MHT CET 2024 April 23 Shift 1 Question Paper with Solutions

Total Time Allowed : 3 hours	Maximum Marks : 200	Total Questions : 20	Questions to be answered :20

General Instructions

Read the following instructions very carefully and strictly follow them:

(1) This question booklet contains 200 Multiple Choice Questions (MCQs).
Section-A: Physics Chemistry - 50 Questions each and
Section-B: Biology - 100 Questions.
(2) Choice and sequence for attempting questions will be as per the convenience of the candidate.
(3) Read each question carefully.
(4) Determine the one correct answer out of the four available options given for each question. (5) Each question with correct response shall be awarded one (1) mark. There shall be no negative marking.
(6) No mark shall be granted for marking two or more answers of same question, scratching or overwriting.
(7) Duration of paper is 3 Hours.

Biology

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:

Step 1: Understanding lymphocytes.

Lymphocytes are a type of white blood cell (WBC) involved in the immune response. They include T-cells, B-cells, and natural killer (NK) cells, which play roles in adaptive and innate immunity.

Step 2: Size range of lymphocytes.

Lymphocytes typically range in size from 10-15 micrometers. Larger lymphocytes are generally activated or immature forms, while smaller ones are resting lymphocytes.

Step 3: Explanation of options.

- **Option (A):** Incorrect. The size range of 5-10 micrometers is too small for most lymphocytes.
- **Option (B):** Correct. Lymphocytes typically range between 10-15 micrometers.
- **Option (C):** Incorrect. 15-20 micrometers is too large for most lymphocytes.
- **Option (D):** Incorrect. Lymphocytes do not reach 20-25 micrometers in size.

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

Quick Tip

Lymphocytes are small white blood cells that play key roles in adaptive immunity. Their size typically ranges between 10-15 micrometers.

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:
Step 1: Role of ADH in osmoregulation.
Antidiuretic hormone (ADH), also known as vasopressin, is released by the posterior pituitary gland. It increases water reabsorption in the collecting ducts of the nephron by increasing the permeability of the duct walls to water.
Step 2: Explanation of other hormones.

- **Insulin (Option A):** Incorrect. Insulin regulates glucose metabolism, not osmoregulation.
- **Glucagon (Option B):** Incorrect. Glucagon increases blood glucose levels and has no role in water reabsorption.
- **Aldosterone (Option D):** Incorrect. Aldosterone regulates sodium and potassium balance, indirectly affecting water reabsorption, but it is not the primary hormone for osmoregulation.

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

Quick Tip

ADH regulates water balance in the body by increasing water reabsorption in the collecting ducts, 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:
Step 1: Function of the proximal convoluted tubule (PCT).
The proximal convoluted tubule (PCT) is the first segment of the nephron tubule where reabsorption occurs. It reabsorbs approximately 65-70% of the water and solutes, including glucose, amino acids, sodium, and chloride ions, from the filtrate into the blood.
Step 2: Explanation of other options.

- **Option (A): Glomerulus.** Incorrect. The glomerulus is responsible for the filtration of blood, not reabsorption.
- **Option (B): Bowman's capsule.** Incorrect. 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 selective reabsorption and secretion, but the majority of reabsorption occurs in the proximal convoluted tubule.

Step 3: Conclusion.
The proximal convoluted tubule is the primary site for the reabsorption of water and solutes from the filtrate.

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

Quick Tip

The proximal convoluted tubule is responsible for bulk reabsorption of water, nutrients, and ions, which is essential 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:
Step 1: Setting up the Punnett square.
The genotypes of the parents are Aa and Aa. The Punnett square is set up as follows:

	A	a
A	AA	Aa
a	Aa	aa

Step 2: Calculating the genotypic ratio.
From the Punnett square, the offspring have the following genotypes:

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

The genotypic ratio is therefore:

$$1 : 2 : 1.$$

Step 3: Explanation of options.

- **Option (A):** Incorrect. This represents an equal distribution between two genotypes, which is not the case.
- **Option (B):** Correct. The genotypic ratio for a monohybrid cross is $1 : 2 : 1$.
- **Option (C):** Incorrect. This represents the phenotypic ratio, not the genotypic ratio.
- **Option (D):** Incorrect. This represents the phenotypic ratio for a dihybrid cross, not a monohybrid cross.

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

Quick Tip

In a monohybrid cross between heterozygous parents, the genotypic ratio is always $1 : 2 : 1$, while the phenotypic ratio is $3 : 1$.

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:
Step 1: Understanding the sympathetic response.
Sympathetic stimulation is part of the "fight or flight" response, which prioritizes blood flow to vital organs (e.g., muscles and brain) by reducing blood flow to the kidneys.
Step 2: Effect on the glomerulus.
Sympathetic stimulation causes vasoconstriction of the afferent arteriole. This reduces blood flow into the glomerulus, leading to a decreased glomerular filtration rate (GFR). This response helps conserve water and maintain blood pressure during stress.
Step 3: Explanation of other options.

- **Option (A):** Incorrect. Vasodilation of the afferent arteriole would increase GFR, which is opposite to the sympathetic response.
- **Option (B):** Correct. Vasoconstriction of the afferent arteriole decreases GFR during sympathetic stimulation.
- **Option (C):** Incorrect. Sympathetic stimulation significantly affects renal blood flow and GFR.
- **Option (D):** Incorrect. Vasodilation of the efferent arteriole would decrease filtration pressure, but this is not a typical sympathetic response.

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, helping 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:
Step 1: Role of the hypothalamus in kidney function.
The hypothalamus is a critical region of the brain that regulates homeostasis, including water and salt balance. It influences kidney function by:

- Releasing antidiuretic hormone (ADH) via the posterior pituitary gland to increase water reabsorption in the collecting ducts.
- Controlling thirst mechanisms and fluid intake, which indirectly affects the glomerular filtration rate (GFR).

Step 2: Explanation of other options.

- **Option (A): Cerebellum.** Incorrect. The cerebellum regulates motor functions and balance, not kidney function.
- **Option (C): Medulla oblongata.** Incorrect. While the medulla controls vital functions like heart rate and respiration, it does not directly regulate kidney hormones.
- **Option (D): Cerebrum.** Incorrect. The cerebrum is involved in higher cognitive functions and does not regulate kidney function.

Step 3: Conclusion.
The hypothalamus is the primary brain region responsible for regulating hormones like ADH, which play a key role in kidney function.

The correct answer is: Hypothalamus.

Quick Tip

The hypothalamus maintains water balance in the body by regulating ADH secretion and controlling thirst mechanisms.

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:
Step 1: Understanding chromosome arrangements.
Chromosome arrangement refers to the number and structure of chromosomes within a cell. The normal condition, where an organism has the correct number of chromosomes (a complete set), is termed euploidy.
Step 2: Explanation of terms.

- **Monoploidy (Option A):** Refers to cells with a single set of chromosomes (e.g., n), typically seen in some specialized organisms but not in normal diploid organisms.
- **Aneuploidy (Option B):** Refers to an abnormal chromosome number due to the gain or loss of specific chromosomes (e.g., trisomy, monosomy).
- **Polyploidy (Option C):** Refers to organisms with more than two complete sets of chromosomes (e.g., $3n, 4n$), common in plants but not normal for humans.
- **Euploidy (Option D):** Refers to organisms with the correct and complete number of chromosomes in multiples of a basic set (e.g., $2n$ in diploids), representing the normal state.

Step 3: Conclusion.
The term euploidy describes the normal chromosome arrangement in organisms.

The correct answer is: Euploidy.

Quick Tip

Euploidy represents the normal chromosome arrangement, while aneuploidy refers to abnormalities caused by the loss or gain of specific chromosomes.

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:
Step 1: Role of PCR in DNA fingerprinting.
Polymerase Chain Reaction (PCR) is a technique used to amplify specific regions of DNA. This allows for the production of millions of copies of DNA fragments, which are then analyzed in DNA fingerprinting to identify genetic markers.

Step 2: Explanation of other techniques.

- **Gel Electrophoresis (Option B):** Used to separate DNA fragments by size, but it does not amplify DNA.
- **DNA Sequencing (Option C):** Determines the nucleotide sequence of DNA, not used for amplification in fingerprinting.
- **Southern Blotting (Option D):** Detects specific DNA sequences but does not involve amplification.

Step 3: Conclusion.
PCR is the primary method for amplifying DNA regions in fingerprinting.

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

Quick Tip

PCR is a vital tool in molecular biology, allowing the amplification of specific DNA regions for applications like fingerprinting and diagnostics.

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:
Step 1: Understanding Chargaff's rule.
According to Chargaff's rule, in a double-stranded DNA molecule:

The amount of adenine (A) = The amount of thymine (T),

and

The amount of guanine (G) = The amount of cytosine (C).

Thus, the sum of adenine and thymine is equal to the sum of guanine and cytosine:

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

Step 2: Calculating the percentage of guanine.
Given that adenine constitutes 30% of the bases, thymine must also constitute 30%:

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

This leaves 40% for guanine and cytosine:

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

Since the amount of guanine equals the amount of cytosine:

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

Step 3: Conclusion.
The percentage of guanine in the DNA molecule is 20%.

The correct answer is: 20%.

Quick Tip

Chargaff's rule states that in a double-stranded DNA molecule, $A = T$ and $G = C$. Use this to calculate the percentages of bases when given the percentage of one base.

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:
Step 1: Understanding India's geographical area.
India has a total land area of approximately 3.28 million square kilometers, which constitutes about 2.4% of the total geographical area of the world. The world's total land area is approximately 148.94 million square kilometers.
Step 2: Calculation of India's percentage.
The percentage of the world's area occupied by India is calculated as:

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

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

Step 3: Explanation of other options.

- **Option (A):** Incorrect. 4.4% is too high compared to India's actual land area proportion.
- **Option (B):** Incorrect. 6.1% is significantly higher than the actual percentage.

- **Option (D):** Incorrect. 9.8% is nearly four times India's actual proportion.

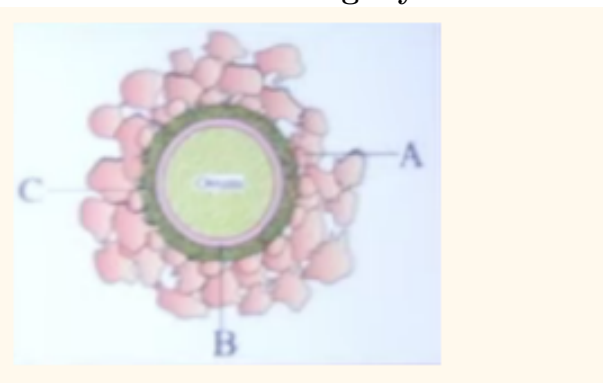
Step 4: Conclusion.
India occupies approximately 2.4% of the world's total geographical area.

The correct answer is: 2.4%.

Quick Tip

India accounts for about 2.4% of the world's total geographical area, making it the 7th largest country in terms of 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:
Step 1: Understanding the layers surrounding the ovum.
The ovum is surrounded by three primary layers:

- **Corona Radiata:** The outermost layer composed of follicular cells, which provides nourishment and protection to the ovum.
- **Perivitelline Space:** The fluid-filled space between the zona pellucida and the cell membrane of the ovum.
- **Zona Pellucida:** A glycoprotein layer surrounding the plasma membrane of the ovum, essential for sperm binding and fertilization.

Step 2: Matching the labels.
From the image:

- **A:** Represents the outermost layer, which is the corona radiata.

- **B:** Represents the space between the zona pellucida and the ovum, the perivitelline space.
- **C:** Represents the glycoprotein layer, the zona pellucida.

Step 3: Conclusion.
The correct labeling is:

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

The correct answer is: (C).

Quick Tip

The layers surrounding the ovum—corona radiata, perivitelline space, and zona pellucida—play crucial roles in protection, fertilization, and sperm binding.

13. Hydrogen is used to prepare?
(A) Olive oil.
(B) Ghee.
(C) Coconut oil.
(D) Vanaspati Ghee.

Correct Answer: (D) Vanaspati Ghee.

Solution:
Step 1: Role of hydrogen in preparing Vanaspati Ghee.
Vanaspati Ghee is prepared through a process called hydrogenation. In this process, hydrogen gas is bubbled through liquid vegetable oils in the presence of a nickel catalyst. This converts unsaturated fatty acids into saturated fatty acids, resulting in a semi-solid product.
Step 2: Explanation of other options.

- **Option (A): Olive oil.** Incorrect. Olive oil is a liquid vegetable oil and is not hydrogenated.
- **Option (B): Ghee.** Incorrect. Ghee is prepared from animal milk fat, not through hydrogenation.
- **Option (C): Coconut oil.** Incorrect. Coconut oil is a natural saturated fat and does not require hydrogenation.

Step 3: Conclusion.
Hydrogen is used in the hydrogenation process to prepare Vanaspati Ghee.

The correct answer is: Vanaspati Ghee.

Quick Tip

Hydrogenation of vegetable oils produces Vanaspati Ghee, a semi-solid cooking fat used as an 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:
Step 1: Understanding the trihybrid cross.
The given cross involves three genes (A, B, C) that segregate independently according to Mendel's law of independent assortment. Each parent ($AaBbCc$) is heterozygous for all three genes.
Step 2: Determining the phenotypic ratio.
For a trihybrid cross, the phenotypic ratio can be calculated using the following rule:

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

The phenotypic ratio is split based on the dominance and recessive nature of the alleles:

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

Step 3: Explanation of the ratio.
- 27: All dominant traits ($A\_B\_C\_$). - 9: Two dominant and one recessive trait ($A\_B\_cc, A\_bbC\_, aaB\_C\_$) - 3: One dominant and two recessive traits ($A\_bbcc, aaB\_cc, aabbC\_$). - 1: All recessive traits ($aabbcc$).
Thus, the final phenotypic ratio is:

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

Quick Tip

For dihybrid and trihybrid crosses, the phenotypic ratios can be derived using the expansion of $(3+1)^n$, where n is the number of genes.

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:
Step 1: Understanding the genetic code.
The genetic code is a set of rules by which nucleotide sequences in mRNA are translated into amino acids. Each codon (a sequence of three nucleotides) corresponds to a specific amino acid.
Step 2: Codon for phenylalanine.
The codons that code for the amino acid phenylalanine (Phe) are:

UUU and UUC.

Among the given options, UUU is the correct codon for phenylalanine.
Step 3: Explanation of other options.

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

Step 4: Conclusion.
The correct codon for phenylalanine is UUU.

The correct answer is: (B).

Quick Tip

Memorize the key codons like AUG (start codon) and those coding for frequently asked amino acids, such as UUU/UUC for phenylalanine.

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:
Step 1: 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.
Step 2: 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.
Step 3: 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.

Step 4: 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.

Chemistry

1. What are the 4 types of hydrocarbons?
Solution:
Step 1: Understanding hydrocarbons.
Hydrocarbons are organic compounds consisting solely of hydrogen and carbon atoms. They are classified into four main types based on their structure and bonding.
Step 2: Types of hydrocarbons.
The four types of hydrocarbons are:

- **Alkanes:** Saturated hydrocarbons containing only single bonds between carbon atoms. Example: Methane (CH_4).
- **Alkenes:** Unsaturated hydrocarbons containing at least one double bond between carbon atoms. Example: Ethene (C_2H_4).

- **Alkynes:** Unsaturated hydrocarbons containing at least one triple bond between carbon atoms. Example: Ethyne (C_2H_2).
- **Aromatic hydrocarbons:** Cyclic compounds containing conjugated π-electron systems, typically with alternating single and double bonds. Example: Benzene (C_6H_6).

Conclusion:
The 4 types of hydrocarbons are alkanes, alkenes, alkynes, and aromatic hydrocarbons.

Quick Tip

Hydrocarbons are classified based on their bonding and structure: saturated (alkanes), unsaturated (alkenes and alkynes), 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:
Step 1: Structure of benzoic acid.
Benzoic acid (C_6H_5COOH) consists of:

- A benzene ring with alternating double bonds (3 π-bonds).
- A carboxylic acid ($-COOH$) group attached to the benzene ring. The carboxylic acid group contains:
  - One π-bond in the C=O bond.
  - No π-bonds in the O-H bond.

Step 2: Total number of π-bonds.

Benzene ring: 3π-bonds.

Carboxylic acid group: 1π-bond in C=O.

Total π-bonds: $3 + 1 + 1 = 5$.

Step 3: Conclusion.
The number of π-bonds in benzoic acid is 5.

The correct answer is: (A).

> **Quick Tip**
>
> To calculate π-bonds in a molecule, count the double and triple bonds, as each contains one and two π-bonds respectively.

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:
Step 1: 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.

Step 2: 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.
Step 3: Narrowest part of the pipe.
At the narrowest part of the pipe:

- The cross-sectional area is minimum.
- By the equation of continuity ($A_1v_1 = A_2v_2$), the velocity is maximum.
- By Bernoulli's principle, the pressure is minimum.

Step 4: 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:
Step 1: 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 ($n_2 > n_1$).

Step 2: 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:

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

Step 3: 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:

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

Step 4: 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:

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

Step 5: 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:
Step 1: 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.

Step 2: Setting $g_h = \frac{g}{4}$.
Substitute $g_h = \frac{g}{4}$ into the equation:

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

Step 3: 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:

$$R + h = 2R.$$

Step 4: Solve for h.

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

Step 5: 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.