



General Instructions

- (i) **Duration:** The total duration of the examination is 2.5 hours (150 minutes).
- (ii) **Total Marks:** The complete paper carries a maximum of 500 marks.
- (iii) **Structure:** The paper has 4 Sections:
 - **Part 1:** 35 Multiple Choice Questions (Physics).
 - **Part 2:** 35 Multiple Choice Questions (Chemistry).
 - **Part 3:** 40 Multiple Choice Questions (Mathematics/Biology).
 - **Part 4:** 10 Multiple Choice Questions (Aptitude).
 - **Part 4:** 5 Multiple Choice Questions (English)
- (iv) **Compulsory Questions:** All 125 questions are compulsory.
- (v) Each question has four options. Only **one** option is correct.
- (vi) **Correct Answer:** +4 marks.
- (vii) **Incorrect Answer:** -1 (Negative marking).
- (viii) **Unanswered/Marked for Review:** 0 marks.

1. A wire of resistance R is stretched to double its original length. What is its new resistance?

- (A) $2R$
- (B) $4R$
- (C) $\frac{R}{2}$
- (D) R

Correct Answer: (B) $4R$

Solution:

Topic - Current Electricity (Resistance of Conductors):

This question deals with the physical factors affecting the resistance of a conductor, specifically the relationship between length, cross-sectional area, and volume conservation during deformation.

Step 1: Understanding the Question:

We need to determine the new resistance of a wire after it has been stretched to twice its initial length.

Step 2: Key Formula or Approach:

The resistance R is defined as:

$$R = \rho \frac{L}{A}$$

Where:

ρ = Resistivity of the material.

L = Length of the conductor.

A = Area of cross-section.

Since the wire is stretched, its volume $V = A \times L$ remains constant.

Step 3: Detailed Solution:

1. Let the initial length be L and area be A .
2. The initial resistance is $R = \rho \frac{L}{A}$.
3. The new length is $L' = 2L$.
4. Since volume is constant ($V = V'$):

$$A \cdot L = A' \cdot L'$$

$$A \cdot L = A' \cdot (2L)$$

$$A' = \frac{A}{2}$$

5. The new resistance R' is:

$$R' = \rho \frac{L'}{A'}$$

$$R' = \rho \frac{2L}{A/2}$$

$$R' = 4 \left(\rho \frac{L}{A} \right)$$

$$R' = 4R$$

Step 4: Final Answer:

The new resistance is $4R$.

Quick Tip: When a wire is stretched by a factor n , the new resistance becomes n^2 times the original resistance.

Here, $n = 2$, so $R' = 2^2 R = 4R$.

2. What is the de Broglie wavelength of an electron accelerated through a potential difference of 100 V?

- (A) $0.1227 \text{ \AA}$
- (B) $1.227 \text{ \AA}$
- (C) $12.27 \text{ \AA}$
- (D) $0.01227 \text{ \AA}$

Correct Answer: (B) $1.227 \text{ \AA}$

Solution:

Topic - Dual Nature of Matter (de Broglie Wavelength):

This topic explores the wave nature of particles. For charged particles like electrons, the

wavelength depends on the accelerating potential.

Step 1: Understanding the Question:

The objective is to calculate the de Broglie wavelength for an electron given its accelerating voltage $V = 100\text{ V}$.

Step 2: Key Formula or Approach:

For an electron accelerated from rest through a potential V , the wavelength λ is:

$$\lambda = \frac{h}{\sqrt{2meV}}$$

In a simplified numerical form for electrons:

$$\lambda = \frac{12.27}{\sqrt{V}} \text{ \AA}$$

Step 3: Detailed Solution:

1. Identify the given value: $V = 100\text{ V}$.
2. Substitute the value into the simplified formula:

$$\lambda = \frac{12.27}{\sqrt{100}} \text{ \AA}$$

3. Since $\sqrt{100} = 10$:

$$\lambda = \frac{12.27}{10} \text{ \AA}$$

$$\lambda = 1.227 \text{ \AA}$$

Step 4: Final Answer:

The de Broglie wavelength is $1.227 \text{ \AA}$.

Quick Tip: Memorize the shortcut $\lambda \approx \sqrt{\frac{150}{V}} \text{ \AA}$ or $\frac{12.27}{\sqrt{V}} \text{ \AA}$ specifically for electrons to save time in competitive exams.

3. In a Young's Double Slit Experiment, if the distance between the slits is halved and the distance to the screen is doubled, what happens to the fringe width?

- (A) Doubled
- (B) Halved
- (C) Quadrupled
- (D) Unchanged

Correct Answer: (C) Quadrupled

Solution:

Topic - Wave Optics (Interference):

This question focuses on Young's Double Slit Experiment (YDSE) and how the geometric parameters of the setup influence the interference pattern.

Step 1: Understanding the Question:

We need to find the ratio of the new fringe width to the old fringe width based on changes in slit separation (d) and screen distance (D).

Step 2: Key Formula or Approach:

The fringe width β is given by:

$$\beta = \frac{\lambda D}{d}$$

Where:

λ = Wavelength of light.

D = Distance between slits and screen.

d = Distance between the two slits.

Step 3: Detailed Solution:

1. Let the initial parameters be D and d . Initial fringe width $\beta = \frac{\lambda D}{d}$.
2. New screen distance $D' = 2D$.
3. New slit separation $d' = \frac{d}{2}$.
4. Substitute these into the formula for new fringe width β' :

$$\beta' = \frac{\lambda D'}{d'} = \frac{\lambda(2D)}{(d/2)}$$

$$\beta' = \frac{2\lambda D}{d/2} = 4\left(\frac{\lambda D}{d}\right)$$

$$\beta' = 4\beta$$

Step 4: Final Answer:

The fringe width becomes quadrupled (4 times).

Quick Tip: Fringe width β is directly proportional to D and inversely proportional to d .
If $D \uparrow 2$ and $d \downarrow 2$, the total change is $2 \times 2 = 4$ times.

4. What is the coordination number of Cobalt in $[Co(en)_3]^{3+}$?

- (A) 3
- (B) 4
- (C) 6
- (D) 2

Correct Answer: (C) 6

Solution:

Topic - Coordination Compounds (Ligands and Coordination Number):

The coordination number is determined by the total number of sigma bonds formed between the ligands and the central metal atom.

Step 1: Understanding the Question:

The goal is to find the coordination number of Cobalt in the complex ion $[Co(en)_3]^{3+}$.

Step 2: Key Formula or Approach:

Coordination Number (C.N.) = (Number of ligands) $\times$ (Denticity of the ligand).

en stands for ethylenediamine, which is a **bidentate** ligand.

Step 3: Detailed Solution:

1. Identify the ligand: *en* (ethylenediamine) is $H_2N - CH_2 - CH_2 - NH_2$.
2. Determine denticity: Since it has two donor nitrogen atoms, its denticity is 2.
3. Calculate C.N.: There are 3 such ligands.

$$\text{C.N.} = 3 \times 2 = 6$$

This means there are 6 coordinate bonds formed with the Cobalt ion.

Step 4: Final Answer:

The coordination number is 6.

Quick Tip: Common bidentate ligands include *en* (ethylenediamine) and ox^{2-} (oxalate). Always multiply the number of these ligands by 2 to find the coordination number.

5. Which gas is evolved when Sodium metal reacts with Ethanol?

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

Correct Answer: (B) Hydrogen (H_2)

Solution:

Topic - Organic Chemistry (Alcohols):

This question concerns the acidic nature of alcohols and their reactions with active metals.

Step 1: Understanding the Question:

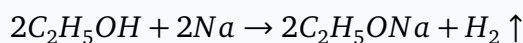
We need to identify the gaseous byproduct formed when sodium metal is added to ethanol.

Step 2: Key Formula or Approach:

Alcohols react with active metals (like Na, K, Mg) to form metal alkoxides and release hydrogen gas. This reaction confirms the presence of the acidic hydrogen in the $-OH$ group.

Step 3: Detailed Solution:

1. The chemical formula for ethanol is C_2H_5OH .
2. When Sodium (Na) reacts with it:



3. The products are Sodium ethoxide and Hydrogen gas.

Step 4: Final Answer:

The gas evolved is Hydrogen (H_2).

Quick Tip: The evolution of H_2 gas (which burns with a pop sound) is a standard test for the acidic hydrogen in alcohols and carboxylic acids.

6. What is the order of a reaction if the rate constant unit is $L \cdot mol^{-1} \cdot s^{-1}$?

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

Correct Answer: (C) Second Order

Solution:

Topic - Chemical Kinetics (Rate Constant Units):

The units of the rate constant k vary depending on the overall order of the chemical reaction.

Step 1: Understanding the Question:

We are given the unit $L \cdot mol^{-1} \cdot s^{-1}$ and asked to identify the corresponding reaction order n .

Step 2: Key Formula or Approach:

The general unit for a rate constant of an n^{th} order reaction is:

$$\text{Unit} = (mol \cdot L^{-1})^{1-n} \cdot s^{-1}$$

Step 3: Detailed Solution:

1. Given unit: $L \cdot mol^{-1} \cdot s^{-1}$, which is equivalent to $(mol \cdot L^{-1})^{-1} \cdot s^{-1}$.
2. Compare the exponents of the concentration term $(mol \cdot L^{-1})$:

$$1 - n = -1$$

3. Solving for n :

$$n = 1 + 1 = 2$$

4. Therefore, the reaction is of the second order.

Step 4: Final Answer:

The reaction is second order.

Quick Tip: Quick check for units:

0-order: $mol \cdot L^{-1} \cdot s^{-1}$

1-order: s^{-1}

2-order: $L \cdot mol^{-1} \cdot s^{-1}$

7. If $\tan^{-1} x + \tan^{-1} y = \frac{\pi}{4}$, then what is the value of $x + y + xy$?

- (A) 0
- (B) 1
- (C) 2
- (D) -1

Correct Answer: (B) 1

Solution:

Topic - Inverse Trigonometric Functions:

This problem uses the addition property of inverse tangent functions to find a relationship between variables.

Step 1: Understanding the Question:

Given the sum of two inverse tangents equals $\pi/4$, we must calculate the specific algebraic expression $x + y + xy$.

Step 2: Key Formula or Approach:

The identity for addition is:

$$\tan^{-1} x + \tan^{-1} y = \tan^{-1} \left(\frac{x + y}{1 - xy} \right)$$

Step 3: Detailed Solution:

1. Apply the identity:

$$\tan^{-1} \left(\frac{x + y}{1 - xy} \right) = \frac{\pi}{4}$$

2. Take the tangent of both sides:

$$\frac{x + y}{1 - xy} = \tan \left(\frac{\pi}{4} \right)$$

3. Since $\tan(\pi/4) = 1$:

$$\frac{x+y}{1-xy} = 1$$

4. Rearrange the equation:

$$x+y = 1-xy$$

$$x+y+xy = 1$$

Step 4: Final Answer:

The value is 1.

Quick Tip: Whenever you see $\tan^{-1} A + \tan^{-1} B = \pi/4$, remember that the argument $\frac{A+B}{1-AB}$ must equal 1.

8. Find the value of $\int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x} dx$.

- (A) $\frac{\pi}{2}$
- (B) $\frac{\pi}{8}$
- (C) $\frac{\pi}{4}$
- (D) 1

Correct Answer: (C) $\frac{\pi}{4}$

Solution:

Topic - Definite Integrals (Properties):

This is a classic integral problem solvable using the properties of definite integrals, often referred to as "King's Rule".

Step 1: Understanding the Question:

The objective is to evaluate the definite integral of a trigonometric fraction over the interval

$[0, \pi/2]$.

Step 2: Key Formula or Approach:

Use the property:

$$\int_0^a f(x) dx = \int_0^a f(a-x) dx$$

Step 3: Detailed Solution:

1. Let $I = \int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x} dx$ — (Eq. 1).

2. Apply the property $x \rightarrow \pi/2 - x$:

$$I = \int_0^{\pi/2} \frac{\sin(\pi/2 - x)}{\sin(\pi/2 - x) + \cos(\pi/2 - x)} dx$$

$$I = \int_0^{\pi/2} \frac{\cos x}{\cos x + \sin x} dx$$

— (Eq. 2).

3. Add (Eq. 1) and (Eq. 2):

$$2I = \int_0^{\pi/2} \frac{\sin x + \cos x}{\sin x + \cos x} dx$$

$$2I = \int_0^{\pi/2} 1 dx$$

4. Integrate:

$$2I = [x]_0^{\pi/2} = \frac{\pi}{2}$$

$$I = \frac{\pi}{4}$$

Step 4: Final Answer:

The value of the integral is $\frac{\pi}{4}$.

Quick Tip: For any integral of the form $\int_0^{\pi/2} \frac{\sin^n x}{\sin^n x + \cos^n x} dx$, the answer is always $\frac{\text{Upper Limit}}{2} = \frac{\pi}{4}$.

9. What is the distance of the point $(1, 2, 3)$ from the yz -plane?

- (A) 3
- (B) 2
- (C) 1
- (D) $\sqrt{3}$

Correct Answer: (C) 1

Solution:

Topic - Three Dimensional Geometry (Coordinates):

This question deals with the concept of coordinate planes and how to calculate the distance of a point from them.

Step 1: Understanding the Question:

We are given a point $P(1, 2, 3)$ and need to find how far it is from the yz -plane.

Step 2: Key Formula or Approach:

The equation of the yz -plane is $x = 0$.

The perpendicular distance of a point (x_1, y_1, z_1) from:

- yz -plane is $|x_1|$.
- xz -plane is $|y_1|$.
- xy -plane is $|z_1|$.

Step 3: Detailed Solution:

1. Identify the coordinates of the point: $x = 1, y = 2, z = 3$.
2. To find the distance from the yz -plane, we look at the absolute value of the x -coordinate.
3. Distance = $|1| = 1$.

Step 4: Final Answer:

The distance is 1 unit.

Quick Tip: The distance of a point from a coordinate plane is simply the absolute value of the coordinate not present in the plane's name.

Distance from yz -plane $\rightarrow$ use x .

10. Pointing to a man, a woman said, "His mother is the only daughter of my mother." How is the woman related to the man?

- (A) Sister
- (B) Mother
- (C) Aunt
- (D) Grandmother

Correct Answer: (B) Mother

Solution:

Topic - Blood Relations:

This logical reasoning question requires breaking down family ties through a descriptive statement.

Step 1: Understanding the Question:

We need to determine the relationship between the woman speaking and the man she is pointing to.

Step 2: Key Formula or Approach:

Break the sentence into parts from the end to the beginning.

Step 3: Detailed Solution:

1. "Only daughter of my mother": This refers to the woman herself (since she is the speaker and the only daughter).
2. Now substitute this back into the statement: "His mother is [Me]".
3. This implies the woman is the mother of the man.

Step 4: Final Answer:

The woman is the man's mother.

Quick Tip: In blood relation problems, "Only daughter of my mother" or "Only son of my father" always refers to the person themselves.

11. Find the missing number in the series: 2, 6, 12, 20, 30, ?

- (A) 36
- (B) 40
- (C) 42
- (D) 44

Correct Answer: (C) 42

Solution:**Topic - Number Series:**

This question requires identifying the mathematical pattern or progression in a given sequence of numbers.

Step 1: Understanding the Question:

Analyze the gap between consecutive numbers to find the rule governing the series.

Step 2: Key Formula or Approach:

Check for the difference between terms (Arithmetic progression or increasing difference).

Step 3: Detailed Solution:

1. Calculate the differences:

$$6 - 2 = 4$$

$$12 - 6 = 6$$

$$20 - 12 = 8$$

$$30 - 20 = 10$$

2. The differences are 4, 6, 8, 10. This is an AP with a common difference of 2.

3. The next difference should be $10 + 2 = 12$.

4. The missing number is $30 + 12 = 42$.

Step 4: Final Answer:

The next number in the series is 42.

Quick Tip: This series also follows the pattern $n^2 + n$:

$$1^2 + 1 = 2, 2^2 + 2 = 6, 3^2 + 3 = 12, 4^2 + 4 = 20, 5^2 + 5 = 30, 6^2 + 6 = 42.$$

12. If "WATER" is coded as "YCVGT", what is the code for "FIRE"?

(A) HKTG

(B) HKUF

(C) HJTG

(D) HKTE

Correct Answer: (A) HKTG

Solution:

Topic - Coding-Decoding:

In this topic, we decipher the logic used to transform a word into a code and apply it to a new word.

Step 1: Understanding the Question:

Compare "WATER" and "YCVGT" to find the shift in alphabet positions.

Step 2: Key Formula or Approach:

Identify the positional shift (forward or backward) for each letter.

Step 3: Detailed Solution:

1. $W \xrightarrow{+2} Y$

2. $A \xrightarrow{+2} C$

3. $T \xrightarrow{+2} V$

4. $E \xrightarrow{+2} G$

5. $R \xrightarrow{+2} T$

Each letter is shifted 2 places forward.

Apply this to "FIRE":

1. $F \xrightarrow{+2} H$

2. $I \xrightarrow{+2} K$

3. $R \xrightarrow{+2} T$

4. $E \xrightarrow{+2} G$

Step 4: Final Answer:

The code for FIRE is HKTG.

Quick Tip: Writing the alphabet with their numerical positions (A=1, B=2, etc.) quickly helps in identifying complex shifts in coding questions.

13. Identify the error: "Neither the players nor the coach were present at the meeting."

- (A) Neither
- (B) players
- (C) were
- (D) meeting

Correct Answer: (C) Replace "were" with "was"

Solution:

Topic - English Grammar (Subject-Verb Agreement):

This question tests the "Rule of Proximity" used with correlative conjunctions.

Step 1: Understanding the Question:

We need to find the grammatical error in a sentence using "Neither...nor".

Step 2: Key Formula or Approach:

Rule: When two subjects are joined by "Neither...nor", the verb must agree with the subject closest to it.

Step 3: Detailed Solution:

1. The two subjects are "players" (plural) and "coach" (singular).
2. The verb follows the subject "coach", which is singular.
3. Therefore, the verb should be "was" instead of "were".

Step 4: Final Answer:

The error is in "were"; it should be "was".

Quick Tip: Remember: Neither S1 nor S2 + Verb (agrees with S2).

Example: Neither the teacher nor the students **are** here. (Students is plural).

14. Choose the correct preposition: "The property was divided ___ the four brothers."

- (A) Between
- (B) Among
- (C) With
- (D) For

Correct Answer: (B) Among

Solution:

Topic - English Grammar (Prepositions):

This question involves selecting the appropriate preposition based on the number of entities involved in a distribution.

Step 1: Understanding the Question:

Determine whether to use "between" or "among" for dividing property among four people.

Step 2: Key Formula or Approach:

- Use "Between" for two people/items.
- Use "Among" for more than two people/items.

Step 3: Detailed Solution:

1. The sentence refers to "four brothers".
2. Since 4 is greater than 2, the correct preposition for distribution is "among".

Step 4: Final Answer:

The correct word is "Among".

Quick Tip: While "between" is mostly for two, it can be used for more than two if referring to distinct, specific individual relationships (e.g., a treaty between four countries). However, for general distribution, "among" is preferred for groups.

15. What is the antonym of "Vague"?

- (A) Uncertain
- (B) Doubtful
- (C) Precise
- (D) Ambiguous

Correct Answer: (C) Precise (or Clear)

Solution:

Topic - Vocabulary (Antonyms):

Antonyms are words with opposite meanings. Understanding the context and definition is key to solving these.

Step 1: Understanding the Question:

Find a word that means the opposite of "Vague".

Step 2: Key Formula or Approach:

Define the given word and evaluate the options based on their meanings.

Step 3: Detailed Solution:

1. Vague: Not clearly expressed, indefinite, or blurred.
2. Uncertain/Doubtful/Ambiguous: These are synonyms or related in meaning to vague.
3. Precise: Marked by exactness and accuracy of expression; clearly defined.
4. Therefore, "Precise" is the opposite.

Step 4: Final Answer:

The antonym is Precise.

Quick Tip: If you are unsure of the answer, eliminate options that have similar meanings. Since A, B, and D all imply lack of clarity, C is the only logical outlier.