



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. Evaluate the integral $\int_0^{\pi/2} \frac{\sin x}{\sin x + \cos x} dx$.

- (A) $\frac{\pi}{2}$
- (B) $\frac{\pi}{4}$
- (C) $\frac{\pi}{6}$
- (D) $\frac{\pi}{3}$

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

Solution:

Step 1: Understanding the Question:

The problem asks us to calculate the value of a definite integral involving trigonometric functions in the denominator where the limits are from 0 to $\pi/2$.

Step 2: Key Formula or Approach:

We use the "King's Property" of definite integrals:

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

This property is particularly useful for integrals involving $\sin x$ and $\cos x$ over the interval $[0, \pi/2]$.

Step 3: Detailed Explanation:

Let the given integral be I :

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

Applying the property $\int_0^a f(x) dx = \int_0^a f(a-x) dx$, we replace x with $\frac{\pi}{2} - x$:

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

Since $\sin(\frac{\pi}{2} - x) = \cos x$ and $\cos(\frac{\pi}{2} - x) = \sin x$, we get:

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

Adding equations (i) and (ii):

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

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

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

$$2I = \frac{\pi}{2} - 0$$

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

Step 4: Final Answer:

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

Quick Tip: Whenever you see an integral of the form $\int_0^{\pi/2} \frac{f(\sin x)}{f(\sin x) + f(\cos x)} dx$, the result is always $\frac{\pi}{4}$. This symmetry saves time during exams.

2. Find the area bounded by the curve $y^2 = 4x$ and its latus rectum.

- (A) $\frac{4}{3}$ sq units
- (B) $\frac{8}{3}$ sq units
- (C) $\frac{16}{3}$ sq units
- (D) $\frac{2}{3}$ sq units

Correct Answer: (B) $\frac{8}{3}$ sq units

Solution:

Step 1: Understanding the Question:

The objective is to find the area enclosed between a standard rightward-opening parabola and the vertical line passing through its focus (the latus rectum).

Step 2: Key Formula or Approach:

1. For the parabola $y^2 = 4ax$, the latus rectum is the line $x = a$.
2. The area is symmetric about the x -axis, so total area $A = 2 \times \int_0^a y \, dx$.

Step 3: Detailed Explanation:

The given equation is $y^2 = 4x$.

Comparing this with the standard form $y^2 = 4ax$, we find $4a = 4$, which implies $a = 1$.

The latus rectum is the line $x = 1$.

The required area is bounded by $x = 0$ to $x = 1$.

From $y^2 = 4x$, we get $y = 2\sqrt{x}$ (for the upper half).

$$\text{Required Area} = 2 \int_0^1 y \, dx$$

$$\text{Area} = 2 \int_0^1 2\sqrt{x} \, dx$$

$$\text{Area} = 4 \int_0^1 x^{1/2} \, dx$$

$$\text{Area} = 4 \left[\frac{x^{3/2}}{3/2} \right]_0^1$$

$$\text{Area} = 4 \times \frac{2}{3} [x^{3/2}]_0^1$$

$$\text{Area} = \frac{8}{3}(1 - 0) = \frac{8}{3} \text{ sq units}$$

Step 4: Final Answer:

The area bounded by the curve and its latus rectum is $\frac{8}{3}$ sq units.

Quick Tip: The area bounded by the parabola $y^2 = 4ax$ and its latus rectum is always $\frac{8a^2}{3}$. Substituting $a = 1$ directly gives $8/3$.

3. What happens to the magnetic field at the center of a circular coil if the number of turns is doubled while current remains constant?

- (A) It becomes half ($\frac{B}{2}$)
- (B) It remains the same (B)
- (C) It doubles ($2B$)
- (D) It becomes four times ($4B$)

Correct Answer: (C) $2B$

Solution:

Step 1: Understanding the Question:

We need to determine the change in the magnetic field magnitude at the center of a circular loop when the number of turns n is modified, keeping the current I and radius R constant.

Step 2: Key Formula or Approach:

The magnetic field B at the center of a circular coil with n turns is given by:

$$B = \frac{\mu_0 n I}{2R}$$

From this, we observe that $B \propto n$ when I and R are constant.

Step 3: Detailed Explanation:

Initially, let the magnetic field be $B_1 = \frac{\mu_0 n_1 I}{2R}$.

Given: $n_2 = 2n_1$ and current I remains the same.

The new magnetic field B_2 is:

$$B_2 = \frac{\mu_0 (2n_1) I}{2R}$$

$$B_2 = 2 \left(\frac{\mu_0 n_1 I}{2R} \right)$$

$$B_2 = 2B_1$$

Thus, the magnetic field is doubled.

Step 4: Final Answer:

The magnetic field becomes $2B$.

Quick Tip: Note the difference: If a wire of fixed length is rewound to double the turns, the radius R also changes (R becomes half), leading to a 4-fold increase in B . Here, only n changes, so it is a simple linear proportionality.

4. An object is placed 15 cm in front of a concave mirror of focal length 10 cm. Find the position and nature of the image.

- (A) 20 cm in front, real and inverted
- (B) 30 cm in front, real and inverted
- (C) 30 cm behind, virtual and erect
- (D) 15 cm behind, virtual and erect

Correct Answer: (B) 30 cm in front of mirror, real and inverted

Solution:

Step 1: Understanding the Question:

We are given the object distance and focal length for a concave mirror and must find the image distance v and determine if the image is real or virtual.

Step 2: Key Formula or Approach:

1. Mirror Formula: $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$
2. Magnification: $m = -\frac{v}{u}$
3. Sign Convention: For a concave mirror, f is negative. Object distance u is always negative.

Step 3: Detailed Explanation:

Given:

$$u = -15 \text{ cm}$$

$$f = -10 \text{ cm}$$

Applying the mirror formula:

$$\frac{1}{-10} = \frac{1}{v} + \frac{1}{-15}$$

$$\frac{1}{v} = \frac{1}{15} - \frac{1}{10}$$

Taking LCM of 15 and 10, which is 30:

$$\frac{1}{v} = \frac{2-3}{30}$$

$$\frac{1}{v} = -\frac{1}{30}$$

$$v = -30 \text{ cm}$$

Since v is negative, the image is formed 30 cm in front of the mirror.

A negative v for a real object in mirrors signifies a **real and inverted** image.

Step 4: Final Answer:

The image is formed 30 cm in front of the mirror and is real and inverted.

Quick Tip: If the object is between C and F (here $C = 20, F = 10, u = 15$), the image will always be formed beyond C , and it will be real, inverted, and magnified.

5. Identify the IUPAC name for the coordination compound $[Co(NH_3)_6]Cl_3$.

- (A) Hexaamminecobalt(II) chloride
- (B) Hexaamminecobalt(III) chloride
- (C) Hexaamminecobalt(IV) chloride
- (D) Amminecobalt(III) chloride

Correct Answer: (B) Hexaamminecobalt(III) chloride

Solution:

Step 1: Understanding the Question:

The task is to name the given coordination complex according to IUPAC rules, which involve naming ligands, the central metal, and its oxidation state.

Step 2: Key Formula or Approach:

1. Name the ligands in alphabetical order (here only one type: ammine).
2. Use prefixes (hexa for 6).
3. Name the central metal (cobalt).
4. Calculate the oxidation state of the metal.
5. Name the counter ion (chloride).

Step 3: Detailed Explanation:

1. **Ligands:** There are 6 NH_3 groups. NH_3 is a neutral ligand named "ammine". Thus, "hexaammine".
 2. **Oxidation State:** Let the oxidation state of Co be x .
 NH_3 is neutral (charge = 0), and Cl has a charge of -1.
$$x + 6(0) + 3(-1) = 0$$
$$x - 3 = 0 \Rightarrow x = +3.$$

So, it is Cobalt(III).
 3. **Metal Name:** Since the complex cation is positive, the metal name remains "cobalt".
 4. **Counter Ion:** The ion outside the bracket is chloride.
- Combining these, we get: Hexaamminecobalt(III) chloride.

Step 4: Final Answer:

The IUPAC name is Hexaamminecobalt(III) chloride.

Quick Tip: Double-check the spelling of "ammine" (with two 'm's) for NH_3 , as "amine" (one 'm') refers to organic compounds. Also, never use numerical prefixes for the counter ions (like trichloride).

6. Which of the following is an example of a condensation polymer?

- (A) Polyethylene
- (B) PVC
- (C) Nylon 6,6
- (D) Polystyrene

Correct Answer: (C) Nylon 6,6

Solution:

Step 1: Understanding the Question:

We need to distinguish between addition polymers (formed by simply linking monomers) and condensation polymers (formed with the loss of small molecules).

Step 2: Key Formula or Approach:

Condensation polymerization typically involves bifunctional or trifunctional monomers and results in the elimination of a byproduct like H_2O , NH_3 , or HCl .

Step 3: Detailed Explanation:

1. **Polyethylene, PVC, and Polystyrene:** These are addition polymers formed from alkenes (ethene, vinyl chloride, and styrene respectively) without any loss of molecules.
2. **Nylon 6,6:** It is prepared by the condensation of hexamethylenediamine and adipic acid.



In this process, water (H_2O) molecules are eliminated as the amide bonds form. This makes it a condensation polymer.

Step 4: Final Answer:

Nylon 6,6 is the correct example of a condensation polymer.

Quick Tip: Most polymers containing heteroatoms (like N or O) in the main backbone (polyamides, polyesters) are condensation polymers. Purely hydrocarbon chains (like plastics) are usually addition polymers.

7. Find the missing number in the series: 2, 6, 12, 20, 30, __.

- (A) 38
- (B) 40
- (C) 42
- (D) 44

Correct Answer: (C) 42

Solution:

Step 1: Understanding the Question:

We are given a sequence of numbers and need to identify the underlying mathematical rule to find the next term.

Step 2: Key Formula or Approach:

The first step in series completion is to check the difference between consecutive terms. If the difference is not constant, check if the differences themselves form a sequence.

Step 3: Detailed Explanation:

Let's analyze the gaps between the terms:

$$6 - 2 = 4$$

$$12 - 6 = 6$$

$$20 - 12 = 8$$

$$30 - 20 = 10$$

The differences are 4, 6, 8, 10.

We see that the difference is increasing by 2 at each step.

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

Therefore, the missing number is $30 + 12 = 42$.

Alternatively, the pattern can be seen as $n^2 + n$:

$$1^2 + 1 = 2$$

$$2^2 + 2 = 6$$

$$3^2 + 3 = 12$$

$$4^2 + 4 = 20$$

$$5^2 + 5 = 30$$

$$6^2 + 6 = 42.$$

Step 4: Final Answer:

The next number in the series is 42.

Quick Tip: If the differences between terms are in an arithmetic progression (like 4, 6, 8, 10), the series is related to a quadratic equation. Always check both differences and n^2/n^3 patterns.

8. If 'FRIEND' is coded as 'HUMJTK', how is 'CANDLE' coded?

- (A) EDRJRI
- (B) EDQJRI
- (C) EDSJRI
- (D) EDRKRI

Correct Answer: (A) EDRJRI

Solution:

Step 1: Understanding the Question:

We need to find the transformation rule applied to the word "FRIEND" and apply the exact same rule to "CANDLE".

Step 2: Key Formula or Approach:

Map the alphabetical positions of the letters and determine the numerical shift for each position.

Step 3: Detailed Explanation:

Analyze "FRIEND" to "HUMJTK":

F (+2) → H

R (+3) → U

I (+4) → M

E (+5) → J

N (+6) → T

D (+7) → K

The logic is an increasing shift: +2, +3, +4, +5, +6, +7.

Now apply this to "CANDLE":

C (+2) → E

A (+3) → D

N (+4) → R

D (+5) → J

L (+6) → R

E (+7) → I

The resulting code is "EDRJRI".

Step 4: Final Answer:

The code for CANDLE is EDRJRI.

Quick Tip: In the exam, quickly write down the alphabet with numbers (A=1, B=2... Z=26). This makes calculating shifts like +7 much faster and less prone to error.

9. Choose the correct synonym for “Benevolent”.

(A) Cruel

(B) Kind/Generous

- (C) Angry
- (D) Selfish

Correct Answer: (B) Kind/Generous

Solution:

Step 1: Understanding the Question:

The objective is to identify a word from the options that has a similar meaning to "Benevolent".

Step 2: Key Formula or Approach:

Identify the root word or the general sentiment (positive/negative) of the word.

Step 3: Detailed Explanation:

The word "Benevolent" comes from the Latin root "Bene" (meaning well/good) and "Volent" (from "Velle", meaning to wish). Therefore, it means "wishing well" or being charitable and kind.

Evaluating the options:

- **Cruel:** This is the opposite (antonym).
- **Kind/Generous:** This matches the definition of benevolence.
- **Angry:** This refers to an emotional state of displeasure, unrelated to benevolence.
- **Selfish:** This is an antonym, as benevolence implies selflessness.

Step 4: Final Answer:

The correct synonym is Kind/Generous.

Quick Tip: Use root analysis: "Bene-" always signifies something good (benefit, benefactor), whereas "Male-" signifies something bad (malevolent, malicious). This helps in choosing the right sentiment.