MHT CET 2024 23 April Shift 1 Question Paper with Solutions

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question booklet contains 150 Multiple Choice Questions (MCQs).
2. Section-A: Physics & Chemistry - 50 Questions each and Section-B: Mathematics - 50 Questions.
3. Choice and sequence for attempting questions will be as per the convenience of the candidate.
4. Read each question carefully.
5. Determine the one correct answer out of the four available options given for each question.
6. Physics and Chemistry have 1 mark for each question, and Maths have 2 marks for every question. There shall be no negative marking.
7. No mark shall be granted for marking two or more answers of the same question, scratching, or overwriting.
8. Duration of the paper is 3 Hours.

1. What is the approximate size range of lymphocytes, a type of white blood cell?

(A) 5-10 micrometers.

(B) 10-15 micrometers.

(C) 15-20 micrometers.

(D) 20-25 micrometers.

Correct Answer: (B) 10-15 micrometers.

Solution:

Overview of lymphocytes.

Lymphocytes are a category of white blood cells that are vital for the immune system. They include T-cells, B-cells, and natural killer (NK) cells, which are involved in adaptive immunity and innate immune responses.

Lymphocyte size range.

The typical size of lymphocytes ranges from 10 to 15 micrometers. Larger lymphocytes are generally activated or immature, while smaller ones are usually in a resting state.

Explanation of options.

- **Option (A):** Incorrect. Lymphocytes are usually larger than 5-10 micrometers.
- **Option (B):** Correct. The common size range for lymphocytes is 10-15 micrometers.
- **Option (C):** Incorrect. Lymphocytes do not typically exceed 15 micrometers in size.
- **Option (D):** Incorrect. The size of lymphocytes rarely reaches 20-25 micrometers.

The correct size range for lymphocytes is: 10-15 micrometers.

Quick Tip

Lymphocytes, key players in the immune system, typically measure between 10 and 15 micrometers in size.

---

2. Which of the following hormones plays a key role in kidney osmoregulation by promoting water reabsorption in the collecting ducts?

(A) Insulin.

(B) Glucagon.

(C) Antidiuretic hormone (ADH).

(D) Aldosterone.

Correct Answer: (C) Antidiuretic hormone (ADH).

Solution:

Role of ADH in osmoregulation.

Antidiuretic hormone (ADH), also known as vasopressin, is released by the posterior pituitary gland. It facilitates water reabsorption in the collecting ducts by increasing their permeability to water.

Explanation of other hormones.

- **Insulin (Option A):** Incorrect. Insulin regulates glucose metabolism and does not influence kidney function related to water balance.
- **Glucagon (Option B):** Incorrect. Glucagon primarily regulates blood glucose levels and does not affect water reabsorption.
- **Aldosterone (Option D):** Incorrect. Aldosterone regulates sodium reabsorption, indirectly affecting water balance, but it is not the main hormone for osmoregulation.

The key hormone for water reabsorption in the collecting ducts is: Antidiuretic hormone (ADH).

Quick Tip

ADH promotes water reabsorption in the kidneys, helping maintain fluid balance, especially during dehydration or high blood osmolarity.

---

3. Which of the following structures in the kidney is primarily responsible for the reabsorption of water and solutes from the filtrate?

(A) Glomerulus.

(B) Bowman's capsule.

(C) Proximal convoluted tubule.

(D) Distal convoluted tubule.

Correct Answer: (C) Proximal convoluted tubule.

Solution:

Function of the proximal convoluted tubule (PCT).

The proximal convoluted tubule is the first section of the nephron where significant reabsorption occurs. Around 65-70

Explanation of other options.

- **Option (A): Glomerulus.** Incorrect. The glomerulus filters blood but does not directly reabsorb substances.
- **Option (B): Bowman's capsule.** Incorrect. The Bowman's capsule collects the filtrate but does not participate in reabsorption.
- **Option (D): Distal convoluted tubule.** Incorrect. The distal convoluted tubule is involved in fine-tuning solute reabsorption and secretion but does not account for the majority of reabsorption.

Conclusion.

The primary site for the reabsorption of water and solutes in the kidney is the proximal convoluted tubule.

The correct answer is: Proximal convoluted tubule (PCT).

Quick Tip

The proximal convoluted tubule is responsible for the majority of solute and water reabsorption, crucial for maintaining homeostasis.

---

5. In a monohybrid cross between two heterozygous parents ($Aa \times Aa$), what is the genotypic ratio among the offspring?

(A) 1:1.

(B) 1:2:1.

(C) 3:1.

(D) 9:3:3:1.

Correct Answer: (B) 1:2:1.

Solution:

Punnett square analysis.

For the cross $Aa \times Aa$, we construct a Punnett square as follows:

	A	a
A	AA	Aa
a	Aa	aa

Genotypic ratio.

The offspring genotypes are:

- AA: 1 individual.
- Aa: 2 individuals.
- aa: 1 individual.

The genotypic ratio is thus:

$$1 : 2 : 1.$$

Explanation of options.

- **Option (A):** Incorrect. This ratio is not possible for a monohybrid cross with two heterozygous parents.
- **Option (B):** Correct. The genotypic ratio for this cross is $1 : 2 : 1$.
- **Option (C):** Incorrect. This is the phenotypic ratio for a different type of cross.
- **Option (D):** Incorrect. This ratio is associated with a dihybrid cross.

The correct genotypic ratio is: $1 : 2 : 1$.

Quick Tip

For a monohybrid cross between two heterozygous individuals, the genotypic ratio is always $1:2:1$, while the phenotypic ratio is typically $3:1$.

---

6. Which of the following best describes the sympathetic pathway's effect on the glomerulus in the kidney?

(A) Sympathetic stimulation causes vasodilation of the afferent arteriole, increasing glomerular filtration rate (GFR).
(B) Sympathetic stimulation causes vasoconstriction of the afferent arteriole, decreasing glomerular filtration rate (GFR).
(C) Sympathetic stimulation has no effect on the glomerulus.
(D) Sympathetic stimulation causes vasodilation of the efferent arteriole, decreasing glomerular filtration rate (GFR).

Correct Answer: (B) Sympathetic stimulation causes vasoconstriction of the afferent arteriole, decreasing glomerular filtration rate (GFR).

Solution:

Sympathetic response in kidney function.

The sympathetic nervous system, activated during stress, causes vasoconstriction of the afferent arteriole, which reduces blood flow to the glomerulus and decreases the glomerular filtration rate (GFR).

Explanation of other options.

- **Option (A):** Incorrect. Vasodilation of the afferent arteriole would increase GFR, not decrease it.
- **Option (B):** Correct. Sympathetic stimulation causes vasoconstriction of the afferent arteriole, reducing GFR.
- **Option (C):** Incorrect. Sympathetic stimulation significantly impacts kidney function.
- **Option (D):** Incorrect. Sympathetic stimulation affects the afferent arteriole, not the efferent arteriole.

The correct answer is: Sympathetic stimulation causes vasoconstriction of the afferent arteriole, decreasing GFR.

Quick Tip

The sympathetic nervous system reduces GFR by causing vasoconstriction of the afferent arteriole, which helps conserve water and maintain blood pressure.

---

7. Which region of the brain plays a crucial role in regulating glomerular filtrate by influencing the release of hormones involved in kidney function?

(A) Cerebellum.
(B) Hypothalamus.
(C) Medulla oblongata.
(D) Cerebrum.

Correct Answer: (B) Hypothalamus.

Solution:

Role of the hypothalamus in kidney function.

The hypothalamus plays a key role in maintaining homeostasis, including fluid and electrolyte balance. It regulates kidney function by influencing the release of antidiuretic hormone (ADH) from the posterior pituitary gland, which in turn promotes water reabsorption in the kidneys.

Explanation of other options.

- **Option (A): Cerebellum.** Incorrect. The cerebellum is primarily responsible for motor coordination and balance, not kidney function.
- **Option (C): Medulla oblongata.** Incorrect. While it controls vital functions such as heart rate, it does not directly regulate kidney hormones.
- **Option (D): Cerebrum.** Incorrect. The cerebrum is responsible for higher cognitive functions and does not regulate kidney function.

Conclusion.

The hypothalamus is the primary brain region responsible for regulating hormones like ADH, which are crucial for kidney function.

The correct answer is: Hypothalamus.

Quick Tip

The hypothalamus regulates water balance in the body by influencing the release of hormones such as ADH, which control kidney function.

---

8. Which of the following terms describes the normal type of chromosome arrangement where an organism has the correct number of chromosomes?

(A) Monoploidy.
(B) Aneuploidy.
(C) Polyploidy.
(D) Euploidy.

Correct Answer: (D) Euploidy.

Solution:

Understanding chromosome arrangements.

The term "euploidy" refers to the normal chromosome arrangement in an organism, where the number of chromosomes is balanced and appropriate for the species. In humans, this means having two complete sets of chromosomes (diploid, $2n$).

Explanation of terms.

- **Monoploidy (Option A):** Refers to cells with a single set of chromosomes (e.g., n), which is rare in diploid organisms.
- **Aneuploidy (Option B):** Refers to an abnormal number of chromosomes due to the gain or loss of specific chromosomes (e.g., trisomy, monosomy).
- **Polyploidy (Option C):** Refers to organisms having more than two complete sets of chromosomes (e.g., $3n, 4n$), which is common in plants but abnormal in humans.

- **Euploidy (Option D):** Refers to the normal condition in which an organism has a complete set of chromosomes, either haploid or diploid depending on the species.

Conclusion.

The correct term for a normal chromosome arrangement is euploidy.

The correct answer is: Euploidy.

Quick Tip

Euploidy refers to the normal number of chromosomes in an organism, whereas aneuploidy indicates abnormalities in chromosome number.

---

9. In DNA fingerprinting, which of the following techniques is used to amplify specific regions of DNA for analysis?

(A) Polymerase Chain Reaction (PCR).

(B) Gel Electrophoresis.

(C) DNA Sequencing.

(D) Southern Blotting.

Correct Answer: (A) Polymerase Chain Reaction (PCR).

Solution:

Role of PCR in DNA fingerprinting.

Polymerase Chain Reaction (PCR) is a technique used to selectively amplify specific regions of DNA, enabling the creation of multiple copies of a target DNA sequence for analysis. This is a crucial step in DNA fingerprinting to identify genetic markers.

Explanation of other techniques.

- **Gel Electrophoresis (Option B):** This technique is used to separate DNA fragments by size but does not amplify DNA.
- **DNA Sequencing (Option C):** DNA sequencing identifies the exact sequence of nucleotides, but it is not used for amplification in fingerprinting.

- **Southern Blotting (Option D):** This technique detects specific DNA sequences but does not involve amplification of the DNA.

Conclusion.

PCR is the technique used to amplify specific regions of DNA for analysis in DNA fingerprinting.

The correct answer is: Polymerase Chain Reaction (PCR).

Quick Tip

PCR is an essential tool in molecular biology for amplifying specific DNA regions, making it fundamental in DNA fingerprinting and genetic analysis.

---

10. If adenine constitutes 30% of the bases in a DNA molecule, what percentage of the bases is guanine?

(A) 30%.

(B) 40%.

(C) 20%.

(D) 25%.

Correct Answer: (C) 20%.

Solution:

Understanding Chargaff's rule.

According to Chargaff's rule, in a double-stranded DNA molecule, adenine (A) pairs with thymine (T), and guanine (G) pairs with cytosine (C). Therefore:

$$A = T \quad \text{and} \quad G = C.$$

This means the sum of adenine and thymine equals the sum of guanine and cytosine:

$$A + T + G + C = 100\%.$$

Calculating the percentage of guanine.

If adenine makes up 30% of the bases, thymine must also make up 30%. This gives:

$$A + T = 30\% + 30\% = 60\%.$$

Thus, guanine and cytosine together must account for 40%:

$$G + C = 100\% - 60\% = 40\%.$$

Since guanine and cytosine are present in equal amounts:

$$G = C = \frac{40\%}{2} = 20\%.$$

Conclusion.

The percentage of guanine in the DNA molecule is 20%.

The correct answer is: 20%.

Quick Tip

Chargaff's rule states that in double-stranded DNA, adenine equals thymine, and guanine equals cytosine. This allows you to calculate base percentages when given one base's percentage.

---

11. What percentage of the world's area does India occupy?

(A) 4.4%.

(B) 6.1%.

(C) 2.4%.

(D) 9.8%.

Correct Answer: (C) 2.4%.

Solution:

Overview of India's land area.

India spans approximately 3.28 million square kilometers, accounting for around 2.4% of the total global land area, which is estimated to be 148.94 million square kilometers.

Calculating the percentage.

The percentage occupied by India is calculated by dividing its area by the total world land area:

$$\text{Percentage} = \left(\frac{\text{India's land area}}{\text{World's total land area}} \right) \times 100$$

$$\text{Percentage} = \left(\frac{3.28}{148.94} \right) \times 100 \approx 2.4\%.$$

Clarification of the other options.

- **Option (A):** Incorrect. 4.4% is too large compared to India's actual share of the world's land area.
- **Option (B):** Incorrect. 6.1% is far higher than the actual percentage.
- **Option (D):** Incorrect. 9.8% is significantly overestimated for India's land area.

Conclusion.

India occupies approximately 2.4% of the world's land area.

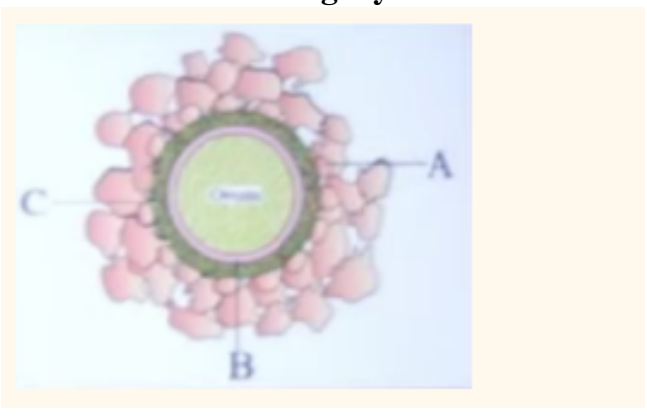
The correct answer is: 2.4%.

Quick Tip

India covers about 2.4% of the global land area, making it the seventh-largest country by land area.

---

12. Label the following layers around ovum properly.



(A) A - Zona Pellucida; B - Corona Radiata; C - Perivitelline Space.

(B) A - Corona Radiata; B - Zona Pellucida; C - Perivitelline Space.

(C) A - Corona Radiata; B - Perivitelline Space; C - Zona Pellucida.

(D) A - Perivitelline Space; B - Zona Pellucida; C - Corona Radiata.

Correct Answer: (C) A - Corona Radiata; B - Perivitelline Space; C - Zona Pellucida.

Solution:

Understanding the ovum layers.

The ovum is surrounded by three distinct layers:

- **Corona Radiata:** The outermost layer of cells that nourishes and protects the ovum.
- **Perivitelline Space:** A fluid-filled area between the zona pellucida and the ovum's cell membrane.
- **Zona Pellucida:** The glycoprotein-rich layer around the ovum, which facilitates sperm binding during fertilization.

Labeling the layers.

From the image:

- **A:** This corresponds to the outermost layer, which is the corona radiata.
- **B:** This represents the space between the zona pellucida and the ovum, known as the perivitelline space.
- **C:** This is the zona pellucida, the glycoprotein layer surrounding the ovum.

Conclusion.

The correct labeling is:

$$A - CoronaRadiata, B - PerivitellineSpace, C - ZonaPellucida.$$

The correct answer is: (C).

Quick Tip

The corona radiata, perivitelline space, and zona pellucida play essential roles in the protection, fertilization, and sperm binding processes.

---

13. Hydrogen is used to prepare?

(A) Olive oil.

(B) Ghee.

(C) Coconut oil.

(D) Vanaspati Ghee.

Correct Answer: (D) Vanaspati Ghee.

Solution:

Hydrogenation process for Vanaspati Ghee.

Vanaspati Ghee is produced by hydrogenating liquid vegetable oils. In this process, hydrogen gas is added to unsaturated fatty acids in the oil in the presence of a catalyst, typically nickel, converting them into saturated fatty acids, resulting in a solidified product.

Explanation of other options.

- **Option (A): Olive oil.** Incorrect. Olive oil remains liquid and is not hydrogenated.
- **Option (B): Ghee.** Incorrect. Ghee is made from animal fats and does not require hydrogenation.
- **Option (C): Coconut oil.** Incorrect. Coconut oil is naturally saturated and does not require hydrogenation.

Conclusion.

Hydrogenation is used in the preparation of Vanaspati Ghee.

The correct answer is: Vanaspati Ghee.

Quick Tip

Hydrogenation of vegetable oils produces Vanaspati Ghee, which is a commonly used semi-solid fat alternative to traditional ghee.

---

14. In a trihybrid cross involving three different genes ($AaBbCc \times AaBbCc$), what is the expected genotypic ratio among the offspring?

(A) $1:1:1:1:1:1:1:1$

(B) $27:9:9:9:3:3:3:1$

(C) $64:16:16:16:16:4:4:4:1$

(D) $81:27:27:27:27:9:9:9:9:3:3:3:1$

Correct Answer: (B) $27:9:9:9:3:3:3:1$

Solution:

Understanding the trihybrid cross.

This cross involves three genes (A, B, C) that assort independently, as per Mendel's law. The parents are both heterozygous for all three traits $(AaBbCc)$.

Calculating the phenotypic ratio.

For a trihybrid cross, the total number of possible phenotypes can be calculated using the formula:

$$(3+1)(3+1)(3+1) = 64 \text{ phenotypes.}$$

The resulting phenotypic ratio is:

$$27:9:9:9:3:3:3:1.$$

Explanation of the ratio.

- 27: Organisms with all dominant traits. - 9: Organisms with two dominant traits and one recessive. - 3: Organisms with one dominant and two recessive traits. - 1: Organisms with all recessive traits.

Thus, the phenotypic ratio is:

$$\boxed{27:9:9:9:3:3:3:1}.$$

Quick Tip

In trihybrid crosses, the phenotypic ratio follows the pattern $27:9:9:9:3:3:3:1$, derived from the expansion of $(3+1)^n$.

---

15. Which of the following codons codes for the amino acid phenylalanine?

(A) AUG.

(B) UUU.

(C) GCA.

(D) CCC.

Correct Answer: (B) UUU.

Solution:

Overview of the genetic code.

The genetic code consists of codons, sequences of three nucleotides, each of which codes for a specific amino acid.

Codon for phenylalanine.

The codons that code for the amino acid phenylalanine (Phe) are:

UUU and UUC.

Among the options, UUU is the codon that specifies phenylalanine.

Explanation of other options.

- **Option (A): AUG.** Incorrect. AUG is the start codon and codes for methionine.
- **Option (B): UUU.** Correct. UUU is the codon for phenylalanine.
- **Option (C): GCA.** Incorrect. GCA codes for alanine.
- **Option (D): CCC.** Incorrect. CCC codes for proline.

Conclusion.

The codon UUU codes for phenylalanine.

The correct answer is: (B).

Quick Tip

Memorizing key codons like AUG (start codon) and those for commonly tested amino acids, such as UUU for phenylalanine, can help in genetic code-based questions.

---

16. To increase wool production and to improve the quality of wool, the bacterial genes concerned with biosynthesis of cysteine amino acids involved in formation of keratin protein found in wool are cloned and introduced in sheep.

(A) cys E, cys M.

(B) cys F, cys G.

(C) cys F, cys M.

(D) lac y, lac a.

Correct Answer: (A) cys E, cys M.

Solution:

Understanding the role of cysteine in wool production.

Cysteine is a sulfur-containing amino acid crucial for forming disulfide bonds in keratin, which enhances the strength and quality of wool. Genes involved in the biosynthesis of cysteine are targeted for genetic modification.

Key bacterial genes.

The bacterial genes $cysE$ and $cysM$ are responsible for the biosynthesis of cysteine. These genes are cloned and introduced into sheep to enhance wool quality and production.

Explanation of other options.

- **Option (A): cys E, cys M.** Correct. These are the genes involved in cysteine biosynthesis.
- **Option (B): cys F, cys G.** Incorrect. These genes are not involved in cysteine biosynthesis.
- **Option (C): cys F, cys M.** Incorrect. Only $cysM$ is relevant; $cysF$ is not involved.
- **Option (D): lac y, lac a.** Incorrect. These are lactose metabolism genes and are unrelated to wool production.

Conclusion.

The genes $cysE$ and $cysM$ are critical for improving wool quality.

The correct answer is: (A).

Quick Tip

Genetic modification using bacterial genes like $cysE$ and $cysM$ improves the quality of wool by enhancing keratin production.

1. What are the 4 types of hydrocarbons?

Solution:

Understanding hydrocarbons.

Hydrocarbons are organic compounds made up exclusively of carbon and hydrogen atoms. They are categorized into four main types based on their structure and bonding patterns.

Types of hydrocarbons.

The four types of hydrocarbons are:

- **Alkanes:** These are saturated hydrocarbons, meaning they have only single bonds between carbon atoms. An example is methane (CH_4).
- **Alkenes:** These are unsaturated hydrocarbons containing at least one double bond between carbon atoms. An example is ethene (C_2H_4).
- **Alkynes:** These hydrocarbons are also unsaturated but contain at least one triple bond between carbon atoms. An example is ethyne (C_2H_2).
- **Aromatic hydrocarbons:** These include cyclic compounds with alternating single and double bonds, forming a conjugated π-electron system. An example is benzene (C_6H_6).

Conclusion:

The four types of hydrocarbons are alkanes, alkenes, alkynes, and aromatic hydrocarbons.

Quick Tip

Hydrocarbons are classified based on their bonding and structure: alkanes (saturated), alkenes and alkynes (unsaturated), and aromatic (cyclic with resonance).

---

2. The number of π-bonds present in benzoic acid is:

Options:

(A) 5.

(B) 4.

(C) 7.

(D) 3.

Correct Answer: (A) 5.

Solution:

Structure of benzoic acid.

Benzoic acid (C_6H_5COOH) consists of a benzene ring with alternating double bonds (three π-bonds) and a carboxylic acid group ($-COOH$) attached to the benzene ring. The carboxylic group has one π-bond in the C=O bond.

Total number of π-bonds.

Benzene ring: 3π-bonds.

Carboxyl group: 1π-bond in C=O.

Total π-bonds: $3 + 1 + 1 = 5$.

Conclusion.

The total number of π-bonds in benzoic acid is 5.

The correct answer is: (A).

Quick Tip

To count π-bonds, include the bonds in double and triple bonds. Each double bond has one π-bond, and each triple bond has two π-bonds.

Physics Questions

1. Water is flowing through a horizontal pipe in streamline flow. At the narrowest part of the pipe:

(A) Velocity is maximum and pressure is minimum.

(B) Pressure is maximum and velocity is minimum.

(C) Both pressure and velocity are minimum.

(D) Both pressure and velocity are maximum.

Correct Answer: (A) Velocity is maximum and pressure is minimum.

Solution:

Understanding Bernoulli's principle.

Bernoulli's principle states that for an incompressible, non-viscous fluid in streamline flow:

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{constant},$$

where:

- P: Pressure of the fluid,
- ρ: Density of the fluid,
- v: Velocity of the fluid,
- h: Height of the fluid.

Application to a horizontal pipe.

For a horizontal pipe (h is constant), the equation simplifies to:

$$P + \frac{1}{2}\rho v^2 = \text{constant}.$$

This implies that when the velocity (v) of the fluid increases, the pressure (P) decreases, and vice versa.

Narrowest part of the pipe.

At the narrowest part of the pipe:

- The cross-sectional area is minimum.
- By the equation of continuity ($A_1 v_1 = A_2 v_2$), the velocity is maximum.
- By Bernoulli's principle, the pressure is minimum.

Conclusion.

At the narrowest part of the pipe, the velocity is maximum, and the pressure is minimum.

The correct answer is: (A).

Quick Tip

In streamline flow, an increase in velocity corresponds to a decrease in pressure as per Bernoulli's principle. This is especially evident in areas with a smaller cross-section.

2. If an electron jumps from the 3rd orbit to the 2nd orbit, its wavelength is λ. Then the wavelength of the electron when it jumps from the 4th orbit to the 3rd orbit in terms of λ is:

Correct Answer: $\frac{20}{7}\lambda$.

Solution:

Using the Rydberg formula for wavelength.

The wavelength λ of the photon emitted during an electronic transition is given by the Rydberg formula:

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right),$$

where:

- R: Rydberg constant,
- n_1: Final orbit number,
- n_2: Initial orbit number ($n_2 > n_1$).

For the transition from the 3rd orbit ($n_2 = 3$) to the 2nd orbit ($n_1 = 2$).

The wavelength is given as λ. Substituting into the Rydberg formula:

$$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right).$$

Simplify the terms:

$$\frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{9}\right) = R\left(\frac{9-4}{36}\right) = R \cdot \frac{5}{36}.$$

For the transition from the 4th orbit ($n_2 = 4$) to the 3rd orbit ($n_1 = 3$).

The wavelength for this transition, say λ', is:

$$\frac{1}{\lambda'} = R\left(\frac{1}{3^2} - \frac{1}{4^2}\right).$$

Simplify the terms:

$$\frac{1}{\lambda'} = R\left(\frac{1}{9} - \frac{1}{16}\right) = R\left(\frac{16-9}{144}\right) = R \cdot \frac{7}{144}.$$

Relating λ' to λ.

Divide the two equations:

$$\frac{1}{\lambda'} \div \frac{1}{\lambda} = \frac{R \cdot \frac{7}{144}}{R \cdot \frac{5}{36}}.$$

Simplify:

$$\frac{\lambda}{\lambda'} = \frac{\frac{7}{144}}{\frac{5}{36}} = \frac{7}{144} \cdot \frac{36}{5} = \frac{7 \cdot 36}{144 \cdot 5} = \frac{7}{20}.$$

Thus:

$$\lambda' = \frac{20}{7}\lambda.$$

Conclusion.

The wavelength of the electron when it jumps from the 4th orbit to the 3rd orbit is:

$$\boxed{\frac{20}{7}\lambda}.$$

Quick Tip

To find the relationship between wavelengths in different transitions, compare the terms $\frac{1}{n_1^2} - \frac{1}{n_2^2}$ using the Rydberg formula.

---

3. The height from Earth's surface at which acceleration due to gravity becomes $\frac{g}{4}$ is __? (Where g is the acceleration due to gravity on the surface of the Earth and R is the radius of the Earth.)

(A) $\sqrt{2}R$.

(B) R.

(C) $\frac{R}{\sqrt{2}}$.

(D) $2R$.

Correct Answer: (B) R.

Solution:

Formula for acceleration due to gravity at a height h from Earth's surface.

The acceleration due to gravity at a height h is given by:

$$g_h = g\left(\frac{R}{R+h}\right)^2,$$

where:

- g_h: Acceleration due to gravity at height h,
- g: Acceleration due to gravity on the surface of the Earth,
- R: Radius of the Earth.

Setting $g_h = \frac{g}{4}$.

Substitute $g_h = \frac{g}{4}$ into the equation:

$$\frac{g}{4} = g\left(\frac{R}{R+h}\right)^2.$$

Simplifying the equation.

Cancel g from both sides:

$$\frac{1}{4} = \left(\frac{R}{R+h}\right)^2.$$

Take the square root of both sides:

$$\frac{1}{2} = \frac{R}{R+h}.$$

Cross-multiply:

$$R + h = 2R.$$

Solve for h.

$$h = 2R - R = R.$$

Conclusion.

The height from Earth's surface at which acceleration due to gravity becomes $\frac{g}{4}$ is:

$$\boxed{R}.$$

Quick Tip

The acceleration due to gravity decreases with the square of the distance from the center of the Earth. Use $g_h = g\left(\frac{R}{R+h}\right)^2$ for calculations involving heights above the Earth's surface.
