AIIMS Paramedical 2026

Question Paper (Memory-Based) with Solutions

Conducted by AIIMS Delhi

General Instructions

(i) Duration of the exam is 90 minutes.

(ii) This question paper consists of 90 questions.

(iii) Question Paper is divided into 3 sections- Physics, Chemistry and Mathematics or Biology having 30 questions each.

(iv) Each question carries 1 mark and their is negative marking of 1/3 for every incorrect answer.

Biology

1. Oxytocin and Vasopressin are secreted by:

(A) Anterior pituitary
(B) Posterior pituitary
(C) Hypothalamus
(D) Adrenal gland

Correct Answer: (B) Posterior pituitary

Solution:

Step 1: Understanding the Question:
The question is based on the human endocrine system, specifically the site of secretion of neurohypophyseal hormones.

It requires identifying which gland is responsible for releasing oxytocin and vasopressin into the systemic circulation.

Step 2: Key Formula or Approach:
This is a concept-based biology question.
The approach involves distinguishing between the site of hormone synthesis and the site of hormone secretion.

Step 3: Detailed Explanation:

- Oxytocin and vasopressin (or antidiuretic hormone, ADH) are nonapeptides synthesized in the hypothalamus.
- Specifically, oxytocin is synthesized in the neurons of the paraventricular nucleus, while vasopressin is synthesized in the supraoptic nucleus.
- Following synthesis, these hormones are packaged into secretory granules and transported axonally down the hypothalamo-hypophyseal tract.
- They terminate and are stored in the posterior pituitary gland (neurohypophysis) in specialized axon terminals called Herring bodies.
- Upon stimulation by appropriate electrical signals, these hormones are released via exocytosis into the capillary plexus of the posterior pituitary.
- Thus, while the hypothalamus is the site of synthesis, the posterior pituitary is the anatomical site of storage and secretion into the bloodstream.

Step 4: Final Answer:
Since the question asks which organ secretes these hormones, the correct option is the

posterior pituitary.

Quick Tip: Remember that the posterior pituitary (neurohypophysis) does not synthesize any hormones of its own.
It only stores and secretes hormones that are synthesized by the hypothalamus.

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2. The outer layer of Dicot root is called:

(A) Epidermis
(B) Endodermis
(C) Pericycle
(D) Cortex

Correct Answer: (A) Epidermis

Solution:

Step 1: Understanding the Question:
The question requires us to identify the outermost tissue layer of a dicotyledonous root.
This is a standard question from plant anatomy focusing on root tissue organization.

Step 2: Key Formula or Approach:
We examine the concentric arrangement of tissue layers in a typical dicot root from the outside to the inside.
The order of layers is: Epidermis (Epiblema) → Cortex → Endodermis → Pericycle → Vascular Bundles.

Step 3: Detailed Explanation:

- The outermost layer of a dicot root is called the epidermis, also commonly referred to as

the epiblema or piliferous layer.

- It consists of a single layer of compactly arranged, thin-walled parenchymatous cells.
- Unlike the stem epidermis, the root epidermis typically lacks a thick cuticle and stomata to allow for efficient water absorption.
- Many of the epidermal cells protrude outwards to form unicellular root hairs, which significantly increase the surface area for absorption of water and minerals.
- The layer directly beneath the epidermis is the cortex, which consists of multiple layers of loosely packed parenchyma cells.
- The endodermis is the innermost layer of the cortex, characterized by barrel-shaped cells containing Casparian strips.
- The pericycle lies inward to the endodermis and gives rise to lateral roots.

Step 4: Final Answer:
Thus, the outermost layer of the dicot root is the epidermis (epiblema).

Quick Tip: In root anatomy, the terms 'epidermis', 'epiblema', and 'piliferous layer' are used interchangeably.
Look for these synonyms when solving questions about root tissue systems.

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3. The notch of kidney where vessels enter is called:

(A) Hilum

(B) Pelvis

(C) Calyx

(D) Ureter

Correct Answer: (A) Hilum

Solution:

Step 1: Understanding the Question:

The question asks for the anatomical name of the specific notch on the kidney where blood vessels, nerves, and ureters enter or exit.

This is a fundamental question of renal anatomy.

Step 2: Key Formula or Approach:

The approach involves identifying the structural entry and exit portal on the medial surface of the kidney.

We analyze the role and position of the hilum, pelvis, calyx, and ureter.

Step 3: Detailed Explanation:

- The kidney is a bean-shaped organ located in the retroperitoneal space.
- On the medial concave border of each kidney, there is a deep, vertical slit or notch known as the renal hilum (or hilus).
- The hilum serves as the primary gateway for structures entering and leaving the kidney.
- These structures include the renal artery, renal vein, lymphatic vessels, nerves, and the renal pelvis which leads to the ureter.
- The renal pelvis is a funnel-shaped structure internal to the hilum that collects urine from the calyces.

- Calyces (minor and major) are cup-like subdivisions of the pelvis that receive urine from the renal papillae of the medullary pyramids.

- The ureter is the long muscular tube that carries urine from the renal pelvis to the urinary bladder.

Step 4: Final Answer:

The notch on the medial surface where vessels and nerves enter the kidney is the hilum.

Quick Tip: To easily recall renal landmarks, remember:

Hilum = Entrance/Exit Gate.

Pelvis = Funnel collector.

Ureter = Transport pipe.

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4. Who is called the Father of Ecology in India?

(A) Ramdeo Misra

(B) S. P. Singh

(C) Salim Ali

(D) M. S. Swaminathan

Correct Answer: (A) Ramdeo Misra

Solution:

Step 1: Understanding the Question:

The question asks for the identity of the scientist recognized as the "Father of Ecology in India". This is a factual and historical question in the field of Indian environmental biology.

Step 2: Key Formula or Approach:

We identify the contributions of the listed scientists to find who pioneered ecological research and education in India.

Step 3: Detailed Explanation:

- Professor Ramdeo Misra is widely recognized as the Father of Ecology in India.
- He established the first dedicated postgraduate course in ecology at Banaras Hindu University (BHU) in Varanasi.
- His extensive research on tropical communities, primary productivity, and nutrient cycling laid the foundation for modern ecological studies in the country.
- He also played an instrumental role in the establishment of the National Committee for Environmental Planning and Coordination, which later evolved into the Ministry of Environment and Forests.
- Let us evaluate the other options:
- S. P. Singh is a prominent ecologist known for his work on forest ecology, but is not the founder.
- Salim Ali is famously known as the "Birdman of India" and was a renowned ornithologist and naturalist.
- M. S. Swaminathan is internationally celebrated as the "Father of the Green Revolution in India" for his work in agriculture and genetics.

Step 4: Final Answer:

Therefore, Professor Ramdeo Misra is the correct choice as the pioneer of Indian ecology.

Quick Tip: In biological history questions, associate key terms with scientists:

Ramdeo Misra = Indian Ecology.

M. S. Swaminathan = Green Revolution.

Salim Ali = Ornithology.

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5. Which animal was not Uricotelic?

(A) Birds

(B) Land snail

(C) Reptiles

(D) Adult Frog

Correct Answer: (D) Adult Frog

Solution:

Step 1: Understanding the Question:

The question asks to identify the animal among the given options that is NOT uricotelic.

Uricotelic animals are those that excrete nitrogenous waste primarily in the form of uric acid.

Step 2: Key Formula or Approach:

We analyze the mode of excretion of different animal groups based on water conservation needs.

Animals are classified into three major groups:

1. Ammonotelic (excrete ammonia, requires high water).
2. Ureotelic (excrete urea, requires moderate water).
3. Uricotelic (excrete uric acid, requires minimal water).

Step 3: Detailed Explanation:

- Uricotelic organisms excrete uric acid or its salts as a paste or dry pellet.
- Uric acid is highly insoluble in water and relatively non-toxic, allowing organisms to conserve maximum body water.
- This is a vital adaptation for terrestrial environments with limited water availability, such as those inhabited by birds, land snails, insects, and reptiles.
- Consequently, birds, land snails, and reptiles are classically categorized as uricotelic.
- On the other hand, the adult frog is a semi-aquatic amphibian.
- Adult frogs live in environments where water is accessible, and they excrete their nitrogenous waste as urea, which is soluble in water and moderately toxic.
- Thus, adult frogs are ureotelic, not uricotelic.
- Note that the larval stage of a frog (tadpole) is ammonotelic because it lives exclusively in water.

Step 4: Final Answer:

The adult frog is ureotelic, making it the correct option for an animal that is not uricotelic.

Quick Tip: An easy way to remember the excretory products based on habitat:

Aquatic (fish, tadpoles) → Ammonotelic.

Terrestrial/Semi-aquatic (mammals, adult frogs) → Ureotelic.

Highly dry-adapted/Aerial (birds, reptiles, snails) → Uricotelic.

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6. Which bacteria converts nitrite to nitrate?

(A) Nitrosomonas

(B) Nitrobacter

(C) Rhizobium

(D) Azotobacter

Correct Answer: (B) Nitrobacter

Solution:

Step 1: Understanding the Question:

The question asks for the name of the bacterium that specifically oxidizes nitrite (NO_2^-) into nitrate (NO_3^-).

This is a standard question from the nitrogen cycle in mineral nutrition.

Step 2: Key Formula or Approach:

We examine the two distinct steps of the biological process called nitrification:

Step 1: Ammonia (NH_3) is oxidized to Nitrite (NO_2^-).

Step 2: Nitrite (NO_2^-) is oxidized to Nitrate (NO_3^-).

Step 3: Detailed Explanation:

- Nitrification is an aerobic process carried out by chemoautotrophic bacteria.

- The first step, converting ammonia to nitrite, is catalyzed by ammonia-oxidizing bacteria such as *Nitrosomonas* and *Nitrosococcus*:

$$2NH_3 + 3O_2 \rightarrow 2NO_2^- + 2H^+ + 2H_2O$$

- The second step, converting the toxic nitrite to the plant-absorbable nitrate, is catalyzed by nitrite-oxidizing bacteria such as *Nitrobacter* and *Nitrococcus*:

$$2NO_2^- + O_2 \rightarrow 2NO_3^-$$

- Let us evaluate the other options:

- *Rhizobium* is a symbiotic nitrogen-fixing bacterium associated with root nodules of legumes.

- *Azotobacter* is a free-living, aerobic nitrogen-fixing bacterium found in the soil.

- Since the question specifies the conversion of nitrite to nitrate, *Nitrobacter* is the correct organism.

Step 4: Final Answer:

The bacterium responsible for converting nitrite to nitrate is *Nitrobacter*.

Quick Tip: Remember the alphabetic flow of the nitrification process:

Ammonia → Nitrite (by **Nitrosomonas**).

Nitrite → Nitrate (by **Nitrobacter**).

S comes before **B** in 'Nitroso' and 'Nitroba', matching the order of reactions.

7. What is the function of Tapetum?

(A) Provides nourishment to pollen grains

(B) Protects the ovule

(C) Helps in fertilization

(D) Produces pollen grains

Correct Answer: (A) Provides nourishment to pollen grains

Solution:

Step 1: Understanding the Question:

The question asks for the physiological function of the tapetum layer in the anther of a flower. This is a core topic in the reproductive anatomy of angiosperms.

Step 2: Key Formula or Approach:

We examine the structural layers of a microsporangium (anther wall) from the outside in: Epidermis → Endothecium → Middle layers → Tapetum.

We identify the function of the innermost layer, which surrounds the sporogenous tissue.

Step 3: Detailed Explanation:

- The tapetum is the innermost cellular layer of the microsporangium wall.
- The cells of the tapetum are characterized by dense cytoplasm and are generally multinucleate (due to endomitosis).
- The primary function of the tapetum is to provide nourishment to the developing microspores (pollen grains).
- In addition to nourishment, the tapetum plays several other critical roles:
  1. It synthesizes and secretes the enzyme callase, which breaks the callose wall holding

the pollen tetrad together.

2. It produces Ubisch bodies, which contribute to the synthesis of sporopollenin, the extremely resistant organic substance forming the outer wall (exine) of pollen grains.

3. In insect-pollinated species, it contributes to the formation of a sticky, lipid-rich layer called pollenkitt on the surface of pollen grains.

- The outer three layers (epidermis, endothecium, and middle layers) primarily serve protective roles and help in the dehiscence of the anther to release pollen grains.

Step 4: Final Answer:

Thus, the primary and well-established function of the tapetum is to provide nourishment to the developing pollen grains.

Quick Tip: The tapetum is easily recognized in histological sections by its multinucleate cells and dense cytoplasm, reflecting its high metabolic activity in nourishing pollen grains.

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8. Which of the following is NOT a stop codon?

(A) UAA

(B) UAG

(C) UGA

(D) AUG

Correct Answer: (D) AUG

Solution:

Step 1: Understanding the Question:

The question asks us to identify the codon among the options that does NOT act as a translation termination (stop) codon.

This relates to the properties of the genetic code in molecular biology.

Step 2: Key Formula or Approach:

The genetic code consists of 64 codons, of which 61 code for amino acids and 3 serve as termination signals.

We recall the specific sequences of the three stop codons and the start codon.

Step 3: Detailed Explanation:

- During translation, ribosomes synthesize polypeptide chains based on mRNA sequences.
- Translation termination occurs when the ribosome encounters a stop codon (nonsense codon) on the mRNA.
- No transfer RNA (tRNA) has anticodons complementary to these stop codons; instead, release factors bind to them to release the polypeptide chain.
- The three stop codons in the standard genetic code are:
  1. UAA (Ochre)
  2. UAG (Amber)
  3. UGA (Opal)
- In contrast, the codon AUG is known as the initiation (start) codon.
- AUG serves a dual function: it signals the start of translation and codes for the amino acid methionine (or N-formylmethionine in prokaryotes).
- Since AUG is a start codon, it is not a stop codon.

Step 4: Final Answer:

Therefore, AUG is not a stop codon.

Quick Tip: Mnemonic to remember the three stop codons:

U Are **A**way (UAA)

U Are **G**one (UAG)

U Go **A**way (UGA)

And remember: **AUG** = **A**ll **U**sers **G**o (Start).

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9. How many bones are found in the forelimb?

(A) 30

(B) 32

(C) 34

(D) 36

Correct Answer: (A) 30

Solution:

Step 1: Understanding the Question:

The question asks for the total number of bones present in a single human forelimb (upper limb).

This is a standard anatomical question about the appendicular skeleton.

Step 2: Key Formula or Approach:

We count the individual bones starting from the upper arm down to the fingertips of one limb.

We sum the bones: Humerus + Radius + Ulna + Carpals + Metacarpals + Phalanges.

Step 3: Detailed Explanation:

- The human skeleton is divided into the axial and appendicular skeleton. The appendicular skeleton includes the limbs and their girdles.

- A single human forelimb contains exactly 30 bones, distributed as follows:
  1. **Humerus:** 1 bone in the upper arm.
  2. **Radius:** 1 bone in the lateral side of the forearm.
  3. **Ulna:** 1 bone in the medial side of the forearm.
  4. **Carpals:** 8 bones making up the wrist (Scaphoid, Lunate, Triquetrum, Pisiform, Trapezium, Trapezoid, Capitate, Hamate).
  5. **Metacarpals:** 5 bones forming the palm of the hand.
  6. **Phalanges:** 14 bones forming the fingers (2 in the thumb, 3 in each of the other four fingers).

- Adding these together:
  $1\ (\text{Humerus}) + 1\ (\text{Radius}) + 1\ (\text{Ulna}) + 8\ (\text{Carpals}) + 5\ (\text{Metacarpals}) + 14\ (\text{Phalanges}) = 30$ bones

- The shoulder girdle (clavicle and scapula) is associated with the limb but is structurally considered part of the pectoral girdle, not the forelimb itself.

Step 4: Final Answer:
The total number of bones in one human forelimb is 30.

Quick Tip: Both the human upper limb (forelimb) and lower limb (hindlimb) contain exactly 30 bones each, though their structural components differ (e.g., carpals vs tarsals, patella present in the knee).

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10. The Environment Protection Act was launched in India in which year?

(A) 1972

(B) 1980

(C) 1986

(D) 1990

Correct Answer: (C) 1986

Solution:

Step 1: Understanding the Question:
The question asks for the year of enactment of the Environment Protection Act in India. This is an important historical and legislative fact in environmental studies.

Step 2: Key Formula or Approach:
We recall the timeline of major environmental legislations enacted by the Indian Parliament.

Step 3: Detailed Explanation:

- The Environment Protection Act (EPA) of India was enacted in May 1986 and came into force on November 19, 1986.
- This Act was passed under Article 253 of the Constitution of India.
- The immediate catalyst for the creation of this comprehensive act was the catastrophic Bhopal Gas Tragedy, which occurred in December 1984.
- The primary objective of the Act is to provide an overarching framework for environmental protection, regulation, and the prevention of hazards to human beings, other living creatures, plants, and property.
- Let us examine the significance of the other years listed in the options:

- 1972: The Wildlife Protection Act was enacted.
- 1980: The Forest Conservation Act was passed.
- The Water (Prevention and Control of Pollution) Act was enacted in 1974, and the Air Act was enacted in 1981.

Step 4: Final Answer:

The Environment Protection Act was launched in the year 1986.

Quick Tip: Remember the sequence of major Indian environmental laws:

1972 → Wildlife Protection Act

1974 → Water Act

1981 → Air Act

1986 → Environment Protection Act (EPA)

Chemistry

11. The bond order of Li_2 is _____ and it is _____.

(A) 1, diamagnetic

(B) 2, paramagnetic

(C) 1, paramagnetic

(D) 2, diamagnetic

Correct Answer: (A) 1, diamagnetic

Solution:

Step 1: Understanding the Question:

The question asks for the bond order and magnetic nature of the dilithium (Li_2) molecule. This is solved using the principles of Molecular Orbital Theory (MOT).

Step 2: Key Formula or Approach:

The bond order is calculated using the formula:

$$\text{Bond Order} = \frac{N_b - N_a}{2}$$

Where N_b is the number of bonding electrons and N_a is the number of anti-bonding electrons.
Magnetic behavior is determined by the presence of unpaired electrons:
- Paramagnetic: At least one unpaired electron.
- Diamagnetic: All electrons are paired.

Step 3: Detailed Explanation:

- Lithium (Li) has an atomic number of 3, with an electronic configuration of $1s^2 2s^1$.

- A neutral Li_2 molecule has a total of 6 electrons ($3 \times 2 = 6$).

- According to Molecular Orbital Theory, the 6 electrons are filled into molecular orbitals in order of increasing energy:

$$\sigma_{1s}^2 \ \sigma_{1s}^{*2} \ \sigma_{2s}^2$$

- Let us identify the number of bonding and anti-bonding electrons:
  - Bonding orbitals (σ_{1s}, σ_{2s}) contain: $2 + 2 = 4$ electrons ($N_b = 4$).
  - Anti-bonding orbital (σ_{1s}^*) contains: 2 electrons ($N_a = 2$).

- Now, calculate the bond order:

$$\text{Bond Order} = \frac{4-2}{2} = \frac{2}{2} = 1$$

- Next, we check for unpaired electrons in the molecular orbital configuration.

- Since all occupied molecular orbitals (σ_{1s}, σ^*_{1s}, σ_{2s}) contain exactly two electrons, all 6 electrons are paired.

- Because there are no unpaired electrons, the Li_2 molecule is diamagnetic.

Step 4: Final Answer:

The bond order of Li_2 is 1, and its magnetic nature is diamagnetic.

Quick Tip: For light homonuclear diatomic molecules, if the total number of electrons is even (except for B_2 with 10 electrons and O_2 with 16 electrons), the molecule is almost always diamagnetic.

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12. The oxidation state of Cr in $K_2Cr_2O_7$ is:

(A) +4

(B) +5

(C) +6

(D) +7

Correct Answer: (C) +6

Solution:

Step 1: Understanding the Question:

The question asks for the oxidation state of Chromium (Cr) in Potassium Dichromate ($K_2Cr_2O_7$).

This is a redox chemistry question requiring algebraic determination of oxidation states.

Step 2: Key Formula or Approach:

The sum of oxidation states of all atoms in a neutral chemical compound is equal to zero.

We use the established oxidation numbers of known elements:

- Potassium (K), an alkali metal (Group 1), always has an oxidation state of $+1$ in its compounds.
- Oxygen (O), a chalcogen, typically has an oxidation state of -2 in non-peroxide compounds.

Step 3: Detailed Explanation:

- Let the oxidation state of Chromium (Cr) in $K_2Cr_2O_7$ be represented by x.

- The compound contains:
  - 2 Potassium (K) atoms
  - 2 Chromium (Cr) atoms
  - 7 Oxygen (O) atoms

- We set up the algebraic equation for the neutral molecule:

$$2 \times (\text{oxidation state of K}) + 2 \times (\text{oxidation state of Cr}) + 7 \times (\text{oxidation state of O}) = 0$$

- Substitute the known values into the equation:

$$2(+1) + 2(x) + 7(-2) = 0$$

- Simplify the equation step-by-step:

$$2 + 2x - 14 = 0$$

$$2x - 12 = 0$$

$$2x = 12$$

$$x = +6$$

- Therefore, the oxidation state of each Chromium atom is +6.

Step 4: Final Answer:

The calculated oxidation state of Chromium in Potassium Dichromate is +6.

Quick Tip: Chromium in its +6 oxidation state is in its highest possible oxidation state, which explains why Potassium Dichromate ($K_2Cr_2O_7$) is a very powerful oxidizing agent in chemical reactions.

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13. The oxidation states of carbon in CH_4 and CCl_4 respectively are:

(A) -4 and +4

(B) +4 and -4

(C) -4 and -4

(D) +4 and +4

Correct Answer: (A) -4 and +4

Solution:

Step 1: Understanding the Question:

The question asks to determine the oxidation state of Carbon (C) in Methane (CH_4) and Carbon Tetrachloride (CCl_4).

This requires evaluating electronegativity differences between carbon and the bonded atoms.

Step 2: Key Formula or Approach:

The oxidation state of an atom in a molecule is calculated by assigning formal charges based on electronegativity:

- Carbon (C) has a electronegativity of 2.55.
- Hydrogen (H) has a electronegativity of 2.20. (Hydrogen is less electronegative than Carbon, so it is assigned a +1 oxidation state).
- Chlorine (Cl) has a electronegativity of 3.16. (Chlorine is more electronegative than Carbon, so it is assigned a −1 oxidation state).

Step 3: Detailed Explanation:

- **Case 1: Methane (CH_4)**

  Let the oxidation state of carbon in CH_4 be x.

  Since hydrogen has an oxidation state of +1:

$$x + 4(+1) = 0$$

$$x + 4 = 0$$

$$x = -4$$

- **Case 2: Carbon Tetrachloride (CCl_4)**
  Let the oxidation state of carbon in CCl_4 be y.
  Since chlorine has an oxidation state of -1:

$$y + 4(-1) = 0$$

$$y - 4 = 0$$

$$y = +4$$

- This comparison shows that carbon can exhibit highly contrasting oxidation states (from -4 to $+4$) depending on the electronegativity of the atoms to which it is covalently bound.

Step 4: Final Answer:

The oxidation states of carbon in CH_4 and CCl_4 are -4 and $+4$, respectively.

Quick Tip: When bonded to less electronegative elements (like H), Carbon takes a negative oxidation state.
When bonded to more electronegative elements (like Halogens, O, N), Carbon takes a positive oxidation state.

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14. Which of the following statements is correct about Hg?

(A) Hg is paramagnetic

(B) Hg is diamagnetic

(C) Hg is ferromagnetic

(D) Hg has unpaired electrons

Correct Answer: (B) Hg is diamagnetic

Solution:

Step 1: Understanding the Question:

The question asks to identify the correct magnetic property of Mercury (Hg).

This is determined by checking the electronic configuration of Mercury for the presence of unpaired electrons.

Step 2: Key Formula or Approach:

We write the electronic configuration of Mercury (Hg, atomic number $Z = 80$).

We assess the filling of the subshells:

- If all electrons are paired, the substance is diamagnetic.
- If unpaired electrons are present, the substance is paramagnetic.

Step 3: Detailed Explanation:

- Mercury (Hg) is a transition element located in Group 12 and Period 6 of the periodic table, with atomic number 80.

- The complete electronic configuration of Mercury is:

$$[\text{Xe}]\ 4f^{14}\ 5d^{10}\ 6s^2$$

- Let us examine the outer subshells:

- The $4f$ subshell is fully filled with 14 electrons.
- The $5d$ subshell is fully filled with 10 electrons.
- The $6s$ subshell is fully filled with 2 electrons.

- Because every single atomic orbital in Mercury is completely filled, there are zero unpaired electrons.

- In the absence of unpaired electrons, the magnetic fields of the individual electron spins cancel each other out.

- Therefore, Mercury is weakly repelled by an external magnetic field, which is the defining characteristic of a diamagnetic substance.

- Since it has no unpaired electrons, options (A), (C), and (D) are incorrect.

Step 4: Final Answer:

Thus, Hg is diamagnetic due to its fully filled d and s subshells.

Quick Tip: Group 12 elements (Zn, Cd, Hg) have the general configuration $(n-1)d^{10}ns^2$.
Because of their completely filled d-orbitals, they are always diamagnetic in their elemental ground states.

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15. If 32 g of methane reacts completely with oxygen, how much water is produced? (CH_4 = 16 g/mol, H_2O = 18 g/mol)

(A) 36 g

(B) 54 g

(C) 72 g

(D) 18 g

Correct Answer: (C) 72 g

Solution:

Step 1: Understanding the Question:

The question asks for the mass of water produced from the complete combustion of 32 g of methane (CH_4) in the presence of excess oxygen.

This is a stoichiometry problem.

Step 2: Key Formula or Approach:

1. Write the balanced chemical equation for the combustion of methane.
2. Convert the given mass of methane to moles using the formula:

$$\text{Moles} = \frac{\text{Mass}}{\text{Molar Mass}}$$

3. Use the stoichiometric ratio from the balanced equation to find the moles of water produced.
4. Convert the moles of water back to mass.

Step 3: Detailed Explanation:

- **Step 3.1: Balanced Chemical Equation**

  The combustion of methane is represented as:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

  From this equation, we see that 1 mole of CH_4 reacts to produce 2 moles of H_2O.

- **Step 3.2: Calculate Moles of Methane**

  Given mass of $CH_4 = 32$ g

  Molar mass of $CH_4 = 16$ g/mol

$$\text{Moles of } CH_4 = \frac{32 \text{ g}}{16 \text{ g/mol}} = 2 \text{ moles}$$

- **Step 3.3: Calculate Moles of Water Produced**

  Using the stoichiometric coefficient ratio ($CH_4 : H_2O = 1 : 2$):

$$\text{Moles of } H_2O = 2 \times \text{Moles of } CH_4 = 2 \times 2 = 4 \text{ moles}$$

- **Step 3.4: Calculate Mass of Water Produced**

  Molar mass of $H_2O = 18$ g/mol

$$\text{Mass of } H_2O = \text{Moles of } H_2O \times \text{Molar Mass of } H_2O$$

$$\text{Mass of } H_2O = 4 \text{ moles} \times 18 \text{ g/mol} = 72 \text{ g}$$

Step 4: Final Answer:

The total mass of water produced is 72 g.

Quick Tip: We can also solve this quickly using mass-mass ratios:

16 g of methane (1 mole) gives 36 g of water (2 moles).

Doubling the reactant mass to 32 g simply doubles the product mass to 72 g.

Physics

16. A spherical ball of radius r falls through a viscous liquid. If the radius is doubled, the terminal velocity becomes:

(A) Same

(B) 2 times

(C) 4 times

(D) 8 times

Correct Answer: (C) 4 times

Solution:

Step 1: Understanding the Question:

The question asks how the terminal velocity of a falling spherical ball changes if its radius is doubled while falling through a viscous fluid.

This is a standard fluid mechanics problem governed by Stokes' Law.

Step 2: Key Formula or Approach:

The terminal velocity (v_t) of a spherical body falling through a viscous medium is given by the formula:

$$v_t = \frac{2}{9}\frac{r^2(\rho - \sigma)g}{\eta}$$

Where:

- r is the radius of the spherical ball.
- ρ is the density of the ball.
- σ is the density of the liquid.
- η is the coefficient of viscosity of the liquid.
- g is the acceleration due to gravity.

Step 3: Detailed Explanation:

- From the terminal velocity formula, we establish that if the densities of the ball and the fluid, the gravity, and the viscosity remain constant, terminal velocity is directly proportional to the square of the radius:

$$v_t \propto r^2$$

- Let the initial radius of the ball be $r_1 = r$, and the corresponding initial terminal velocity be $v_{t1} = v$.
- The final radius of the ball is doubled: $r_2 = 2r$.
- Let the new terminal velocity be v_{t2}.
- We take the ratio of the terminal velocities:

$$\frac{v_{t2}}{v_{t1}} = \left(\frac{r_2}{r_1}\right)^2$$

- Substitute r_1 and r_2 into the ratio:

$$\frac{v_{t2}}{v} = \left(\frac{2r}{r}\right)^2 = 2^2 = 4$$

$$v_{t2} = 4v$$

- This shows that doubling the radius results in a fourfold increase in the terminal velocity.

Step 4: Final Answer:

The terminal velocity becomes 4 times the original value.

Quick Tip: Remember that terminal velocity depends on the square of the radius ($v_t \propto r^2$).
If the radius increases by a factor of x, the terminal velocity will increase by a factor of x^2.

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17. The linear mass density of a stretched string is μ and tension is T. The wave velocity is:

(A) $\sqrt{T/\mu}$
(B) $\sqrt{\mu/T}$
(C) T/μ
(D) μ/T

Correct Answer: (A) $\sqrt{T/\mu}$

Solution:

Step 1: Understanding the Question:
The question asks for the mathematical expression of the speed of a transverse wave traveling along a stretched string.
This is a standard relation in wave mechanics.

Step 2: Key Formula or Approach:
The velocity of a transverse wave in a stretched string depends on the tension (T) in the string and its linear mass density (μ).
We can verify this formula using dimensional analysis.

Step 3: Detailed Explanation:

- The wave velocity (v) is determined by the restoring force (tension, T) and the inertial property (linear mass density, μ).

- Let us check the dimensions of each quantity:
  1. Tension (T) is a force, so its dimensional formula is:

$$[T] = [M^1 L^1 T^{-2}]$$

2. Linear mass density (μ) is mass per unit length (m/L), so its dimensional formula is:

$$[\mu] = [M^1 L^{-1} T^0]$$

- Let us find the dimensions of the ratio T/μ:

$$\left[\frac{T}{\mu}\right] = \frac{[M^1 L^1 T^{-2}]}{[M^1 L^{-1}]} = [L^2 T^{-2}]$$

- Taking the square root of this ratio:

$$\left[\sqrt{\frac{T}{\mu}}\right] = \sqrt{[L^2 T^{-2}]} = [L^1 T^{-1}]$$

- The dimensional formula $[L^1 T^{-1}]$ corresponds exactly to velocity.

- This confirms the physical derivation, which yields the wave velocity as:

$$v = \sqrt{\frac{T}{\mu}}$$

Step 4: Final Answer:

The velocity of the wave in a stretched string is given by the expression $\sqrt{T/\mu}$.

Quick Tip: To increase the speed of a wave in a string, you can either increase the tension (T) by stretching it tighter, or use a lighter string (decrease μ).

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18. The dimensional formula of magnetic field B is:

(A) $[M^1L^0T^{-2}A^{-1}]$
(B) $[M^1L^2T^{-2}A^{-1}]$
(C) $[M^1T^{-2}A^{-1}]$
(D) $[M^1L^0T^{-1}A^{-1}]$

Correct Answer: (A) $[M^1L^0T^{-2}A^{-1}]$

Solution:

Step 1: Understanding the Question:
The question asks for the dimensional formula of the magnetic field vector (B).
This is solved by using a standard physical equation that relates the magnetic field to other quantities with known dimensions.

Step 2: Key Formula or Approach:
We use the magnetic force equation acting on a moving charge (Lorentz Force):

$$F = qvB\sin\theta$$

Rearranging this to solve for B:

$$B = \frac{F}{qv\sin\theta}$$

We substitute the fundamental dimensions of Force (F), Charge (q), and Velocity (v).

Step 3: Detailed Explanation:

- Let us list the dimensional formulas of the individual variables:

  1. Force (F):

$$[F] = [M^1 L^1 T^{-2}]$$

  2. Charge (q): Since current $I = q/t$, we have $q = I \cdot t$.

$$[q] = [A^1 T^1]$$

  3. Velocity (v):

$$[v] = [L^1 T^{-1}]$$

  4. The term $\sin\theta$ is a dimensionless ratio:

$$[\sin\theta] = [M^0 L^0 T^0]$$

- Now, substitute these dimensions into the expression for B:

$$[B] = \frac{[M^1 L^1 T^{-2}]}{[A^1 T^1] \cdot [L^1 T^{-1}]}$$

- Simplify the denominator first:

$$[A^1 T^1] \cdot [L^1 T^{-1}] = [A^1 L^1 T^0]$$

- Now divide the numerator by the simplified denominator:

$$[B] = \frac{[M^1L^1T^{-2}]}{[A^1L^1T^0]} = [M^1L^0T^{-2}A^{-1}]$$

- Therefore, the dimensional formula for the magnetic field is $[M^1L^0T^{-2}A^{-1}]$.

Step 4: Final Answer:

The correct dimensional representation of the magnetic field B is $[M^1L^0T^{-2}A^{-1}]$.

Quick Tip: Alternatively, use the formula $F = ILB\sin\theta$.

Then, $[B] = [F]/([I][L]) = [MLT^{-2}]/([A][L]) = [MT^{-2}A^{-1}]$, which is equivalent to $[M^1L^0T^{-2}A^{-1}]$.

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19. If the temperature of a black body is doubled, the wavelength of maximum emission:

(A) Doubles

(B) Halves

(C) Becomes 4 times

(D) Remains same

Correct Answer: (B) Halves

Solution:

Step 1: Understanding the Question:

The question asks how the wavelength of maximum emission (λ_{max}) from a black body changes if its absolute temperature (T) is doubled.

This is governed by the laws of thermal radiation.

Step 2: Key Formula or Approach:

We apply Wien's Displacement Law, which relates the peak wavelength of black body radiation

to its absolute temperature:

$$\lambda_{max} \cdot T = b$$

Where b is Wien's displacement constant ($b \approx 2.898 \times 10^{-3}$ m $\cdot$ K).
This indicates that:

$$\lambda_{max} \propto \frac{1}{T}$$

Step 3: Detailed Explanation:

- Wien's Displacement Law states that the wavelength (λ_{max}) at which the emissive power of a black body is maximum is inversely proportional to its absolute temperature (T).
- Let the initial absolute temperature be $T_1 = T$ and the initial wavelength of maximum emission be λ_1.
- The final temperature is doubled: $T_2 = 2T$.
- Let the final wavelength of maximum emission be λ_2.
- Using the inverse proportionality:

$$\frac{\lambda_2}{\lambda_1} = \frac{T_1}{T_2}$$

- Substitute the values into the ratio:

$$\frac{\lambda_2}{\lambda_1} = \frac{T}{2T} = \frac{1}{2}$$

$$\lambda_2 = \frac{\lambda_1}{2}$$

- Thus, doubling the absolute temperature causes the wavelength of maximum emission to be halved.

Step 4: Final Answer:

The wavelength of maximum emission is halved.

Quick Tip: Wien's Law states $\lambda_{max} \propto 1/T$.

As a black body gets hotter, it shifts its peak emission to shorter wavelengths (higher frequencies), which is why heating metal makes it change color from red to yellow and then blue.

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20. The correct increasing order of wavelength for UV, Visible light, and Microwaves is:

(A) UV < Visible < Microwaves

(B) Microwaves < Visible < UV

(C) Visible < UV < Microwaves

(D) UV < Microwaves < Visible

Correct Answer: (A) UV < Visible < Microwaves

Solution:

Step 1: Understanding the Question:

The question asks for the correct increasing order of wavelength for three components of the electromagnetic spectrum: Ultraviolet (UV) radiation, Visible light, and Microwaves.

Step 2: Key Formula or Approach:

We recall the organization of the electromagnetic spectrum in terms of wavelength (λ).

The general order from shortest to longest wavelength is:

Gamma Rays → X-Rays → Ultraviolet → Visible → Infrared → Microwaves → Radio Waves.

Step 3: Detailed Explanation:

- Let us examine the specific wavelength ranges for the three types of radiation mentioned:

  1. **Ultraviolet (UV) Radiation:** Wavelength ranges approximately from 10 nm to 400 nm (10^{-8} m to 4×10^{-7} m).

  2. **Visible Light:** Wavelength ranges approximately from 400 nm to 700 nm (4×10^{-7} m to 7×10^{-7} m).

  3. **Microwaves:** Wavelength ranges approximately from 1 mm to 1 m (10^{-3} m to 1 m).

- Comparing these values, we have:

$$10 \text{ nm} - 400 \text{ nm (UV)} < 400 \text{ nm} - 700 \text{ nm (Visible)} < 1 \text{ mm} - 1 \text{ m (Microwaves)}$$

- Therefore, the correct increasing order of wavelength is:

$$\text{UV} < \text{Visible} < \text{Microwaves}$$

Step 4: Final Answer:

The correct increasing order of wavelength is represented by option (A).

Quick Tip: Remember that energy and frequency are inversely proportional to wavelength ($E = h\nu = hc/\lambda$).

Since UV has the highest energy among the three, it must have the shortest wavelength, while Microwaves have the lowest energy and the longest wavelength.
