financial loss or its consequences.

14. Answer: B

Explanation: "Abate" means to become less intense or to reduce in degree.

15. Answer: A

Explanation: "Candid" means open, honest, and frank.

16. Answer: C

Explanation: "Meticulous" describes someone extremely careful and attentive to detail.

17. Answer: B

Explanation: "Transient" means lasting for only a short time; temporary is the closest synonym.

18. Answer: A

Explanation: A prudent person acts with good judgment and caution.

19. Answer: C

Explanation: "Scarce" means insufficient or uncommon; "abundant" means plentiful.

20. Answer: C

Explanation: "Obscure" can mean unclear or difficult to understand; its opposite is clear.

21. Answer: A

Explanation: A reluctant person is unwilling or hesitant; the direct opposite is willing.

22. Answer: C

Explanation: "Rigid" means stiff or inflexible; "flexible" is its opposite.

23. Answer: B

Explanation: To conceal is to hide; to reveal is to make known or visible.

24. Answer: B

Explanation: "Neither" is singular in formal agreement, so it takes "has submitted."

25. Answer: C

Explanation: The subject "Each" is singular, so the correct verb is "was."

26. Answer: B

Explanation: The main subject is the singular noun "manager." The phrase "along with her assistants" does not change the number of the subject.

27. Answer: B

Explanation: A past unreal condition requires the third conditional: "had known" + "would have informed."

28. Answer: A

Explanation: "Discuss" is a transitive verb and takes a direct object; the preposition "about" is unnecessary.

29. Answer: B

Explanation: "Spill the beans" means to disclose information that was supposed to remain secret.

30. Answer: B

Explanation: The idiom describes a state of confusion, disorder, or disorganization.

31. Answer: B

Explanation: "Bona fide" is a Latin expression meaning genuine, authentic, or made in good faith.

32. Answer: B

Explanation: "Carte blanche" means full discretionary power or complete freedom to act.

33. Answer: A

Explanation: The simile is conventionally used for a person with very poor eyesight.

34. Answer: B

Explanation: The prefix "mis-" expresses wrongness or error; to misinterpret is to interpret incorrectly.

35. Answer: B

Explanation: A polyglot is a person who knows and can use several languages.



REASONING APTITUDE TEST (GAT/HAT) - 2

100 MULTIPLE-CHOICE QUESTIONS

Section I: Verbal Reasoning (40 MCQs)

Section II: Analytical Reasoning (20 MCQs)

Section III: Quantitative Reasoning (40 MCQs)

Instructions

- Choose the best answer for each question.
- Use only the information supplied in analytical-reasoning questions.
- The answer key and detailed explanations are provided after Question 100.

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SECTION I — VERBAL REASONING

1. Despite repeated criticism, the researcher remained _____, revising her method when the evidence demanded it but refusing to abandon well-supported conclusions.

- A) adaptable
- B) obstinate
- C) negligent
- D) credulous

2. The minister's announcement was so _____ that reporters left with more questions than answers.

- A) precise
- B) vague
- C) comprehensive
- D) decisive

3. Because the available data were incomplete, the committee treated its conclusion as _____ rather than definitive.

- A) irreversible
- B) unanimous
- C) provisional
- D) irrelevant

4. Far from being _____, the manual explains even the most technical procedure in direct and accessible language.

- A) concise
- B) practical
- C) systematic
- D) opaque

5. The critic admired the novel's _____ plot but complained that its principal characters were _____.

- A) intricate; superficial
- B) predictable; vivid
- C) simple; convincing
- D) coherent; profound

6. Because the witness had altered her account several times, the jury regarded her final statement with _____.

- A) enthusiasm
- B) suspicion
- C) gratitude
- D) indifference

7. The newly discovered evidence did not _____ the earlier theory; instead, it _____ the theory by explaining an apparent anomaly.

- A) confirm; rejected
- B) repeat; concealed
- C) refute; refined
- D) simplify; contradicted



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1. Answer: A

Explanation: The sentence describes someone willing to revise a method when evidence changes. 'Adaptable' best captures that flexibility; 'obstinate' means stubborn, while 'negligent' and 'credulous' do not fit.

2. Answer: B

Explanation: An announcement that creates more questions than answers is unclear or vague.

3. Answer: C

Explanation: A provisional conclusion is temporary and subject to revision, which is appropriate when the data are incomplete.

4. Answer: D

Explanation: 'Far from' signals contrast. A manual written in direct, accessible language is not opaque, meaning difficult to understand.

5. Answer: A

Explanation: The contrast is between a complex, skillfully constructed plot and characters lacking depth. 'Intricate; superficial' provides that contrast.

6. Answer: B

Explanation: Repeatedly changing an account undermines credibility, so the jury would view the statement with suspicion.

7. Answer: C

Explanation: The second clause says the evidence improved the theory by explaining an anomaly. Therefore it did not refute the theory; it refined it.

8. Answer: D

Explanation: A task that looks difficult at first but becomes easier after division is 'formidable' initially and 'manageable' afterward.

9. Answer: A

Explanation: A compass is an instrument used for navigation; a stethoscope is an instrument used in medical diagnosis.

10. Answer: B

Explanation: An oasis is a distinct feature located within a desert; similarly, an island is located within an ocean.

11. Answer: C

Explanation: An epilogue is a concluding part added to a novel; a postscript is an additional concluding part added to a letter.

12. Answer: D

Explanation: 'Frugal' and 'extravagant' are opposites. 'Cautious' and 'reckless' form the same antonym relationship.

13. Answer: A

Explanation: A seed develops through germination; an organism emerges from an egg through hatching. The relationship is a developmental process.

14. Answer: B

Explanation: 'Austere' means strict, severe, plain, or without unnecessary comfort.

15. Answer: C

Explanation: To corroborate a claim is to confirm or support it with additional evidence.

16. Answer: D

Explanation: 'Ubiquitous' describes something found or appearing everywhere.

17. Answer: A

Explanation: 'Lucid' means clear, intelligible, and easy to understand.

18. Answer: B

Explanation: To mitigate something is to make it less severe; 'alleviate' is the closest synonym.

19. Answer: C

Explanation: 'Benevolent' means kind and well-meaning; 'malevolent' means wishing harm and is its opposite.

20. Answer: D

Explanation: 'Explicit' means clearly stated; 'implicit' means suggested but not directly expressed.

21. Answer: A

Explanation: To augment is to increase; to diminish is to decrease.

22. Answer: B

Explanation: 'Volatile' means likely to change suddenly or become unstable; 'stable' is the direct opposite.

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REASONING APTITUDE TEST (GAT/HAT) - 3

100 MULTIPLE-CHOICE QUESTIONS

Section I: Verbal Reasoning (40 MCQs)

Section II: Analytical Reasoning (20 MCQs)

Section III: Quantitative Reasoning (40 MCQs)

Instructions

- Choose the best answer for each question.
- Use only the information supplied in analytical-reasoning questions.
- The answer key and detailed explanations are provided after Question 100.

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SECTION I — VERBAL REASONING

1. The board praised the report for being _____ without sacrificing essential detail.
A) concise
B) obscure
C) redundant
D) speculative
2. Although the policy was intended to simplify procedures, its wording was so _____ that it produced conflicting interpretations.
A) transparent
B) ambiguous
C) systematic
D) authoritative
3. The historian was careful to _____ between documented fact and later legend.
A) alternate
B) distinguish
C) combine
D) vacillate
4. The speaker's argument was initially persuasive, but its unsupported assumptions made it ultimately _____.
A) tenable
B) innovative
C) untenable
D) conclusive
5. The new evidence did not merely support the hypothesis; it _____ its central prediction.
A) verified
B) obscured
C) postponed
D) qualified
6. Because the negotiator remained _____ under pressure, the talks continued despite repeated setbacks.
A) composed
B) indignant
C) impulsive
D) evasive
7. The editor removed several _____ passages that repeated points already established.
A) incisive
B) redundant
C) coherent
D) indispensable
8. Unlike a _____ account, the memoir acknowledges both the author's successes and failures.
A) balanced
B) self-serving

C) 15

D) 16

98. What is the mode of 3, 4, 4, 5, 6, 6, 6, and 8?

A) 4

B) 5

C) 6

D) 8

99. One card is drawn at random from a standard deck of 52 cards. What is the probability of drawing an ace?

A) $\frac{1}{26}$

B) $\frac{1}{13}$

C) $\frac{1}{4}$

D) $\frac{4}{13}$

100. How many different committees of 3 students can be selected from 8 students?

A) 24

B) 48

C) 56

D) 64

ANSWER KEY AND EXPLANATIONS

Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.
1	A	21	C	41	B	61	C	81	C
2	B	22	C	42	C	62	C	82	B
3	B	23	B	43	A	63	B	83	C
4	C	24	B	44	B	64	C	84	B
5	A	25	B	45	A	65	B	85	A
6	A	26	C	46	B	66	C	86	D
7	B	27	A	47	D	67	C	87	B
8	B	28	B	48	B	68	C	88	C
9	A	29	C	49	C	69	C	89	B
10	A	30	B	50	A	70	B	90	B
11	A	31	C	51	A	71	B	91	C
12	A	32	B	52	C	72	C	92	C
13	A	33	A	53	C	73	B	93	C
14	A	34	C	54	C	74	B	94	B
15	B	35	B	55	B	75	B	95	C
16	A	36	A	56	B	76	C	96	C
17	B	37	C	57	B	77	B	97	B
18	A	38	A	58	B	78	C	98	C
19	B	39	B	59	C	79	B	99	B
20	B	40	C	60	B	80	B	100	C

Detailed Explanations

Section I — Verbal Reasoning

1. Answer: A

Explanation: 'Concise' means brief and clearly expressed. It fits a report that avoids unnecessary length while retaining essential detail.

2. Answer: B

Explanation: Conflicting interpretations arise when wording is ambiguous, meaning open to more than one interpretation.

3. Answer: B

Explanation: To distinguish between two things is to recognize and explain the difference between them.

4. Answer: C

Explanation: An argument resting on unsupported assumptions cannot be maintained successfully; it is untenable.



REASONING APTITUDE TEST (GAT/HAT) - 4

100 MULTIPLE-CHOICE QUESTIONS

Section I: Verbal Reasoning (40 MCQs)

Section II: Analytical Reasoning (20 MCQs)

Section III: Quantitative Reasoning (40 MCQs)

Instructions

- Choose the best answer for each question.
- Use only the information supplied in analytical-reasoning questions.
- The answer key and detailed explanations are provided after Question 100.

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SECTION I — VERBAL REASONING

1. The auditor was praised for her _____ examination of every transaction in the account.
A) meticulous
B) casual
C) impulsive
D) superficial
2. The two sides reached an agreement only after each made a significant _____.
A) accusation
B) concession
C) prediction
D) objection
3. Because the market remained highly _____, investors avoided making long-term commitments.
A) stable
B) transparent
C) volatile
D) profitable
4. The scientist was both _____ in collecting evidence and _____ in drawing conclusions from it.
A) careless; dogmatic
B) secretive; reckless
C) hasty; impartial
D) systematic; cautious
5. Although the witness appeared _____, several details in his account were internally _____.
A) confident; inconsistent
B) nervous; accurate
C) honest; complete
D) uncertain; verified
6. The proposal seemed _____ at first, but a careful cost analysis showed that it was financially _____.
A) impractical; impossible
B) promising; unsustainable
C) ordinary; economical
D) controversial; popular
7. The road was closed because heavy rain had made the hillside _____.
A) fertile
B) visible
C) unstable
D) accessible
8. Her review was refreshingly _____: it acknowledged both the strengths and the weaknesses of the book.
A) partial
B) hostile
C) vague
D) candid

Reasoning Aptitude Test (GAT/HAT)



98. Two fair coins are tossed. What is the probability of getting exactly one head?

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

99. A bag contains 5 red, 3 blue, and 2 green balls. One ball is drawn at random. What is the probability that it is not blue?

- A) $3/10$
- B) $1/2$
- C) $7/10$
- D) $4/5$

100. How many distinct arrangements can be made from the letters of the word BOOK?

- A) 6
- B) 24
- C) 18
- D) 12

ANSWER KEY AND EXPLANATIONS

Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.
1	A	21	A	41	A	61	A	81	A
2	B	22	B	42	B	62	B	82	B
3	C	23	C	43	C	63	C	83	C
4	D	24	D	44	D	64	D	84	D
5	A	25	A	45	A	65	A	85	A
6	B	26	B	46	B	66	B	86	B
7	C	27	C	47	C	67	C	87	C
8	D	28	D	48	D	68	D	88	D
9	A	29	A	49	A	69	A	89	A
10	B	30	B	50	B	70	B	90	B
11	C	31	C	51	C	71	C	91	C
12	D	32	D	52	D	72	D	92	D
13	A	33	A	53	A	73	A	93	A
14	B	34	B	54	B	74	B	94	B
15	C	35	C	55	C	75	C	95	C
16	D	36	D	56	D	76	D	96	D
17	A	37	A	57	A	77	A	97	A
18	B	38	B	58	B	78	B	98	B
19	C	39	C	59	C	79	C	99	C
20	D	40	D	60	D	80	D	100	D

Detailed Explanations

Section I — Verbal Reasoning

1. Answer: A

Explanation: A meticulous examination is extremely careful and attentive to detail, which is appropriate for auditing transactions.

2. Answer: B

Explanation: A concession is something yielded during negotiation to help the parties reach agreement.

3. Answer: C

Explanation: A volatile market changes rapidly and unpredictably, making long-term commitments risky.

4. Answer: D

Explanation: A good scientist collects evidence systematically and draws conclusions cautiously; the two words form a coherent pair.

5. Answer: A

Explanation: The contrast signaled by 'although' is between a confident appearance and an account containing inconsistent details.

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6. Answer: B

Explanation: The sentence contrasts an initially promising proposal with later evidence that it cannot be sustained financially.

7. Answer: C

Explanation: Heavy rain can make a hillside unstable, creating a safety risk that justifies closing the road.

8. Answer: D

Explanation: A candid review is honest and direct, including both positive and negative aspects.

9. Answer: A

Explanation: An archive preserves records; a museum preserves artifacts.

10. Answer: B

Explanation: A gavel is a characteristic professional tool used by a judge; a stethoscope is a characteristic professional tool used by a physician.

11. Answer: C

Explanation: A monument is created to commemorate a person or event; a trophy is awarded to recognize an achievement.

12. Answer: D

Explanation: A blueprint provides a plan for creating a building; a recipe provides a plan for preparing a meal.

13. Answer: A

Explanation: A glance is a brief look; a sip is a small or brief drink.

14. Answer: B

Explanation: 'Diligent' means showing steady, careful, and persistent effort.

15. Answer: C

Explanation: To alleviate something is to make it less severe or to relieve it.

16. Answer: D

Explanation: 'Obsolete' means no longer in use or out of date.

17. Answer: A

Explanation: To venerate someone or something is to regard it with deep respect.

18. Answer: B

Explanation: To placate someone is to calm or satisfy that person, especially by reducing anger.

19. Answer: C

Explanation: 'Abundant' means plentiful; 'scarce' means insufficient or rare.

20. Answer: D

Explanation: 'Rigid' means stiff or inflexible; 'flexible' is its direct opposite.

21. Answer: A

Explanation: To conceal is to hide; to reveal is to make known or visible.

22. Answer: B

Explanation: A novice is a beginner; an expert has advanced skill or knowledge.

23. Answer: C

Explanation: 'Transient' means temporary or short-lived; 'permanent' is the opposite.

24. Answer: D

Explanation: The subject 'each' is singular, so it requires the singular verb 'contains.'

25. Answer: A

Explanation: In 'the panel appointed whom,' the pronoun is the object of 'appoint,' so 'whom' is correct.

26. Answer: B

Explanation: 'Questions' is a countable plural noun, so 'fewer' is correct. 'Traffic' and 'information' normally take 'less.'

27. Answer: C

Explanation: The standard construction is 'No sooner had ... than ...,' using the past participle 'rung.'

28. Answer: D

Explanation: The three items are parallel noun or gerund phrases: careful planning, accurate writing, and meeting deadlines.

29. Answer: A

Explanation: To break the ice is to reduce initial tension and begin friendly interaction.



REASONING APTITUDE TEST (GAT/HAT) - 5

100 MULTIPLE-CHOICE QUESTIONS

Section I: Verbal Reasoning (40 MCQs)

Section II: Analytical Reasoning (20 MCQs)

Section III: Quantitative Reasoning (40 MCQs)

Instructions

- Choose the best answer for each question.
- Use only the information supplied in analytical-reasoning questions.
- The answer key and detailed explanations are provided after Question 100.

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Section I — VERBAL REASONING

1. The committee postponed its decision because the available evidence was too _____ to support a firm conclusion.

- A) fragmentary
- B) conclusive
- C) abundant
- D) consistent

2. The editor removed several _____ claims that were not supported by reliable sources.

- A) substantiated
- B) speculative
- C) measured
- D) verifiable

3. The instructor's explanation was so _____ that even the most complicated procedure seemed easy to follow.

- A) technical
- B) ambiguous
- C) lucid
- D) lengthy

4. The new disciplinary policy is intended to be corrective rather than _____.

- A) preventive
- B) formal
- C) consistent
- D) punitive

5. Although the address lasted only ten minutes, it was remarkably _____ and covered every major point.

- A) comprehensive
- B) repetitive
- C) hesitant
- D) irrelevant

6. The figures initially appeared _____, but a detailed audit revealed several calculation errors.

- A) random
- B) accurate
- C) incomplete
- D) controversial

7. The plan was rejected not because it was innovative, but because its cost estimates were _____.

- A) realistic
- B) transparent
- C) implausible
- D) conservative

8. During repeated interviews, the witness gave an increasingly _____ account, changing several important details.

- A) consistent



97. What is the mode of 4, 5, 5, 7, 8, 8, 8, and 9?

- A) 8
- B) 7
- C) 5
- D) 9

98. Two fair dice are rolled. What is the probability that their sum is 7?

- A) $\frac{1}{12}$
- B) $\frac{1}{6}$
- C) $\frac{1}{4}$
- D) $\frac{1}{3}$

99. A bag contains 4 red and 6 blue balls. Two balls are drawn without replacement. What is the probability that both are red?

- A) $\frac{1}{10}$
- B) $\frac{1}{5}$
- C) $\frac{2}{15}$
- D) $\frac{4}{15}$

100. How many different groups of 3 people can be selected from 8 people?

- A) 24
- B) 48
- C) 336
- D) 56

ANSWER KEY AND EXPLANATIONS

Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.	Q	Ans.
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4	D	24	D	44	D	64	D	84	D
5	A	25	A	45	A	65	A	85	A
6	B	26	B	46	B	66	B	86	B
7	C	27	C	47	C	67	C	87	C
8	D	28	D	48	D	68	D	88	D
9	A	29	A	49	A	69	A	89	A
10	B	30	B	50	B	70	B	90	B
11	C	31	C	51	C	71	C	91	C
12	D	32	D	52	D	72	D	92	D
13	A	33	A	53	A	73	A	93	A
14	B	34	B	54	B	74	B	94	B
15	C	35	C	55	C	75	C	95	C
16	D	36	D	56	D	76	D	96	D
17	A	37	A	57	A	77	A	97	A
18	B	38	B	58	B	78	B	98	B
19	C	39	C	59	C	79	C	99	C
20	D	40	D	60	D	80	D	100	D

Detailed Explanations

Section I — Verbal Reasoning

1. Answer: A

Explanation: Fragmentary evidence is incomplete and disconnected, so it cannot support a firm conclusion.

2. Answer: B

Explanation: Speculative claims are based on conjecture rather than dependable evidence.

3. Answer: C

Explanation: Lucid means clear and easy to understand, which fits an explanation that makes a complex procedure accessible.

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4. Answer: D

Explanation: Corrective action aims to improve behavior, whereas punitive action primarily imposes punishment.

5. Answer: A

Explanation: The contrast is between short duration and broad coverage; comprehensive means complete and wide-ranging.

6. Answer: B

Explanation: The word 'but' introduces a contrast between an initial appearance of accuracy and later discovery of errors.

7. Answer: C

Explanation: Implausible cost estimates are not credible and provide a sound reason to reject a plan.

8. Answer: D

Explanation: Changing important details makes the account inconsistent.

9. Answer: A

Explanation: A barometer measures pressure; a scale measures weight.

10. Answer: B

Explanation: A vaccine protects against disease; a firewall protects against intrusion.

11. Answer: C

Explanation: A sculptor works with marble; a carpenter works with wood.

12. Answer: D

Explanation: A murmur is a soft manner of speaking; an amble is a leisurely manner of walking.

13. Answer: A

Explanation: A drought is a severe shortage of water; a famine is a severe shortage of food.

14. Answer: B

Explanation: To ameliorate is to improve a bad situation or make it less severe.

15. Answer: C

Explanation: Equitable means fair and just.

16. Answer: D

Explanation: Intermittent means stopping and starting at intervals rather than continuing without interruption.

17. Answer: A

Explanation: To substantiate is to support or confirm a claim with evidence.

18. Answer: B

Explanation: Feasible means capable of being done successfully or workable.

19. Answer: C

Explanation: Enigmatic means mysterious or difficult to understand; clear is the opposite.

20. Answer: D

Explanation: Frugal means economical and avoiding waste; wasteful is the opposite.

21. Answer: A

Explanation: To diminish is to become smaller or weaker; to increase is the opposite.

22. Answer: B

Explanation: Mandatory means required; optional means left to choice.

23. Answer: C

Explanation: Resilient describes an ability to recover or withstand stress; fragile describes easy damage or failure.

24. Answer: D

Explanation: The subject 'neither' is singular, so it takes the singular verb 'is.'

25. Answer: A

Explanation: The introductory phrase must modify the person who was walking, so Amina must immediately follow it.

26. Answer: B

Explanation: Affect is normally a verb meaning influence; effect is normally a noun meaning result.

27. Answer: C

Explanation: A contrary-to-fact present condition uses the subjunctive 'were' and the result form 'would revise.'

28. Answer: D

Explanation: The three coordinated items are parallel noun phrases: critical reading, clear writing, and effective presentation.

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