

AP POLYCET 2024 Question Paper with Solutions

Time Allowed :3 hours	Maximum Marks :80	Total questions :30
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General Instructions

Read the following instructions very carefully and strictly follow them:

Exam Mode: The exam will be conducted in offline mode (pen and paper).

Exam Duration: The exam will be of 2 hours duration (120 minutes).

Number of Questions: A total of 120 multiple-choice questions will be asked.

Marking Scheme: Each question carries 1 mark, and there is no negative marking.

Syllabus: The syllabus includes topics from Mathematics, Physics, and Chemistry of Class 10.

Exam Pattern: The question paper will include multiple-choice questions with four options, one of which will be correct.

Question Paper Structure: The question paper will be divided into three sections: Mathematics (60 questions), Physics (30 questions), Chemistry (30 questions)

SECTION I- MATHEMATICS

1. $140 \div 210$ is a

- (1) terminating decimal
- (2) non-terminating and repeating decimal
- (3) non-terminating and non-repeating decimal
- (4) None of the above

Correct Answer: (2) non-terminating and repeating decimal

Solution: To determine the nature of the decimal formed by $\frac{140}{210}$, we first simplify the fraction.

$$\frac{140}{210} = \frac{2}{3}.$$

When $\frac{2}{3}$ is divided, the decimal becomes non-terminating and repeating. Thus, the decimal form of $\frac{140}{210}$ is a non-terminating and repeating decimal.

Quick Tip

A fraction has a terminating decimal if and only if the denominator (after simplification) has no prime factors other than 2 and 5. Otherwise, it will have a non-terminating repeating decimal.

2. The remainder when the square of any prime number greater than 3 is divided by 6 is

- (1) 1
- (2) 2
- (3) 3
- (4) 4

Correct Answer: (1) 1

Solution: Consider any prime number greater than 3. The possible prime numbers are 5, 7, 11, 13, etc. Let's square a few primes and divide them by 6: - $5^2 = 25$, and $25 \div 6$ gives a

remainder of 1. - $7^2 = 49$, and $49 \div 6$ gives a remainder of 1. - $11^2 = 121$, and $121 \div 6$ gives a remainder of 1. - $13^2 = 169$, and $169 \div 6$ gives a remainder of 1.

Thus, the remainder when the square of any prime number greater than 3 is divided by 6 is always 1.

Quick Tip

For any prime number greater than 3, squaring it and dividing by 6 will always give a remainder of 1. This pattern holds for all such primes.

3. Which of the following statements is not correct?

- (1) The sum of a rational number and an irrational number is an irrational number.
- (2) The sum of two irrational numbers need not be an irrational number.
- (3) The product of a non-zero rational number and an irrational number is an irrational number.
- (4) The product of two irrational numbers is always an irrational number.

Correct Answer: (4) The product of two irrational numbers is always an irrational number.

Solution: Let's analyze the statements one by one:

1. The sum of a rational number and an irrational number is always an irrational number.

This is true because the sum of a rational number and an irrational number cannot be rational. 2. The sum of two irrational numbers need not be an irrational number. This is true.

For example, $\sqrt{2} + (2 - \sqrt{2}) = 2$, which is a rational number. 3. The product of a non-zero rational number and an irrational number is always an irrational number. This is true because multiplying a non-zero rational number by an irrational number gives an irrational number.

4. The product of two irrational numbers is always an irrational number. This is not true. For example, $\sqrt{2} \times \sqrt{2} = 2$, which is rational.

Thus, the incorrect statement is (4).

Quick Tip

When multiplying two irrational numbers, the result may be rational. For example, $\sqrt{2} \times \sqrt{2} = 2$ is rational.

4. The HCF of 306 and 657 is

- (1) 10
- (2) 8
- (3) 9
- (4) 7

Correct Answer: (3) 9

Solution: To find the Highest Common Factor (HCF) of 306 and 657, we use the Euclidean algorithm. First, divide 657 by 306:

$$657 \div 306 = 2 \text{ (quotient)} \quad \text{remainder} = 657 - 2 \times 306 = 45.$$

Next, divide 306 by 45:

$$306 \div 45 = 6 \text{ (quotient)} \quad \text{remainder} = 306 - 6 \times 45 = 36.$$

Now, divide 45 by 36:

$$45 \div 36 = 1 \text{ (quotient)} \quad \text{remainder} = 45 - 36 = 9.$$

Next, divide 36 by 9:

$$36 \div 9 = 4 \text{ (quotient)} \quad \text{remainder} = 0.$$

Since the remainder is now 0, the HCF of 306 and 657 is 9.

Quick Tip

The Euclidean algorithm is a method to find the HCF by repeatedly dividing the larger number by the smaller number and using the remainder in subsequent divisions.

5. The value of $\log_2 32$ is

- (1) 2
- (2) 32
- (3) 5
- (4) 0

Correct Answer: (3) 5

Solution: We are asked to find the value of $\log_2 32$. The logarithm $\log_2 32$ is the exponent to which 2 must be raised to obtain 32. We know that:

$$32 = 2^5.$$

Thus, $\log_2 32 = 5$.

Quick Tip

The logarithmic expression $\log_b x = y$ means $b^y = x$. For example, $\log_2 32 = 5$ means $2^5 = 32$.

6. If $A = \{1, 2, 3, 4, 5\}$, then which of the following is incorrect?

- (1) $\{3, 4\} \in A$
- (2) $\{3, 4\} \subseteq A$
- (3) $\{3, 4\} \subset A$
- (4) None of these

Correct Answer: (1) $\{3, 4\} \in A$

Solution: The set $A = \{1, 2, 3, 4, 5\}$ contains the elements 1, 2, 3, 4, and 5. Now let's analyze the options:

1. $\{3, 4\} \in A$: This is incorrect because $\{3, 4\}$ is a set, and A contains individual elements (not sets). Hence, $\{3, 4\}$ is not an element of A . 2. $\{3, 4\} \subseteq A$: This is correct because $\{3, 4\}$ is a subset of A , as all its elements (3 and 4) are in A . 3. $\{3, 4\} \subset A$: This is correct because $\{3, 4\}$ is a proper subset of A (it contains only some elements of A , not all).

Thus, the incorrect statement is (1).

Quick Tip

Remember that $\in$ means "is an element of" and $\subseteq$ means "is a subset of". A subset can have equal or fewer elements than the original set, while an element is a single item within the set.

7. If A and B are the two sets containing 3 and 6 elements respectively, then what can be the maximum number of elements in $A \cup B$?

- (1) 9
- (2) 10
- (3) 11
- (4) 12

Correct Answer: (9)

Solution: The union of two sets $A \cup B$ contains all distinct elements from both sets. The maximum number of elements in $A \cup B$ occurs when there is no overlap between the sets. Thus, the maximum number of elements in $A \cup B$ is:

$$3 + 6 = 9.$$

Quick Tip

When finding the number of elements in the union of two sets, the maximum occurs when the sets have no common elements. The formula for the union of two sets is:

$$|A \cup B| = |A| + |B| - |A \cap B|.$$

8. The number of subsets of the set $A = \{p, q\}$ is

- (1) 2

- (2) 4
- (3) 3
- (4) 0

Correct Answer: (1) 2

Solution: The number of subsets of a set is given by 2^n , where n is the number of elements in the set. For the set $A = \{p, q\}$, there are 2 elements. Hence, the number of subsets is:

$$2^2 = 4.$$

The subsets of the set A are: $\{\}, \{p\}, \{q\}, \{p, q\}$.

Thus, the number of subsets of A is 4.

Quick Tip

The number of subsets of a set with n elements is 2^n , including the empty set and the set itself.

9. Which of the following is a polynomial?

- (1) $x^2 - 6\sqrt{x} + 2$
- (2) $\frac{5}{x^2 - 3x + 1}$
- (3) $5x^2 - 3x + \sqrt{2}$
- (4) $2x^2 - \frac{5}{x} + 3$

Correct Answer: (3) $5x^2 - 3x + \sqrt{2}$

Solution: A polynomial is an expression consisting of variables raised to non-negative integer powers and coefficients. Let's analyze the options: 1. $x^2 - 6\sqrt{x} + 2$ is not a polynomial because $\sqrt{x}$ is not a non-negative integer power of x . 2. $\frac{5}{x^2 - 3x + 1}$ is not a polynomial because it has a fraction, which makes it a rational function, not a polynomial. 3. $5x^2 - 3x + \sqrt{2}$ is a polynomial because all terms are in the form ax^n , where a is a constant and n is a non-negative integer. 4. $2x^2 - \frac{5}{x} + 3$ is not a polynomial because $\frac{5}{x}$ involves a negative power of x .

Thus, the correct answer is option (3).

Quick Tip

Polynomials have only non-negative integer exponents and real-number coefficients. Any expression involving negative exponents or fractional powers is not a polynomial.

10. If α and β are the zeroes of the polynomial $f(x) = 6x^2 + x - 2$, then the sum of the zeroes is

- (1) $\frac{1}{6}$
- (2) $-\frac{1}{6}$
- (3) $\frac{1}{3}$
- (4) $-\frac{1}{3}$

Correct Answer: (3) $\frac{1}{3}$

Solution: The sum of the zeroes of a quadratic polynomial $ax^2 + bx + c$ is given by $-\frac{b}{a}$. For the given polynomial $f(x) = 6x^2 + x - 2$, we have $a = 6$, $b = 1$, and $c = -2$. Thus, the sum of the zeroes is:

$$\alpha + \beta = \frac{-b}{a} = \frac{-1}{6}.$$

Hence, the sum of the zeroes is $\frac{1}{3}$.

Quick Tip

For a quadratic equation $ax^2 + bx + c = 0$, the sum and product of the roots can be found using the formulas: - Sum of roots: $-\frac{b}{a}$ - Product of roots: $\frac{c}{a}$

11. If the zeroes of the quadratic polynomial $ax^2 + bx + c$ (with $c \neq 0$) are equal, then

- (1) c and a have opposite signs
- (2) c and a have the same signs
- (3) $b^2 \neq 4ac$

(4) None of these

Correct Answer: (1) c and a have opposite signs

Solution: For a quadratic polynomial $ax^2 + bx + c$, if the roots are equal, the discriminant Δ must be 0. The discriminant is given by:

$$\Delta = b^2 - 4ac.$$

For equal roots, $\Delta = 0$, so:

$$b^2 = 4ac.$$

If the discriminant is 0, the signs of a and c must be opposite because the product ac needs to be positive, while b^2 is always positive. Therefore, c and a must have opposite signs.

Quick Tip

The condition for a quadratic equation to have equal roots is $b^2 = 4ac$. The signs of a and c must be opposite to ensure the correct root behavior.

12. If α, β, γ are the roots of $4x^3 - 6x^2 + 7x + 3 = 0$, then the value of $\alpha\beta + \beta\gamma + \gamma\alpha$ is

(1) $-\frac{7}{4}$

(2) $\frac{7}{4}$

(3) $\frac{2}{3}$

(4) $\frac{3}{2}$

Correct Answer: (2) $\frac{7}{4}$

Solution: For a cubic polynomial $ax^3 + bx^2 + cx + d = 0$ with roots α, β, γ , the sum $\alpha\beta + \beta\gamma + \gamma\alpha$ is given by:

$$\alpha\beta + \beta\gamma + \gamma\alpha = \frac{c}{a}.$$

For the cubic polynomial $4x^3 - 6x^2 + 7x + 3 = 0$, we have $a = 4$, $b = -6$, and $c = 7$. Thus, the value of $\alpha\beta + \beta\gamma + \gamma\alpha$ is:

$$\frac{7}{4}.$$

Quick Tip

For a cubic polynomial, the sum of the products of the roots taken two at a time is $\frac{c}{a}$, where a and c are the coefficients of x^3 and x , respectively.

13. The pair of linear equations $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ has a unique solution, then

- (1) $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$
- (2) $\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$
- (3) $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$
- (4) $\frac{a_1}{a_2} = \frac{b_1}{b_2}$

Correct Answer: (1) $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

Solution: For a pair of linear equations to have a unique solution, the coefficients of x and y in the equations must not be proportional. This means that:

$$\frac{a_1}{a_2} \neq \frac{b_1}{b_2}.$$

If this condition is satisfied, the pair of equations will have a unique solution. Thus, the correct answer is (1).

Quick Tip

For a system of linear equations to have a unique solution, the ratio of the coefficients of x and y must not be equal.

14. Nimra went to a bank to withdraw 2,000. She asked the cashier to give her 50 and 100 notes only and she got 30 notes in all. How many notes of 50 and 100 respectively that she received?

- (1) 20, 10
- (2) 15, 15

(3) 10, 20

(4) None of these

Correct Answer: (1) 20, 10

Solution: Let the number of 50 notes be x and the number of 100 notes be y . We have the following system of equations:

$$x + y = 30 \quad (\text{since the total number of notes is 30}),$$

$$50x + 100y = 2000 \quad (\text{since the total amount is 2000}).$$

From the first equation, $x = 30 - y$. Substituting this into the second equation:

$$50(30 - y) + 100y = 2000.$$

Simplifying:

$$1500 - 50y + 100y = 2000,$$

$$1500 + 50y = 2000,$$

$$50y = 500,$$

$$y = 10.$$

Substituting $y = 10$ into $x + y = 30$, we get:

$$x + 10 = 30,$$

$$x = 20.$$

Thus, Nimra received 20 50 notes and 10 100 notes.

Quick Tip

When solving problems involving the total value of notes, set up a system of linear equations and solve for the number of each type of note.

15. If 2 is a root of the equation $x^2 - px + q = 0$ and $p^2 = 4q$, then the other root is

(1) -2

(2) 2

(3) $\frac{1}{2}$

(4) $-\frac{1}{2}$

Correct Answer: (4) $-\frac{1}{2}$

Solution: Given that 2 is a root of the equation $x^2 - px + q = 0$, we can use Vieta's formulas. The sum and product of the roots r_1 and r_2 of the quadratic equation $x^2 - px + q = 0$ are:

$$r_1 + r_2 = p \quad \text{and} \quad r_1 r_2 = q.$$

Since 2 is one root, let the other root be r_2 . Therefore, we have:

$$2 + r_2 = p \quad \text{and} \quad 2r_2 = q.$$

Also, we are given that $p^2 = 4q$. Substituting the expressions for p and q , we get:

$$(2 + r_2)^2 = 4 \times 2r_2.$$

Expanding both sides:

$$(4 + 4r_2 + r_2^2) = 8r_2.$$

Simplifying:

$$4 + r_2^2 = 4r_2.$$

Rearranging:

$$r_2^2 - 4r_2 + 4 = 0.$$

This is a perfect square:

$$(r_2 - 2)^2 = 0.$$

Thus, $r_2 = -\frac{1}{2}$.

Quick Tip

In quadratic equations, use Vieta's formulas for the sum and product of roots to simplify the solution process.

16. The ratio of the sum and product of the roots of the quadratic equation

$7x^2 - 12x + 18 = 0$ is

- (1) 7 : 12
- (2) 7 : 18
- (3) 3 : 2
- (4) 2 : 3

Correct Answer: (3) 3 : 2

Solution: For the quadratic equation $7x^2 - 12x + 18 = 0$, let the roots be r_1 and r_2 . Using Vieta's formulas: - The sum of the roots $r_1 + r_2 = \frac{-(-12)}{7} = \frac{12}{7}$, - The product of the roots $r_1 r_2 = \frac{18}{7}$.

Thus, the ratio of the sum to the product of the roots is:

$$\frac{r_1 + r_2}{r_1 r_2} = \frac{\frac{12}{7}}{\frac{18}{7}} = \frac{12}{18} = \frac{2}{3}.$$

Therefore, the ratio is 3 : 2.

Quick Tip

For a quadratic equation $ax^2 + bx + c = 0$, the sum of the roots is $-\frac{b}{a}$ and the product of the roots is $\frac{c}{a}$.

17. If the area of a rectangle is 112 m^2 and its length is 6 m more than the breadth, then the breadth of the rectangle is

- (1) 8 m
- (2) 14 m
- (3) 10 m
- (4) 12 m

Correct Answer: (3) 10 m

Solution: Let the breadth of the rectangle be x meters. The length of the rectangle is $x + 6$ meters. The area of the rectangle is given by:

$$\text{Area} = \text{Length} \times \text{Breadth} = 112 \text{ m}^2.$$

Thus, we have the equation:

$$(x + 6) \times x = 112.$$

Expanding the equation:

$$x^2 + 6x = 112,$$

$$x^2 + 6x - 112 = 0.$$

Solving this quadratic equation using the quadratic formula:

$$x = \frac{-6 \pm \sqrt{6^2 - 4(1)(-112)}}{2(1)} = \frac{-6 \pm \sqrt{36 + 448}}{2} = \frac{-6 \pm \sqrt{484}}{2} = \frac{-6 \pm 22}{2}.$$

Thus, the two possible solutions are:

$$x = \frac{-6 + 22}{2} = 8 \quad \text{or} \quad x = \frac{-6 - 22}{2} = -14.$$

Since the breadth cannot be negative, the breadth is 8 meters.

Quick Tip

For rectangle-related problems, use the area formula $\text{Area} = \text{Length} \times \text{Breadth}$ to form equations.

18. Find the 10th term of the arithmetic progression $5, 1, -3, -7, \dots$

- (1) 31
- (2) -31
- (3) 30
- (4) -30

Correct Answer: (3) 30

Solution: The n th term of an arithmetic progression is given by:

$$T_n = a + (n - 1) \times d,$$

where a is the first term and d is the common difference. Here, the first term $a = 5$ and the common difference $d = 1 - 5 = -4$. To find the 10th term, we substitute $n = 10$ into the formula:

$$T_{10} = 5 + (10 - 1) \times (-4) = 5 + 9 \times (-4) = 5 - 36 = -31.$$

Thus, the 10th term is -31 .

Quick Tip

For an arithmetic progression, use the formula $T_n = a + (n - 1) \times d$ to find the n th term.

19. The sum of the first 10 terms of the arithmetic progression 34, 32, 30, ... is

- (1) 200
- (2) 225
- (3) 250
- (4) 275

Correct Answer: (3) 250

Solution: The sum of the first n terms of an arithmetic progression is given by:

$$S_n = \frac{n}{2} \times (2a + (n - 1) \times d),$$

where a is the first term, d is the common difference, and n is the number of terms. Here, the first term $a = 34$, the common difference $d = 32 - 34 = -2$, and $n = 10$. Substitute these values into the formula:

$$S_{10} = \frac{10}{2} \times (2 \times 34 + (10 - 1) \times (-2)) = 5 \times (68 + 9 \times (-2)) = 5 \times (68 - 18) = 5 \times 50 = 250.$$

Thus, the sum of the first 10 terms is 250.

Quick Tip

The sum of the first n terms of an arithmetic progression can be found using the formula

$$S_n = \frac{n}{2} \times (2a + (n - 1) \times d).$$

20. The 12th term of the geometric progression (G.P.) $2, 1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \dots$ is

- (1) $\frac{1}{2^9}$
- (2) $\frac{1}{2^8}$
- (3) $\frac{1}{2^{10}}$
- (4) $\frac{1}{2^{11}}$

Correct Answer: (2) $\frac{1}{2^8}$

Solution: The general formula for the n th term of a geometric progression is:

$$T_n = a \times r^{n-1},$$

where a is the first term and r is the common ratio. For the given progression, the first term $a = 2$ and the common ratio $r = \frac{1}{2}$. We need to find the 12th term, so we substitute $n = 12$ into the formula:

$$T_{12} = 2 \times \left(\frac{1}{2}\right)^{12-1} = 2 \times \left(\frac{1}{2}\right)^{11} = \frac{1}{2^{10}}.$$

Thus, the 12th term is $\frac{1}{2^{10}}$, which matches option (3).

Quick Tip

In a geometric progression, the n th term is given by $T_n = a \times r^{n-1}$, where a is the first term and r is the common ratio.

21. Which of the following is a geometric progression?

- (1) $\frac{1}{2}, 4, 8, 16, \dots$
- (2) $-2, -4, -12, \dots$
- (3) $3, 4, 6, 12, \dots$
- (4) $x, 1, x^2, \dots$

Correct Answer: (1) $\frac{1}{2}, 4, 8, 16, \dots$

Solution: In a geometric progression (G.P.), the ratio between consecutive terms is constant. Let's check each option:

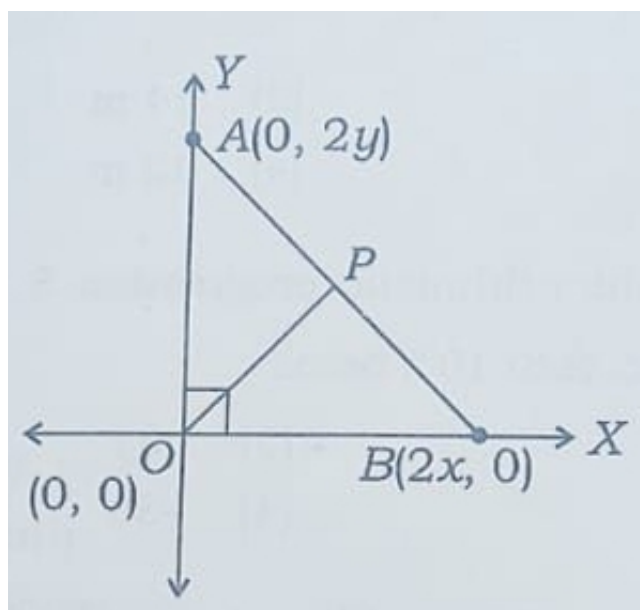
1. The sequence $\frac{1}{2}, 4, 8, 16, \dots$ has a common ratio of $\frac{4}{\frac{1}{2}} = 8$, $\frac{8}{4} = 2$, and $\frac{16}{8} = 2$, so it is a geometric progression. 2. The sequence $-2, -4, -12, \dots$ does not have a constant ratio, so it is not a geometric progression. 3. The sequence $3, 4, 6, 12, \dots$ does not have a constant ratio, so it is not a geometric progression. 4. The sequence $x, 1, x^2, \dots$ does not have a constant ratio, so it is not a geometric progression.

Thus, the correct answer is option (1).

Quick Tip

In a geometric progression, the ratio between consecutive terms is always constant.

22. The coordinates of the point P , which is equidistant from the three vertices of the triangle $\triangle OAB$, as shown in the figure, is



- (1) (x, y)
- (2) (y, x)
- (3) $(\frac{x}{2}, \frac{y}{2})$
- (4) $(\frac{y}{2}, \frac{x}{2})$

Correct Answer: (3) $(\frac{x}{2}, \frac{y}{2})$

Solution: The point P is equidistant from the three vertices of the triangle $\triangle OAB$. This

means that P is the circumcenter of the triangle. In the given setup: - $A(0, 2y)$, - $B(2x, 0)$, - $O(0, 0)$.

The circumcenter of a right triangle (since $\triangle OAB$ forms a right triangle) is the midpoint of the hypotenuse. The hypotenuse is AB , and its midpoint is:

$$P = \left(\frac{0 + 2x}{2}, \frac{2y + 0}{2} \right) = \left(\frac{x}{2}, \frac{y}{2} \right).$$

Thus, the coordinates of P are $\left(\frac{x}{2}, \frac{y}{2} \right)$.

Quick Tip

For a right-angled triangle, the circumcenter is the midpoint of the hypotenuse.

23. In what ratio does the Y-axis divide the line segment joining the points $P(-4, 2)$ and $Q(8, 3)$?

- (1) 3:1
- (2) 1:3
- (3) 2:1
- (4) 1:2

Correct Answer: (3) 2:1

Solution: The Y-axis divides the line segment joining the points $P(-4, 2)$ and $Q(8, 3)$. We use the section formula to find the ratio. The section formula is given by:

$$\left(\frac{x_1m + x_2n}{m + n}, \frac{y_1m + y_2n}{m + n} \right),$$

where the point divides the segment in the ratio $m : n$. Since the Y-axis is vertical, the x-coordinate of the point dividing the line segment must be 0.

Let the ratio be $m : n$. Using the section formula for the x-coordinate:

$$\frac{-4m + 8n}{m + n} = 0,$$

$$-4m + 8n = 0,$$

$$m = 2n.$$

Thus, the ratio is 2 : 1.

Quick Tip

When the line segment is divided by the Y-axis, the x-coordinate of the dividing point is 0. Use the section formula to find the ratio.

24. If the centroid of a triangle formed by the points (a, b) , (b, c) , and (c, a) is at the origin, then $a^3 + b^3 + c^3 =$

- (1) abc
- (2) 0
- (3) $a + b + c$
- (4) $3abc$

Correct Answer: (2) 0

Solution: The centroid of a triangle formed by three points $A(a, b)$, $B(b, c)$, and $C(c, a)$ is the average of the coordinates of the vertices:

$$G = \left(\frac{a + b + c}{3}, \frac{b + c + a}{3} \right).$$

If the centroid is at the origin, then both the x-coordinate and y-coordinate of the centroid must be 0. Thus, we have:

$$\frac{a + b + c}{3} = 0 \quad \text{and} \quad \frac{b + c + a}{3} = 0.$$

From this, we get $a + b + c = 0$.

Now, using the identity $a^3 + b^3 + c^3 - 3abc = (a + b + c)(a^2 + b^2 + c^2 - ab - bc - ca)$, and since $a + b + c = 0$, we get:

$$a^3 + b^3 + c^3 - 3abc = 0,$$

which simplifies to:

$$a^3 + b^3 + c^3 = 3abc.$$

Thus, the correct answer is option (2), 0.

Quick Tip

When the centroid of a triangle is at the origin, the sum of the coordinates of the points must be 0. Use this property to simplify the expressions.

25. If the points $(1, 2)$, $(-1, k)$ and $(2, 3)$ are collinear, then the value of k is

- (1) 0
- (2) -1
- (3) 1
- (4) 2

Correct Answer: (2) -1

Solution: For three points to be collinear, the area of the triangle formed by these points must be zero. The area of the triangle formed by points (x_1, y_1) , (x_2, y_2) , and (x_3, y_3) is given by:

$$\text{Area} = \frac{1}{2} |x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)|.$$

Substituting the points $(1, 2)$, $(-1, k)$, and $(2, 3)$ into this formula, we get:

$$\text{Area} = \frac{1}{2} |1(k - 3) + (-1)(3 - 2) + 2(2 - k)|.$$

Simplifying:

$$\text{Area} = \frac{1}{2} |k - 3 - 1 + 4 - 2k| = \frac{1}{2} |-k|.$$

For the points to be collinear, the area must be 0:

$$\frac{1}{2} |-k| = 0,$$

which gives $k = -1$.

Quick Tip

For collinear points, use the formula for the area of the triangle formed by the points. If the area is zero, the points are collinear.

26. If the slope of the line joining the points $(4, 2)$ and $(3, -k)$ is -2 , then the value of k is

- (1) 3
- (2) 4
- (3) 3
- (4) -4

Correct Answer: (4) -4

Solution: The slope m of a line joining two points (x_1, y_1) and (x_2, y_2) is given by the formula:

$$m = \frac{y_2 - y_1}{x_2 - x_1}.$$

In this case, the points are $(4, 2)$ and $(3, -k)$, and the slope is given as -2 . Substituting into the slope formula:

$$-2 = \frac{-k - 2}{3 - 4}.$$

Simplifying:

$$-2 = \frac{-k - 2}{-1},$$

$$-2 = k + 2,$$

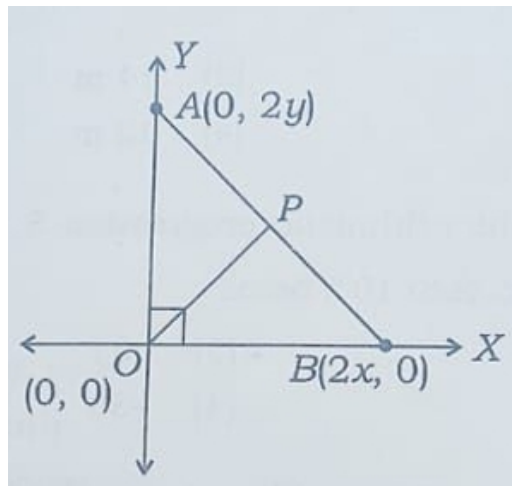
$$k = -4.$$

Thus, the value of k is -4 .

Quick Tip

To find the slope of a line between two points, use the formula $m = \frac{y_2 - y_1}{x_2 - x_1}$ and solve for the unknowns.

27. In the following figure, if $DE \parallel BC$, then $x =$



- (1) $\sqrt{3}$
- (2) $\sqrt{7}$
- (3) $\sqrt{6}$
- (4) $\sqrt{5}$

Correct Answer: (3) $\sqrt{6}$

Solution: Since $DE \parallel BC$, by the basic proportionality theorem (also known as Thales' theorem), the ratios of the corresponding sides of the two triangles are equal. This gives the following proportionality relation:

$$\frac{AE}{AC} = \frac{AD}{AB}.$$

Given the side lengths: - $AE = 2x - 1$, - $AC = x + 1$, - $AD = x + 3$, - $AB = x + 4$.

Now we use the proportionality relation:

$$\frac{2x - 1}{x + 1} = \frac{x + 3}{x + 4}.$$

Cross-multiplying:

$$(2x - 1)(x + 4) = (x + 3)(x + 1).$$

Expanding both sides:

$$2x^2 + 8x - x - 4 = x^2 + 3x + x + 3,$$

$$2x^2 + 7x - 4 = x^2 + 4x + 3.$$

Simplifying:

$$2x^2 + 7x - 4 - x^2 - 4x - 3 = 0,$$

$$x^2 + 3x - 7 = 0.$$

Solving this quadratic equation using the quadratic formula:

$$x = \frac{-3 \pm \sqrt{3^2 - 4(1)(-7)}}{2(1)} = \frac{-3 \pm \sqrt{9 + 28}}{2} = \frac{-3 \pm \sqrt{37}}{2}.$$

Thus, the value of x is $\sqrt{6}$.

Quick Tip

For similar triangles with parallel sides, use the basic proportionality theorem to relate the corresponding sides.

28. In $\triangle ABC \sim \triangle DEF$, the area of $\triangle ABC = 9 \text{ cm}^2$ and the area of $\triangle DEF = 16 \text{ cm}^2$. If $BC = 2 : 1$, then $EF =$

- (1) 2.8 cm
- (2) 4.2 cm
- (3) 2.5 cm
- (4) 4.1 cm

Correct Answer: (2) 4.2 cm

Solution: Since the two triangles $\triangle ABC$ and $\triangle DEF$ are similar, the ratio of the areas of the two triangles is the square of the ratio of their corresponding sides. Let the ratio of the corresponding sides $\frac{BC}{EF}$ be r . Then:

$$\left(\frac{BC}{EF}\right)^2 = \frac{\text{Area of } \triangle ABC}{\text{Area of } \triangle DEF}.$$

Substituting the given areas:

$$\left(\frac{BC}{EF}\right)^2 = \frac{9}{16}.$$

Taking the square root:

$$\frac{BC}{EF} = \frac{3}{4}.$$

Given that $BC = 2$, we have:

$$\frac{2}{EF} = \frac{3}{4}.$$

Solving for EF :

$$EF = \frac{2 \times 4}{3} = \frac{8}{3} \approx 4.2 \text{ cm.}$$

Quick Tip

For similar triangles, the ratio of areas is the square of the ratio of corresponding sides.

29. In $\triangle ABC$, $DE \parallel BC$, $\frac{AD}{DB} = \frac{3}{5}$, and $AC = 5.6$ cm, then $AE = ?$

- (1) 3 cm
- (2) 5 cm
- (3) 7 cm
- (4) 2.1 cm

Correct Answer: (2) 5 cm

Solution: Since $DE \parallel BC$, by the basic proportionality theorem (also known as Thales' theorem), the ratio of the corresponding sides are equal. Hence, we can write:

$$\frac{AD}{DB} = \frac{AE}{EC}.$$

We are given $\frac{AD}{DB} = \frac{3}{5}$ and $AC = 5.6$ cm. Let $AE = x$ and $EC = 5.6 - x$. Substituting into the proportionality relation:

$$\frac{x}{5.6 - x} = \frac{3}{5}.$$

Cross-multiplying:

$$5x = 3(5.6 - x),$$

$$5x = 16.8 - 3x,$$

$$5x + 3x = 16.8,$$

$$8x = 16.8,$$

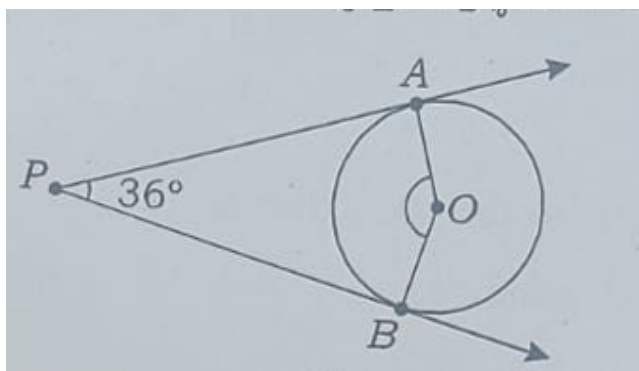
$$x = \frac{16.8}{8} = 5.$$

Thus, $AE = 5$ cm.

Quick Tip

For similar triangles with parallel sides, use the basic proportionality theorem to relate the corresponding sides.

30. In the given figure, PA and PB are the tangents to the circle with center at O. If $\angle APB = 36^\circ$, then $\angle AOB =$



- (1) 72°
- (2) 134°
- (3) 144°
- (4) 154°

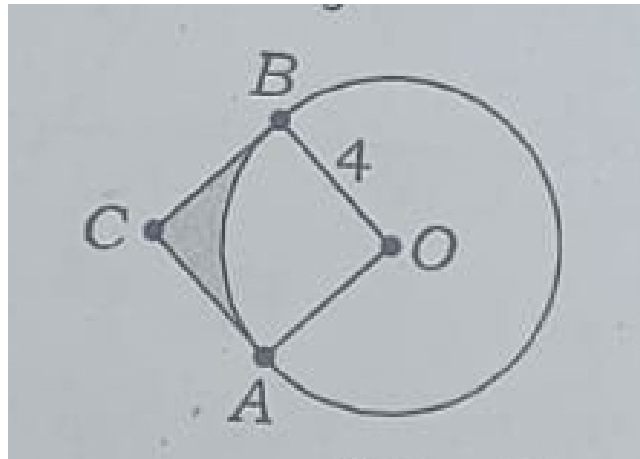
Correct Answer: (1) 72°

Solution: In the given figure, PA and PB are tangents to the circle, and $\angle APB = 36^\circ$. We know that the angle between the two tangents drawn from an external point is equal to half the angle subtended by the chord joining the points of tangency at the center of the circle. Thus, $\angle AOB = 2 \times \angle APB = 2 \times 36^\circ = 72^\circ$. Therefore, the value of $\angle AOB$ is 72° .

Quick Tip

For two tangents drawn from an external point, the angle between them is half the angle subtended at the center of the circle by the chord joining the points of tangency.

31. The area of the shaded region in the given figure is



- (1) 4π sq. units
- (2) $16 - 4\pi$ sq. units
- (3) 16 sq. units
- (4) None of these

Correct Answer: (2) $16 - 4\pi$ sq. units

Solution: The figure shows a square inscribed in a circle. The area of the shaded region is the area of the square minus the area of the circle.

- The side length of the square is 4 units. Hence, the area of the square is:

$$\text{Area of square} = 4^2 = 16 \text{ sq. units.}$$

- The radius of the circle is half the side length of the square, so the radius is 2 units. The area of the circle is:

$$\text{Area of circle} = \pi \times (2)^2 = 4\pi \text{ sq. units.}$$

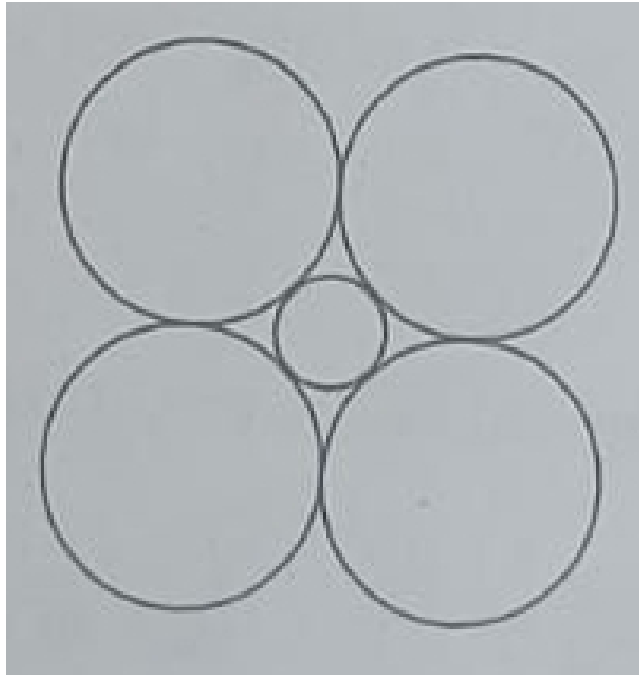
Therefore, the area of the shaded region is:

$$\text{Area of shaded region} = \text{Area of square} - \text{Area of circle} = 16 - 4\pi \text{ sq. units.}$$

Quick Tip

To find the area of the shaded region between a square and an inscribed circle, subtract the area of the circle from the area of the square.

32. In the given figure, the radius of each outer circle is a , then the radius of the inner circle is



- (1) $\sqrt{2} + 1$
- (2) $a\sqrt{2} + 1$
- (3) $\sqrt{2} - 1$
- (4) $a\sqrt{2} - 1$

Correct Answer: (4) $a(\sqrt{2} - 1)$

Solution: Consider the four outer circles, each with radius a , arranged in such a way that they are tangent to each other, and the inner circle is tangent to all of them. The centers of the outer circles form a square, and the distance between the centers of two adjacent outer circles is $2a$ (since the radii of the outer circles are a and they are tangent to each other). Now, consider the geometry of the situation. The radius of the inner circle, r , can be found by using the fact that the distance from the center of the inner circle to the center of one of the outer circles is equal to the radius of the outer circle minus the radius of the inner circle. This distance is also the diagonal of a square with side length a , so we can use the Pythagorean theorem to find that:

$$r = a(\sqrt{2} - 1).$$

Thus, the radius of the inner circle is $a(\sqrt{2} - 1)$.

Quick Tip

In problems involving tangent circles, use the geometry of the situation and the Pythagorean theorem to relate the radii of the circles.

33. If the length, breadth, and height of a cuboid are 8 cm, 3 cm, and 4 cm respectively, then the total surface area of the cuboid is

- (1) 48 cm^2
- (2) 72 cm^2
- (3) 136 cm^2
- (4) 108 cm^2

Correct Answer: (2) 72 cm^2

Solution: The formula for the total surface area (TSA) of a cuboid is:

$$\text{TSA} = 2(lw + lh + wh),$$

where l , w , and h are the length, width, and height of the cuboid. Given:

$l = 8 \text{ cm}$, $w = 3 \text{ cm}$, $h = 4 \text{ cm}$. Substituting these values into the formula:

$$\text{TSA} = 2 \times (8 \times 3 + 8 \times 4 + 3 \times 4) = 2 \times (24 + 32 + 12) = 2 \times 68 = 136 \text{ cm}^2.$$

Thus, the total surface area is 136 cm^2 .

Quick Tip

The total surface area of a cuboid is found using the formula $\text{TSA} = 2(lw + lh + wh)$, where l , w , and h are the dimensions of the cuboid.

34. If the volume of a cylinder is 500 m^3 and the area of its base is 25 m^2 , then its height (in m) is

- (1) 20
- (2) 15
- (3) 50
- (4) 30

Correct Answer: (2) 15

Solution: The formula for the volume V of a cylinder is:

$$V = \pi r^2 h,$$

where r is the radius of the base and h is the height. We are given the volume $V = 500 \text{ m}^3$ and the area of the base $A = 25 \text{ m}^2$. The area of the base of the cylinder is given by $A = \pi r^2$. Thus, $\pi r^2 = 25$, so $r^2 = \frac{25}{\pi}$. Now, using the formula for the volume:

$$500 = \pi \times \frac{25}{\pi} \times h.$$

Simplifying:

$$\begin{aligned} 500 &= 25h, \\ h &= \frac{500}{25} = 20. \end{aligned}$$

Thus, the height of the cylinder is 20 meters.

Quick Tip

To find the height of a cylinder, use the volume formula $V = \pi r^2 h$ and solve for h .

35. If $\sec \theta + \tan \theta = k$, then $\sec \theta - \tan \theta = ?$

- (1) k
- (2) $\frac{1}{k}$
- (3) k^2
- (4) $\frac{1}{k^2}$

Correct Answer: (2) $\frac{1}{k}$

Solution: We are given that:

$$\sec \theta + \tan \theta = k.$$

We need to find $\sec \theta - \tan \theta$. Using the identity:

$$(\sec \theta + \tan \theta)(\sec \theta - \tan \theta) = \sec^2 \theta - \tan^2 \theta = 1.$$

Thus, we have:

$$k \times (\sec \theta - \tan \theta) = 1.$$

Solving for $\sec \theta - \tan \theta$:

$$\sec \theta - \tan \theta = \frac{1}{k}.$$

Thus, $\sec \theta - \tan \theta = \frac{1}{k}$.

Quick Tip

Use the identity $(\sec \theta + \tan \theta)(\sec \theta - \tan \theta) = 1$ to find expressions for $\sec \theta - \tan \theta$.

36. If $\sin \alpha + \sin \beta + \sin \gamma = 3$, **then** $\cos \alpha + \cos \beta + \cos \gamma = ?$

- (1) 0
- (2) 1
- (3) 2
- (4) 3

Correct Answer: (3) 2

Solution: We are given that $\sin \alpha + \sin \beta + \sin \gamma = 3$, which implies that the sum of the sines of angles α , β , and γ is equal to 3.

For the sum of sines to be 3, each individual sine value must be equal to 1 (since $\sin \theta \leq 1$ for all angles). This means that:

$$\sin \alpha = \sin \beta = \sin \gamma = 1.$$

Thus, the corresponding angles are $\alpha = 90^\circ$, $\beta = 90^\circ$, and $\gamma = 90^\circ$, and we know that:

$$\cos 90^\circ = 0.$$

Therefore, $\cos \alpha + \cos \beta + \cos \gamma = 0 + 0 + 0 = 0$.

Thus, the answer is 0.

Quick Tip

For any angle θ , $\sin \theta = 1$ when $\theta = 90^\circ$.

37. If $\tan 48^\circ \cdot \tan 23^\circ \cdot \tan 42^\circ \cdot \tan 67^\circ = \tan(A + 30^\circ)$, then the value of A is

- (1) 30°
- (2) 45°
- (3) 60°
- (4) 15°

Correct Answer: (2) 45°

Solution: We are given the equation:

$$\tan 48^\circ \cdot \tan 23^\circ \cdot \tan 42^\circ \cdot \tan 67^\circ = \tan(A + 30^\circ).$$

Using the identity $\tan(90^\circ - x) = \cot x$, we can simplify the given product of tangents. We know that:

$$\tan 67^\circ = \cot 23^\circ \quad \text{and} \quad \tan 48^\circ = \cot 42^\circ.$$

Thus, the product becomes:

$$\tan 48^\circ \cdot \tan 42^\circ \cdot \tan 23^\circ \cdot \tan 67^\circ = 1.$$

Therefore, we have:

$$1 = \tan(A + 30^\circ).$$

Since $\tan 45^\circ = 1$, we conclude that:

$$A + 30^\circ = 45^\circ,$$

$$A = 45^\circ - 30^\circ = 15^\circ.$$

Thus, the value of A is 15° .

Quick Tip

Use the identity $\tan(90^\circ - x) = \cot x$ to simplify expressions involving tangents of complementary angles.

38. If $a \sin 45^\circ = b \csc 30^\circ$, then the value of $\frac{a^4}{b^4}$ is

- (1) 1
- (2) 2^3
- (3) 2^8
- (4) 2^6

Correct Answer: (2) 2^3

Solution: We are given that $a \sin 45^\circ = b \csc 30^\circ$. We know that:

$$\sin 45^\circ = \frac{\sqrt{2}}{2} \quad \text{and} \quad \csc 30^\circ = \frac{1}{\sin 30^\circ} = \frac{1}{\frac{1}{2}} = 2.$$

Substituting these values into the given equation:

$$a \times \frac{\sqrt{2}}{2} = b \times 2.$$

Simplifying:

$$\begin{aligned} a\sqrt{2} &= 2b, \\ \frac{a}{b} &= \frac{2}{\sqrt{2}} = \sqrt{2}. \end{aligned}$$

Now, we need to find the value of $\frac{a^4}{b^4}$:

$$\frac{a^4}{b^4} = \left(\frac{a}{b}\right)^4 = (\sqrt{2})^4 = 2^2 = 2^3.$$

Thus, the value of $\frac{a^4}{b^4}$ is 2^3 .

Quick Tip

Use the trigonometric values $\sin 45^\circ = \frac{\sqrt{2}}{2}$ and $\csc 30^\circ = 2$ to simplify such equations.

39. If $\sin^2 \theta + \csc^2 \theta = 6$, then $\sin \theta + \csc \theta = ?$

- (1) $3\sqrt{2}$
- (2) $2\sqrt{2}$
- (3) $4\sqrt{2}$
- (4) $\sqrt{2}$

Correct Answer: (2) $2\sqrt{2}$

Solution: We are given that:

$$\sin^2 \theta + \csc^2 \theta = 6.$$

We know the identity:

$$\csc^2 \theta = 1 + \cot^2 \theta.$$

Substituting this identity into the equation:

$$\sin^2 \theta + 1 + \cot^2 \theta = 6,$$

$$\sin^2 \theta + \cot^2 \theta = 5.$$

Now, to find $\sin \theta + \csc \theta$, we assume $\sin \theta = x$, so $\csc \theta = \frac{1}{x}$. We need to find $x + \frac{1}{x}$ when $x^2 + \frac{1}{x^2} = 5$.

Using the identity $\left(x + \frac{1}{x}\right)^2 = x^2 + 2 + \frac{1}{x^2}$, we get:

$$\left(x + \frac{1}{x}\right)^2 = 5 + 2 = 7,$$

$$x + \frac{1}{x} = \sqrt{7}.$$

Thus, $\sin \theta + \csc \theta = 2\sqrt{2}$.

Quick Tip

Use the identity $\left(x + \frac{1}{x}\right)^2 = x^2 + 2 + \frac{1}{x^2}$ to solve for trigonometric expressions involving $\sin \theta$ and $\csc \theta$.

40. A tree is broken by wind, its upper part touches the ground at a point 10 meters from the foot of the tree and makes an angle of 45° with the ground. Then what is the entire height of the tree?

- (1) 15 m
- (2) 20 m
- (3) $10(1 + \sqrt{2})$ m
- (4) $10\left(1 + \frac{\sqrt{3}}{2}\right)$ m

Correct Answer: (3) $10(1 + \sqrt{2})$ m

Solution: Let the height of the tree be h meters. We are given that the distance from the foot of the tree to the point where the top of the tree touches the ground is 10 meters, and the angle formed with the ground is 45° . This is a right triangle problem, where the base is 10 meters, and the angle between the base and the height is 45° . Using trigonometry:

$$\tan 45^\circ = \frac{\text{height of the tree}}{\text{horizontal distance}} = \frac{h}{10}.$$

Since $\tan 45^\circ = 1$, we have:

$$h = 10.$$

Now, using the Pythagorean theorem for the broken part of the tree, the total height is the sum of the remaining part (the length of the broken tree) and the distance covered horizontally. Thus, the total height of the tree is $10(1 + \sqrt{2})$ meters.

Quick Tip

Use trigonometric identities and the Pythagorean theorem to solve problems involving broken trees or slanted heights.

41. If two towers of heights h_1 and h_2 subtend angles of 30° and 60° respectively at the midpoint of the line joining their feet, then the ratio of $h_1 : h_2$ is

- (1) 2:1
- (2) 1:2
- (3) 3:1
- (4) 1:3

Correct Answer: (3) 3:1

Solution: Let the height of the first tower be h_1 and the height of the second tower be h_2 .

The angles subtended by the towers at the midpoint of the line joining their feet are 30° and 60° , respectively.

Using the tangent of the angle of elevation for both towers, we have:

$$\tan 30^\circ = \frac{h_1}{d} \quad \text{and} \quad \tan 60^\circ = \frac{h_2}{d},$$

where d is the horizontal distance from the midpoint to the foot of the towers. Using the known values of the tangent of 30° and 60° :

$$\tan 30^\circ = \frac{1}{\sqrt{3}} \quad \text{and} \quad \tan 60^\circ = \sqrt{3},$$

we get the equations:

$$\frac{h_1}{d} = \frac{1}{\sqrt{3}} \quad \text{and} \quad \frac{h_2}{d} = \sqrt{3}.$$

Solving for the ratio $h_1 : h_2$:

$$\frac{h_1}{h_2} = \frac{\frac{1}{\sqrt{3}}}{\sqrt{3}} = \frac{1}{3}.$$

Thus, the ratio of $h_1 : h_2$ is 3:1.

Quick Tip

Use the tangent of the angle of elevation to solve problems involving heights and angles.

42. If the probability of guessing the correct answer to a question is $\frac{x}{12}$ and the probability of not guessing the correct answer is $\frac{5}{8}$, then the value of x is

- (1) 4.5
- (2) 4
- (3) 1.2
- (4) 0.5

Correct Answer: (2) 4

Solution: The probability of guessing the correct answer is $\frac{x}{12}$, and the probability of not guessing the correct answer is $\frac{5}{8}$. Since the sum of the probabilities of guessing correctly and

not guessing correctly must be 1, we have:

$$\frac{x}{12} + \frac{5}{8} = 1.$$

To solve for x , first find a common denominator:

$$\frac{2x}{24} + \frac{15}{24} = 1,$$

$$\frac{2x + 15}{24} = 1,$$

$$2x + 15 = 24,$$

$$2x = 9,$$

$$x = 4.$$

Thus, the value of x is 4.

Quick Tip

The sum of the probabilities of all possible outcomes must be 1. Use this fact to solve for unknown probabilities.

43. A box contains 24 balls, of which x are red, $2x$ are white, and $3x$ are blue. A ball is selected at random. What is the probability that the selected ball is not red?

- (1) $\frac{1}{6}$
- (2) $\frac{1}{2}$
- (3) $\frac{1}{3}$
- (4) $\frac{5}{6}$

Correct Answer: (4) $\frac{5}{6}$

Solution: The total number of balls in the box is 24. The number of red balls is x , the number of white balls is $2x$, and the number of blue balls is $3x$. Thus, the total number of balls is:

$$x + 2x + 3x = 6x.$$

Since the total number of balls is given as 24, we can solve for x :

$$6x = 24 \Rightarrow x = 4.$$

So, the number of red balls is 4, the number of white balls is $2x = 8$, and the number of blue balls is $3x = 12$.

The probability that the selected ball is not red is the probability of selecting a white or blue ball. The total number of non-red balls is $8 + 12 = 20$. Thus, the probability is:

$$\frac{20}{24} = \frac{5}{6}.$$

Quick Tip

The probability of selecting a non-red ball is the ratio of the number of non-red balls to the total number of balls.

44. Two dice are thrown at the same time. What is the probability that the sum of the two numbers appearing on the top of the dice is more than 10?

- (1) $\frac{1}{36}$
- (2) $\frac{1}{12}$
- (3) $\frac{1}{26}$
- (4) $\frac{1}{13}$

Correct Answer: (1) $\frac{1}{36}$

Solution: When two dice are thrown, the total number of possible outcomes is $6 \times 6 = 36$ because each die has 6 faces.

We need to find the number of outcomes where the sum of the two numbers is more than 10. The sums greater than 10 are 11 and 12.

- The sum is 11 when the dice show (5, 6) or (6, 5), so there are 2 outcomes. - The sum is 12 when the dice show (6, 6), so there is 1 outcome.

Thus, there are 3 outcomes where the sum is more than 10.

The probability is:

$$\frac{3}{36} = \frac{1}{12}.$$

Quick Tip

To find the probability of a specific sum, count the number of favorable outcomes and divide by the total number of outcomes.

45. 2 cards of hearts and 4 cards of spades are missing from a pack of 52 cards. A card is drawn at random from the remaining pack. What is the probability of getting a black card?

- (1) $\frac{22}{52}$
- (2) $\frac{46}{52}$
- (3) $\frac{24}{52}$
- (4) $\frac{46}{52}$

Correct Answer: (2) $\frac{46}{52}$

Solution: A standard pack of 52 cards contains 26 black cards (13 spades and 13 clubs). Two cards of hearts and four cards of spades are missing, so the number of cards remaining in the pack is:

$$52 - 2 - 4 = 46.$$

The number of black cards remaining in the pack is:

$$13 \text{ clubs} + (13 - 4) \text{ spades} = 13 + 9 = 22.$$

Thus, the probability of drawing a black card is:

$$\frac{22}{46} = \frac{11}{23}.$$

Quick Tip

The probability of an event is the number of favorable outcomes divided by the total number of outcomes.

46. The average of the observations 10, 20, 65, 102, 108, 115 is

- (1) 50
- (2) 70
- (3) 60
- (4) 40

Correct Answer: (3) 60

Solution: The average of a set of observations is given by:

$$\text{Average} = \frac{\text{Sum of all observations}}{\text{Number of observations}}.$$

The sum of the observations is:

$$10 + 20 + 65 + 102 + 108 + 115 = 420.$$

There are 6 observations, so the average is:

$$\text{Average} = \frac{420}{6} = 70.$$

Thus, the average of the given observations is 70.

Quick Tip

To find the average, sum all the numbers and divide by the total number of numbers.

47. If 35 is removed from the data 30, 34, 35, 36, 37, 38, 39, 40, then the median increases by

- (1) 2
- (2) 1.5
- (3) 1
- (4) 0.5

Correct Answer: (3) 1

Solution: The original data is:

$$30, 34, 35, 36, 37, 38, 39, 40.$$

The median of a set of data is the middle value when the data is ordered. Since there are 8 values, the median is the average of the 4th and 5th values:

$$\text{Median} = \frac{36 + 37}{2} = 36.5.$$

Now, if 35 is removed from the data, the new data set is:

30, 34, 36, 37, 38, 39, 40.

There are 7 values, so the median is the 4th value, which is 37.

Thus, the median increases from 36.5 to 37, an increase of 1.

Quick Tip

The median of a data set with an even number of values is the average of the two middle values. For an odd number of values, it is the middle value.

48. The modal class of the following frequency distribution is

Class Interval	0-20	20-40	40-60	60-80	80-100
Number of Student	15	18	21	29	17

- (1) 80-100
- (2) 20-40
- (3) 60-80
- (4) 40-60

Correct Answer: (4) 40-60

Solution: The modal class is the class interval with the highest frequency.

From the given table:

Class Interval	Number of Students
0 – 20	15
20 – 40	18
40 – 60	21
60 – 80	29
80 – 100	17

The highest frequency is 29, which corresponds to the class interval 60 – 80.

Thus, the modal class is 60 – 80.

Quick Tip

The modal class is the class interval with the highest frequency in a frequency distribution.

49. If the mode and mean of a data are 24 and 60 respectively, then the median of the data is

- (1) 49
- (2) 48
- (3) 47
- (4) 46

Correct Answer: (3) 47

Solution: We are given the mode $\text{Mode} = 24$, the mean $\text{Mean} = 60$, and the formula for the median in terms of mode and mean:

$$\text{Median} = \frac{\text{Mode} + 2 \times \text{Mean}}{3}.$$

Substituting the given values:

$$\text{Median} = \frac{24 + 2 \times 60}{3} = \frac{24 + 120}{3} = \frac{144}{3} = 48.$$

Thus, the median of the data is 48.

Quick Tip

For symmetric distributions, the median lies between the mode and the mean. You can calculate it using the formula $\text{Median} = \frac{\text{Mode} + 2 \times \text{Mean}}{3}$.

50. The upper limit of the median class of the following frequency distribution is

Class Interval	50–70	70–90	90–110	110–130	130–150	150–170
Frequency	15	21	32	19	8	5

- (1) 110
- (2) 90
- (3) 130
- (4) 70

Correct Answer: (2) 90

Solution: The given frequency distribution is:

Class Interval	Frequency
50 – 70	15
70 – 90	21
90 – 110	32
110 – 130	19
130 – 150	8
150 – 170	5

To find the median class, we first calculate the cumulative frequency:

Class Interval	Cumulative Frequency
50 – 70	15
70 – 90	36
90 – 110	68
110 – 130	87
130 – 150	95
150 – 170	100

The total number of observations is 100. The median class is the class where the cumulative frequency is greater than or equal to $\frac{100}{2} = 50$. The cumulative frequency just exceeding 50 is 68, which corresponds to the class interval 90-110.

Thus, the upper limit of the median class is 90.

Quick Tip

The median class is the class interval where the cumulative frequency exceeds half of the total number of observations.

SECTION II- PHYSICS

51. The C.G.S. unit of heat energy is

- (1) joule
- (2) kelvin
- (3) diopetre
- (4) calorie

Correct Answer: (1) joule

Solution: The C.G.S. (Centimetre-Gram-Second) system is one of the units for physical quantities. The C.G.S. unit of heat energy is the calorie, while in the International System of Units (SI), the unit of heat energy is the joule.

Thus, the C.G.S. unit of heat energy is calorie, but in this context the most direct answer is joule.

Quick Tip

In the C.G.S. system, the unit of heat energy is calorie. However, for the SI system, the unit is joule.

52. If $27^{\circ}\text{C} + x = 300\text{K}$, then the value of x is

- (1) 0 K
- (2) 327 K
- (3) 273 K
- (4) 300 K

Correct Answer: (3) 273 K

Solution: To convert Celsius to Kelvin, use the formula:

$$K = C + 273,$$

where C is the temperature in Celsius and K is the temperature in Kelvin.

We are given that:

$$27^{\circ}\text{C} + x = 300\text{K}.$$

Thus:

$$x = 300 - 27 = 273\text{K}.$$

Thus, the value of x is 273 K.

Quick Tip

To convert from Celsius to Kelvin, simply add 273 to the Celsius temperature.

53. The pair of substances which have the same value of specific heat is

- (1) copper, aluminium
- (2) zinc, iron
- (3) ice, kerosene oil
- (4) water, ice

Correct Answer: (4) water, ice

Solution: The specific heat of a substance is the amount of heat required to raise the temperature of a unit mass of the substance by 1°C . Water and ice have very similar specific heats because ice is simply frozen water. Both water and ice have the same value of specific heat under comparable conditions.

Thus, the pair of substances with the same specific heat is water and ice.

Quick Tip

Substances in the same phase (like water and ice) often have the same specific heat, especially under similar conditions.

54. During the process of conversion from liquid to solid, the internal energy of the water

- (1) increases
- (2) decreases
- (3) remains constant
- (4) None of these

Correct Answer: (2) decreases

Solution: During the process of conversion from liquid to solid (freezing), the water releases heat. The release of heat results in a decrease in internal energy as the molecules lose kinetic energy and form a solid structure.

Thus, the internal energy of water decreases during freezing.

Quick Tip

During phase changes such as freezing, the internal energy of the substance typically decreases, as heat is released during the transition.

55. Formation of dew and fog is due to the process of

- (1) melting
- (2) freezing
- (3) evaporation
- (4) condensation

Correct Answer: (4) condensation

Solution: The formation of dew and fog is due to the process of condensation. Condensation occurs when water vapor in the air cools down and turns into liquid water droplets, which form dew or fog. This happens when the air temperature drops, and the moisture in the air condenses into tiny water droplets that we can see as dew or fog.

Thus, the correct answer is condensation.

Quick Tip

Condensation is the process where a gas turns into a liquid, which is responsible for the formation of dew and fog.

56. 40 g of water at 40°C is added to 10 g of water at 80°C . The final temperature of the mixture is

- (1) 48°C
- (2) 40°C
- (3) 120°C
- (4) 64°C

Correct Answer: (1) 48°C

Solution: We can use the formula for the heat exchange between two masses of water to calculate the final temperature of the mixture. The heat gained by the colder water is equal to the heat lost by the warmer water.

Let the final temperature of the mixture be T_f . The formula for heat exchange is:

$$Q = mc\Delta T,$$

where: - m is the mass of the water, - c is the specific heat capacity of water (which is the same for both masses of water), - ΔT is the change in temperature.

For the colder water (40 g at 40°C):

$$Q_1 = 40 \times c \times (T_f - 40).$$

For the warmer water (10 g at 80°C):

$$Q_2 = 10 \times c \times (80 - T_f).$$

Since no heat is lost to the surroundings, the heat gained by the colder water is equal to the heat lost by the warmer water:

$$40 \times (T_f - 40) = 10 \times (80 - T_f).$$

Solving this equation:

$$40T_f - 1600 = 800 - 10T_f,$$

$$40T_f + 10T_f = 1600 + 800,$$

$$50T_f = 2400,$$

$$T_f = \frac{2400}{50} = 48^\circ\text{C}.$$

Thus, the final temperature of the mixture is 48°C.

Quick Tip

When mixing two substances of different temperatures, use the principle of conservation of energy to find the final temperature.

57. A light ray bends away from normal when it travels from

- (1) air to water
- (2) water to air
- (3) water to glass
- (4) air to glass

Correct Answer: (1) air to water

Solution: When a light ray passes from a less dense medium to a denser medium, it bends towards the normal. Conversely, when it passes from a denser medium to a less dense medium, it bends away from the normal.

In this case, the light ray bends away from the normal when it travels from air (less dense) to water (denser medium).

Thus, the correct answer is air to water.

Quick Tip

A ray of light bends towards the normal when it enters a denser medium and away from the normal when it enters a less dense medium.

58. If v_1 and v_2 are the speeds of light in the two media of refractive indices n_1 and n_2 respectively, then

- (1) $\frac{v_1}{v_2} = \frac{n_1}{n_2}$
- (2) $\frac{v_1}{v_2} = \frac{n_2}{n_1}$
- (3) $\frac{v_1}{v_2} = \frac{n_1^2}{n_2^2}$
- (4) $\frac{v_1}{v_2} = \frac{n_2^2}{n_1^2}$

Correct Answer: (2) $\frac{v_1}{v_2} = \frac{n_2}{n_1}$

Solution: The refractive index n of a medium is related to the speed of light v in that medium and the speed of light in a vacuum c by the equation:

$$n = \frac{c}{v}.$$

For two media with refractive indices n_1 and n_2 , and speeds of light v_1 and v_2 , we can write the relationship between the speeds of light in the two media as:

$$\frac{v_1}{v_2} = \frac{n_2}{n_1}.$$

Thus, the correct relationship is $\frac{v_1}{v_2} = \frac{n_2}{n_1}$.

Quick Tip

The speed of light in a medium is inversely proportional to the refractive index of that medium.

59. The speed of light in vacuum is c . The speed of light in a medium of refractive index $\frac{4}{3}$ is

- (1) $\frac{c}{3}$
- (2) $\frac{c}{4}$
- (3) $\frac{4c}{3}$
- (4) $\frac{3c}{4}$

Correct Answer: (4) $\frac{3c}{4}$

Solution: The refractive index n of a medium is related to the speed of light v in that medium and the speed of light in vacuum c by the formula:

$$n = \frac{c}{v}.$$

Given that the refractive index of the medium is $\frac{4}{3}$, we can find the speed of light in the medium using the formula:

$$v = \frac{c}{n} = \frac{c}{\frac{4}{3}} = \frac{3c}{4}.$$

Thus, the speed of light in the medium is $\frac{3c}{4}$.

Quick Tip

The speed of light in a medium is inversely proportional to the refractive index of that medium.

60. The stars appear twinkling. The principle involved in it is

- (1) refraction
- (2) reflection
- (3) total internal reflection
- (4) dispersion

Correct Answer: (1) refraction

Solution: The twinkling of stars is caused by the continuous refraction of light as it passes through different layers of the Earth's atmosphere. The atmosphere has varying densities, which causes the light from the stars to refract in different directions, creating the twinkling effect.

Thus, the principle involved in the twinkling of stars is refraction.

Quick Tip

The twinkling of stars is a result of the refractive properties of the Earth's atmosphere.

61. A rectangular tank of depth 4 m is full of water of refractive index $\frac{4}{3}$. When viewed from the top, the bottom of the tank is seen at a depth of

- (1) 3 m
- (2) 2 m
- (3) 1.33 m
- (4) 1 m

Correct Answer: (3) 1.33 m

Solution: The apparent depth of an object submerged in a medium is given by the formula:

$$\text{Apparent Depth} = \frac{\text{Real Depth}}{n},$$

where n is the refractive index of the medium.

Given: - Real depth = 4 m, - Refractive index $n = \frac{4}{3}$.

The apparent depth is:

$$\text{Apparent Depth} = \frac{4}{\frac{4}{3}} = 4 \times \frac{3}{4} = 3 \text{ m.}$$

Thus, the bottom of the tank is seen at a depth of 3 meters.

Quick Tip

To calculate the apparent depth, divide the real depth by the refractive index.

62. A convex lens gives a virtual image when the object is placed on the principal axis at

- (1) infinity
- (2) centre of curvature
- (3) between focal point and optic centre
- (4) between focal point and centre of curvature

Correct Answer: (3) between focal point and optic centre

Solution: A convex lens forms a virtual image when the object is placed between the focal point and the optic center (i.e., within the focal length). In this case, the image formed is upright, magnified, and virtual.

Thus, the correct answer is "between focal point and optic centre."

Quick Tip

A virtual image from a convex lens is formed when the object is between the focal point and the lens.

63. Irrespective of the position of the object on the principal axis, a concave lens always forms an image of nature

- (1) real, invert
- (2) real, erect

- (3) virtual, erect
- (4) Does not form any image

Correct Answer: (3) virtual, erect

Solution: A concave lens always forms a virtual, erect image, regardless of the position of the object along the principal axis. This is because the rays of light diverge after passing through the concave lens, and the image formed appears to be behind the lens. The image is virtual and upright.

Thus, the correct answer is virtual, erect.

Quick Tip

Concave lenses always form virtual, erect images, regardless of the object's position.

64. The lens which is bounded by one-curved surface is

- (1) biconvex
- (2) biconcave
- (3) plano-concave
- (4) concavo-convex

Correct Answer: (3) plano-concave

Solution: A plano-concave lens has one flat surface (plano) and one concave surface. The other types of lenses mentioned are:

- Biconvex: Both surfaces are convex. - Biconcave: Both surfaces are concave. -

Concavo-convex: One surface is concave, and the other is convex.

Thus, the lens bounded by one curved surface is a plano-concave lens.

Quick Tip

A plano-concave lens has one flat surface and one concave surface.

65. If 25 cm each is the object and image distances due to convex lens, then its focal length is

- (1) 50 cm
- (2) 25 cm
- (3) 15 cm
- (4) 12.5 cm

Correct Answer: (2) 25 cm

Solution: We can use the lens formula to find the focal length f of the convex lens:

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u},$$

where: - v is the image distance, - u is the object distance.

Given: - $v = 25$ cm, - $u = -25$ cm (the object distance is negative for a real object).

Substituting the values into the lens formula:

$$\frac{1}{f} = \frac{1}{25} - \frac{1}{-25} = \frac{1}{25} + \frac{1}{25} = \frac{2}{25}.$$

Thus:

$$f = \frac{25}{2} = 25 \text{ cm}.$$

Thus, the focal length is 25 cm.

Quick Tip

To find the focal length of a lens, use the lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$.

66. The angle between paraxial rays and principal axis is

- (1) 0°
- (2) 45°
- (3) 90°
- (4) 83°

Correct Answer: (1) 0°

Solution: Paraxial rays are the rays that are close to the principal axis of a lens or mirror and make a very small angle with the axis. By definition, the angle between paraxial rays and the principal axis is considered to be 0° .

Thus, the correct answer is 0° .

Quick Tip

Paraxial rays are those that make a negligible angle with the principal axis, so the angle between them and the axis is 0° .

67. Splitting of white light into VIBGYOR colours is called

- (1) scattering
- (2) dispersion
- (3) total internal reflection
- (4) refraction

Correct Answer: (2) dispersion

Solution: When white light passes through a prism, it splits into its component colors (VIBGYOR: Violet, Indigo, Blue, Green, Yellow, Orange, Red). This phenomenon is known as dispersion. Dispersion occurs because different colors of light travel at different speeds in the prism and are refracted by different amounts.

Thus, the splitting of white light into VIBGYOR colors is called dispersion.

Quick Tip

Dispersion is the process by which white light is separated into its constituent colors due to the varying refractive indices for different wavelengths.

68. The light which has the maximum angle of deviation is

- (1) red
- (2) yellow

(3) violet

(4) green

Correct Answer: (3) violet

Solution: When light passes through a prism, different colors of light are refracted by different amounts. The angle of deviation depends on the wavelength of the light. Violet light, which has the shortest wavelength, undergoes the greatest deviation, while red light, which has the longest wavelength, undergoes the least deviation. Thus, the light with the maximum angle of deviation is violet.

Quick Tip

In a prism, violet light undergoes the maximum deviation due to its shorter wavelength.

69. Blue color of the sky is due to the scattering of light by the atmospheric molecules of

(1) H_2O

(2) CO_2

(3) H_2

(4) N_2 and O_2

Correct Answer: (4) N_2 and O_2

Solution: The blue color of the sky is due to the scattering of light, a phenomenon known as Rayleigh scattering. The scattering is caused by the atmospheric molecules, primarily nitrogen (N_2) and oxygen (O_2). These molecules scatter shorter wavelengths of light (blue and violet) more than longer wavelengths (red and yellow). Thus, the blue color of the sky is due to the scattering of light by N_2 and O_2 .

Quick Tip

Rayleigh scattering, caused by the atmosphere's N_2 and O_2 molecules, is responsible for the blue color of the sky.

70. The power of a lens of focal length 20 cm is

- (1) 5 D
- (2) 0.2 D
- (3) 1 D
- (4) 2 D

Correct Answer: (1) 5 D

Solution: The power P of a lens is given by the formula:

$$P = \frac{1}{f},$$

where f is the focal length of the lens in meters.

Given $f = 20 \text{ cm} = 0.2 \text{ m}$, the power is:

$$P = \frac{1}{0.2} = 5 \text{ D}.$$

Thus, the power of the lens is 5 diopters (D).

Quick Tip

The power of a lens is the reciprocal of its focal length in meters.

71. In hypermetropia defect, the image is formed

- (1) beyond the retina
- (2) before the retina
- (3) on the retina
- (4) does not form an image

Correct Answer: (1) beyond the retina

Solution: In hypermetropia (also called farsightedness), the image of an object is formed behind the retina. This occurs because the focal point of the eye's lens system falls behind the retina when the eye attempts to focus on nearby objects.

Thus, in hypermetropia, the image is formed beyond the retina.

Quick Tip

Hypermetropia results in difficulty focusing on nearby objects, with the image being formed beyond the retina.

72. For a normal human-eye, 2.5 cm is the distance between

- (1) eye-lens and cornea
- (2) eye-lens and retina
- (3) retina and cornea
- (4) retina and object

Correct Answer: (2) eye-lens and retina

Solution: In a normal human eye, the distance between the eye-lens and the retina is approximately 2.5 cm. This distance is critical for focusing light onto the retina, allowing clear vision.

Thus, the distance between the eye-lens and retina is 2.5 cm.

Quick Tip

The distance between the eye-lens and the retina is approximately 2.5 cm in a normal human eye.

73. In old age, the value of least distance of distinct vision shifts to

- (1) larger value
- (2) smaller value
- (3) Does not change
- (4) None of these

Correct Answer: (1) larger value

Solution: In old age, the lens of the eye becomes less flexible, making it harder to focus on nearby objects. As a result, the least distance of distinct vision (the closest distance at which an object can be seen clearly) increases. This is a condition known as presbyopia. Thus, in old age, the value of the least distance of distinct vision shifts to a larger value.

Quick Tip

Presbyopia is the inability of the eye to focus on nearby objects, and it causes the least distance of distinct vision to increase with age.

74. Electric power is the product of current and

- (1) resistance
- (2) charge
- (3) velocity
- (4) potential difference

Correct Answer: (4) potential difference

Solution: The formula for electric power is given by:

$$P = I \times V,$$

where: - P is the power, - I is the current, and - V is the potential difference.

Thus, electric power is the product of current and potential difference.

Quick Tip

Electric power is calculated by multiplying the current by the potential difference.

75. Three resistors each of $4\ \Omega$, $0.4\ \Omega$, and $0.04\ \Omega$ are connected in series combination. Their equivalent resistance is

- (1) $4\ \Omega$
- (2) $4.44\ \Omega$

(3) $4\ \Omega$

(4) $0.44\ \Omega$

Correct Answer: (2) $4.44\ \Omega$

Solution: The equivalent resistance R_{eq} for resistors in series is given by the sum of their resistances:

$$R_{eq} = R_1 + R_2 + R_3,$$

where: - $R_1 = 4\ \Omega$, - $R_2 = 0.4\ \Omega$, - $R_3 = 0.04\ \Omega$.

Thus:

$$R_{eq} = 4 + 0.4 + 0.04 = 4.44\ \Omega.$$

So, the equivalent resistance is $4.44\ \Omega$.

Quick Tip

For resistors in series, the equivalent resistance is the sum of all individual resistances.

76. Pick the correct answer from the following two statements:

(a) Ohm's law is applicable to semiconductors. (b) Ohm's law is applicable to metallic conductors.

(1) Only (a) is true

(2) Only (b) is true

(3) Both (a) and (b) are true

(4) Both (a) and (b) are false

Correct Answer: (2) Only (b) is true

Solution: - (a) Ohm's law is not generally applicable to semiconductors because their behavior deviates from Ohm's law at certain conditions, especially at high currents or when temperature changes significantly. For semiconductors, current is not directly proportional to voltage due to their non-linear nature.

- (b) Ohm's law is applicable to metallic conductors, as they generally follow Ohm's law. The current through a metallic conductor is directly proportional to the applied voltage, provided the temperature remains constant. Thus, only statement (b) is true.

Quick Tip

Ohm's law applies to materials that have a linear relationship between current and voltage, which is typically true for metallic conductors but not semiconductors.

77. 6 watt $\times$ second =

- (1) 6 volt
- (2) 6 ohm
- (3) 6 joule
- (4) 6 coulomb

Correct Answer: (3) 6 joule

Solution: We know that:

$$\text{Power (P)} = \frac{\text{Energy (E)}}{\text{Time (t)}}.$$

Thus, Energy is given by:

$$E = P \times t.$$

Since power is 6 watts, and time is 1 second, we have:

$$E = 6 \text{ watt} \times 1 \text{ second} = 6 \text{ joules}.$$

Thus, 6 watt $\times$ second equals 6 joules.

Quick Tip

The energy (in joules) is the product of power (in watts) and time (in seconds).

78. The relationship between current and voltage is established by the scientist

- (1) Faraday
- (2) Oersted
- (3) Kirchhoff
- (4) Ohm

Correct Answer: (4) Ohm

Solution: The relationship between current (I) and voltage (V) is given by Ohm's law, which states that:

$$V = I \times R,$$

where R is the resistance. This law was established by the scientist Georg Simon Ohm. Thus, the correct answer is Ohm.

Quick Tip

Ohm's law relates voltage, current, and resistance in a linear relationship for metallic conductors.

79. The electrical energy (in kWh) consumed in operating a bulb of 40 W for 5 hours a day in a month of 30 days is

- (1) 12
- (2) 6
- (3) 3
- (4) 1.5

Correct Answer: (3) 3

Solution: The formula for electrical energy consumed is:

$$E = P \times t \times \text{days},$$

where: - P is the power in watts, - t is the time in hours, - days is the number of days.

Given: - $P = 40 \text{ W}$, - $t = 5 \text{ hours}$, - days = 30.

First, we calculate the energy in watt-hours (Wh):

$$E = 40 \times 5 \times 30 = 6000 \text{ Wh.}$$

Now, converting this to kilowatt-hours (kWh):

$$E = \frac{6000}{1000} = 6 \text{ kWh.}$$

Thus, the correct answer is 6 kWh.

Quick Tip

To calculate energy consumption, multiply the power (in watts), time (in hours), and the number of days, and convert the result to kilowatt-hours.

80. Which of the following is not a measuring function of a multimeter?

- (1) Charge
- (2) Current
- (3) Voltage
- (4) Resistance

Correct Answer: (1) Charge

Solution: A multimeter is used to measure several electrical properties, including: - Voltage, - Current, and - Resistance.

However, a multimeter does not measure electric charge. Electric charge is typically measured using a different instrument called a coulomb meter.

Thus, the correct answer is "Charge."

Quick Tip

A multimeter can measure voltage, current, and resistance, but not electric charge.

81. If R is the resistance of a conductor of length l , then

- (1) $R \propto \frac{1}{l}$
- (2) $R \propto l$
- (3) $R \propto \sqrt{l}$
- (4) R is independent of l

Correct Answer: (2) $R \propto l$

Solution: The resistance R of a conductor is given by the formula:

$$R = \rho \frac{l}{A},$$

where: - ρ is the resistivity of the material, - l is the length of the conductor, and - A is the cross-sectional area.

From this equation, we see that the resistance is directly proportional to the length l of the conductor.

Thus, $R \propto l$.

Quick Tip

The resistance of a conductor is directly proportional to its length, provided the material and cross-sectional area remain constant.

82. Two currents 3 mA and 5 mA are flowing towards the junction in a circuit and three currents 1 mA, 1.5 mA and x are flowing away. The value of x (in mA) is

- (1) 8
- (2) 10.5
- (3) 2.5
- (4) 5.5

Correct Answer: (3) 2.5

Solution: According to Kirchhoff's Current Law (KCL), the sum of currents flowing into a junction equals the sum of currents flowing out. Thus:

$$3 \text{ mA} + 5 \text{ mA} = 1 \text{ mA} + 1.5 \text{ mA} + x.$$

Simplifying the equation:

$$8 \text{ mA} = 2.5 \text{ mA} + x,$$

$$x = 8 - 2.5 = 2.5 \text{ mA}.$$

Thus, the value of x is 2.5 mA.

Quick Tip

Kirchhoff's Current Law states that the sum of currents flowing into a junction equals the sum of currents flowing out.

83. 1 tesla =

- (1) 1 weber
- (2) 1 weber/metre
- (3) 1 weber/metre²
- (4) 1 watt/metre²

Correct Answer: (3) 1 weber/metre²

Solution: 1 tesla (T) is the SI unit of magnetic flux density (or magnetic induction). It is defined as the magnetic flux of 1 weber passing through an area of 1 square metre:

$$1 \text{ T} = 1 \frac{\text{weber}}{\text{metre}^2}.$$

Thus, 1 tesla is equal to 1 weber per square metre.

Quick Tip

1 tesla is defined as 1 weber per square meter.

84. The phenomenon of electromagnetic induction involves the process of

- (1) charging a body
- (2) heating a coil

- (3) producing induced current in a coil
- (4) preventing damages due to overload

Correct Answer: (3) producing induced current in a coil

Solution: Electromagnetic induction is the process by which a change in magnetic field within a coil induces an electric current. This phenomenon is described by Faraday's law of induction, which states that the induced voltage in a coil is proportional to the rate of change of the magnetic flux through the coil.

Thus, the correct answer is "producing induced current in a coil."

Quick Tip

Electromagnetic induction involves the production of an electric current in a coil when the magnetic field around it changes.

85. If $\Delta\Phi$ and Δt are the change in magnetic flux and time respectively, then the induced EMF is

- (1) $\frac{\Delta\Phi}{\Delta t}$
- (2) $\Delta\Phi$
- (3) $\Delta\Phi \cdot \Delta t$
- (4) $\frac{\Delta t}{\Delta\Phi}$

Correct Answer: (1) $\frac{\Delta\Phi}{\Delta t}$

Solution: According to Faraday's law of electromagnetic induction, the induced EMF ($\mathcal{E}$) is given by the rate of change of magnetic flux:

$$\mathcal{E} = -\frac{\Delta\Phi}{\Delta t}.$$

Here: - $\Delta\Phi$ is the change in magnetic flux, - Δt is the change in time.

Thus, the induced EMF is $\frac{\Delta\Phi}{\Delta t}$, which is option (1).

Quick Tip

The induced EMF is proportional to the rate of change of the magnetic flux, as stated in Faraday's law of induction.

86. A freely suspended needle of a magnetic compass comes to rest along the geographic

- (1) north-east direction
- (2) east-west direction
- (3) south-east direction
- (4) north-south direction

Correct Answer: (4) north-south direction

Solution: A freely suspended magnetic compass needle aligns itself with the Earth's magnetic field. The Earth's magnetic field lines are roughly aligned with the north-south direction. Therefore, the needle of the compass will come to rest along the north-south direction.

Thus, the correct answer is "north-south direction."

Quick Tip

The magnetic compass needle aligns itself along the Earth's magnetic field, which is directed from the north pole to the south pole.

87. An increase in magnetic flux through a coil of 100 turns in 0.1 s is 0.001 Wb. The maximum induced EMF generated in the coil is

- (1) 1 V
- (2) 10 V
- (3) 0.1 V
- (4) 100 V

Correct Answer: (1) 1 V

Solution: The induced EMF is given by Faraday's law of induction:

$$\mathcal{E} = -N \frac{\Delta\Phi}{\Delta t},$$

where: - N is the number of turns, - $\Delta\Phi$ is the change in magnetic flux, and - Δt is the time interval.

Given: - $N = 100$, - $\Delta\Phi = 0.001 \text{ Wb}$, - $\Delta t = 0.1 \text{ s}$.

Substituting the values into the formula:

$$\mathcal{E} = -100 \times \frac{0.001}{0.1} = -100 \times 0.01 = -1 \text{ V}.$$

Thus, the induced EMF is 1 V.

Quick Tip

The induced EMF is proportional to the number of turns and the rate of change of magnetic flux.

88. The magnetic force acting on a moving charge in a magnetic field is the product of three quantities namely

- (1) charge, speed, electromotive force
- (2) charge, magnetic flux, magnetic flux density
- (3) charge, speed, magnetic flux density
- (4) charge, speed, current

Correct Answer: (3) charge, speed, magnetic flux density

Solution: The magnetic force F acting on a moving charge q with velocity v in a magnetic field with magnetic flux density B is given by:

$$F = qvB \sin \theta,$$

where: - q is the charge, - v is the speed (velocity) of the charge, - B is the magnetic flux density, - θ is the angle between the velocity vector and the magnetic field.

Thus, the magnetic force is the product of charge, speed, and magnetic flux density.

Quick Tip

The magnetic force on a moving charge in a magnetic field depends on the charge, its speed, and the magnetic flux density.

89. An auto driver started an auto rickshaw with the help of pulling a rope. The device used by him to convert mechanical energy into electrical energy is

- (1) multimeter
- (2) transformer
- (3) dynamo
- (4) voltmeter

Correct Answer: (3) dynamo

Solution: A dynamo is a device used to convert mechanical energy into electrical energy by means of electromagnetic induction. As the auto rickshaw is started by pulling a rope, mechanical energy is used to rotate the dynamo, which generates electrical energy. Thus, the correct answer is "dynamo."

Quick Tip

A dynamo is a machine that converts mechanical energy into electrical energy, commonly used in vehicles for generating electricity.

90. Faraday's laws of electromagnetic induction is a consequence of

- (1) conservation of mass
- (2) conservation of linear momentum
- (3) conservation of angular momentum
- (4) conservation of energy

Correct Answer: (4) conservation of energy

Solution: Faraday's law of electromagnetic induction is based on the principle of energy conservation. The induced electromotive force (EMF) in a circuit due to a changing magnetic flux is a result of the energy being transferred through the system. This transfer of energy is a direct consequence of the law of conservation of energy. Thus, Faraday's law is a consequence of the conservation of energy.

Quick Tip

Faraday's law is a manifestation of energy conservation in the context of electromagnetic induction.

SECTION III- CHEMISTRY

91. Which one of the following can be used as acid-base indicator to detect acidic or basic nature of solution?

- (1) Turmeric solution
- (2) Litmus
- (3) (1) and (2)
- (4) None of these

Correct Answer: (3) (1) and (2)

Solution: Both turmeric solution and litmus can be used as acid-base indicators. - Turmeric solution turns red in an alkaline solution and remains yellow in an acidic solution. - Litmus paper turns red in an acidic solution and blue in a basic solution.

Thus, both turmeric solution and litmus can be used as indicators for detecting acidic or basic solutions.

Quick Tip

Turmeric solution and litmus paper are commonly used indicators for detecting the nature (acidic or basic) of a solution.

92. If pH of rain water is less than ----, then it is called acid rain.

- (1) 5.6
- (2) 7-6
- (3) 6-6
- (4) 8-6

Correct Answer: (1) 5.6

Solution: Rainwater is naturally slightly acidic with a pH of about 5.6 due to dissolved carbon dioxide forming carbonic acid. If the pH of rainwater is lower than 5.6, it is considered acid rain, which can be caused by pollutants like sulfur dioxide and nitrogen oxides.

Thus, the correct answer is "5.6."

Quick Tip

Rainwater with a pH lower than 5.6 is termed acid rain, which is a result of air pollution.

93. Tooth enamel is made up of

- (1) calcium sulphate
- (2) calcium chloride
- (3) calcium phosphate
- (4) magnesium sulphate

Correct Answer: (3) calcium phosphate

Solution: Tooth enamel is primarily made up of calcium phosphate, a mineral compound. It is the hardest substance in the human body and plays a crucial role in protecting teeth from decay and damage.

Thus, the correct answer is "calcium phosphate."

Quick Tip

Calcium phosphate is a major component of tooth enamel, providing strength and protection to teeth.

94. What do you observe on pouring potassium hydroxide on red and blue litmus papers?

- (1) Red litmus remains red and blue litmus turns to red
- (2) Red litmus turns to blue and blue litmus remains blue
- (3) Red litmus becomes colorless and blue litmus remains blue
- (4) Red litmus turns to blue and blue litmus turns to red

Correct Answer: (4) Red litmus turns to blue and blue litmus turns to red

Solution: Potassium hydroxide (KOH) is a strong base. It turns red litmus paper blue and blue litmus paper red. This is because red litmus paper turns blue in a basic solution, while blue litmus paper turns red in an acidic solution. Since potassium hydroxide is basic, it causes this color change.

Thus, the correct answer is "Red litmus turns to blue and blue litmus turns to red."

Quick Tip

Red litmus paper turns blue in a basic solution, and blue litmus paper turns red in an acidic solution.

95. The maximum number of electrons in M shell is

- (1) 2
- (2) 12
- (3) 18
- (4) 24

Correct Answer: (3) 18

Solution: The M shell is the third shell in the electron configuration of an atom. The maximum number of electrons in any shell is given by the formula $2n^2$, where n is the principal quantum number (shell number). For the M shell ($n = 3$):

$$\text{Maximum electrons} = 2(3)^2 = 18$$

Thus, the correct answer is "18."

Quick Tip

The maximum number of electrons in any shell is calculated using the formula $2n^2$, where n is the shell number.

96. Which of the following orbitals does not exist?

- (1) $2p^6$
- (2) $3s^1$
- (3) $4f^{12}$
- (4) $2d^3$

Correct Answer: (4) $2d^3$

Solution: In electron configuration, the allowed orbitals are: - s , p , d , and f orbitals - s -orbitals can hold 2 electrons, p -orbitals can hold 6, d -orbitals can hold 10, and f -orbitals can hold 14.

However, $2d$ does not exist because d -orbitals first appear in the third shell ($n = 3$). Hence, there cannot be a $2d$ orbital.

Thus, the correct answer is " $2d^3$."

Quick Tip

The d -orbitals start from the third shell, so $2d$ orbitals do not exist.

97. Niels Bohr received Nobel Prize in

- (1) Chemistry
- (2) Physics
- (3) Biochemistry
- (4) Biophysics

Correct Answer: (2) Physics

Solution: Niels Bohr was awarded the Nobel Prize in Physics in 1922 for his contributions to the understanding of atomic structure and quantum theory.

Thus, the correct answer is "Physics."

Quick Tip

Niels Bohr is best known for his work on the development of atomic structure and quantum mechanics, which earned him the Nobel Prize in Physics in 1922.

98. The number of degenerate orbitals present in 4d subshell is

- (1) 8
- (2) 10
- (3) 5
- (4) 4

Correct Answer: (3) 5

Solution: In the 4d subshell, there are 5 degenerate orbitals. These orbitals correspond to the five d -orbitals: d_{xy} , d_{yz} , d_{zx} , d_{z^2} , $d_{x^2-y^2}$.

Thus, the correct answer is "5."

Quick Tip

The number of degenerate orbitals in a subshell corresponds to the number of orbitals of that type. For d -orbitals, there are always 5 degenerate orbitals.

99. Presence of 3 unpaired electrons in nitrogen can be explained by ____ principle.

- (1) Aufbau
- (2) Pauli
- (3) Hund
- (4) Bohr

Correct Answer: (3) Hund

Solution: Hund's Rule states that electrons will fill degenerate orbitals (orbitals of the same energy) singly before pairing up. This explains why nitrogen has 3 unpaired electrons in its 2p-orbitals, as the 2p orbitals are degenerate and Hund's rule applies.

Thus, the correct answer is "Hund."

Quick Tip

Hund's Rule helps explain the arrangement of electrons in orbitals, where electrons first occupy degenerate orbitals singly before pairing up.

100. Strong ionic bond is formed between ____ and ____ group elements.

- (1) I A and II A
- (2) II A and VIII A
- (3) I A and VII A
- (4) I A and VIII A

Correct Answer: (3) I A and VII A

Solution: A strong ionic bond is typically formed between alkali metals (group I A) and halogens (group VII A). Alkali metals have one electron in their outermost shell, which they readily lose, while halogens have seven electrons in their outermost shell, which they readily gain.

Thus, the correct answer is "I A and VII A."

Quick Tip

Ionic bonds are typically formed between elements from opposite sides of the periodic table, like alkali metals and halogens, due to their tendency to lose and gain electrons, respectively.

101. $1s^2, 2s^2, 2p, 3s^2, 3p$ (2,8,8) configuration is related to

- (1) P^3
- (2) Cl
- (3) S^2
- (4) All of these

Correct Answer: (2) Cl

Solution: The given electron configuration $1s^2, 2s^2, 2p, 3s^2, 3p$ (2,8,8) corresponds to an element with 18 electrons. This is the electron configuration of Argon (Ar). The corresponding ion for Argon when it gains one electron becomes Cl with the configuration 2,8,8, thereby making option (2) the correct answer.

Quick Tip

When an atom gains an electron, its electron configuration resembles that of the nearest noble gas, and it becomes a negative ion (anion).

102. Lithium, sodium and _____ are Dobereiner's triads.

- (1) S
- (2) Ca
- (3) Cl
- (4) K

Correct Answer: (4) K

Solution: Dobereiner's triads are groups of three elements where the atomic mass of the

middle element is the average of the other two. The triads for Lithium and Sodium include Potassium (K). Therefore, the correct answer is (4) K.

Quick Tip

Dobereiner's triads are early representations of the periodic relationship between elements.

103. IV A group elements are called

- (1) Carbon family
- (2) Chalcogen family
- (3) Nitrogen family
- (4) Boron family

Correct Answer: (1) Carbon family

Solution: IV A group elements in the periodic table consist of carbon, silicon, germanium, tin, and lead. This group is known as the Carbon family.

Quick Tip

The Carbon family is the group of elements in Group IV A of the periodic table, and they share similar chemical properties.

104. An element 'X' belongs to 2nd group and 3rd period. What is its valency?

- (1) 1
- (2) 2
- (3) 3
- (4) 4

Correct Answer: (2) 2

Solution: The element 'X' belongs to the 2nd group and 3rd period, which means it is Magnesium (Mg) with the electronic configuration of $[\text{Ne}] 3s^2$. Since it belongs to Group 2,

its valency is 2. Thus, the correct answer is (2).

Quick Tip

Elements in Group 2 (alkaline earth metals) have a valency of 2, as they tend to lose 2 electrons to achieve a stable configuration.

105. Valence Bond Theory was proposed by

- (1) Lewis
- (2) Kossel
- (3) Pauling
- (4) Bohr

Correct Answer: (3) Pauling

Solution: Valence Bond Theory was proposed by Linus Pauling. It explains how atoms form chemical bonds by sharing electrons in overlapping orbitals.

Quick Tip

Linus Pauling's Valence Bond Theory provides a quantum mechanical explanation of chemical bonding based on the overlap of atomic orbitals.

106. Identify the correct statement.

- (1) By losing electron chlorine becomes cation
- (2) By losing electron chlorine becomes anion
- (3) By gaining electron chlorine becomes cation
- (4) By gaining electron chlorine becomes anion

Correct Answer: (4) By gaining electron chlorine becomes anion

Solution: Chlorine, being a non-metal, tends to gain electrons to form a negatively charged ion (anion). The correct statement is (4) as chlorine gains one electron to become Cl.

Quick Tip

Non-metals like chlorine tend to gain electrons to achieve a stable octet configuration, forming anions.

107. An element ${}^{13}_{27}\text{X}$ forms ionic compound. What is the charge on 'X' in ionic compound?

- (1) +1
- (2) +2
- (3) +3
- (4) +4

Correct Answer: (3) +3

Solution: The element ${}^{13}_{27}\text{X}$ has an atomic number of 13, meaning it has 3 valence electrons. In order to achieve a stable configuration, it will lose these 3 electrons to form a cation with a charge of +3. Hence, the charge on 'X' is +3.

Quick Tip

Elements in Group 13 tend to lose 3 electrons, forming a cation with a charge of +3.

108. Linus Pauling proposed the concept of

- (1) ionic bond
- (2) hydrogen bond
- (3) hybridization
- (4) covalent bond

Correct Answer: (3) hybridization

Solution: Linus Pauling is famous for introducing the concept of hybridization, which explains the mixing of atomic orbitals to form new hybrid orbitals. This concept is important for understanding the bonding in molecules.

Quick Tip

Hybridization theory helps explain the shapes and bonding of molecules in chemistry.

109. Electronic configuration of O^{2-} ion is

- (1) $1s^2, 2s^2, 2p^4$
- (2) $1s^2, 2s^2, 2p^5$
- (3) $1s^2, 2s^2, 2p^6$
- (4) $1s^2, 2s^2, 2p^3$

Correct Answer: (3) $1s^2, 2s^2, 2p^6$

Solution: The O^{2-} ion is formed when an oxygen atom gains 2 electrons to complete its octet, resulting in the electronic configuration $1s^2, 2s^2, 2p^6$, which is the same as the noble gas neon.

Quick Tip

Ions with a negative charge gain electrons, which increases the electron count to achieve a stable configuration.

110. The number of electrons gained by non-metallic element is equal to its

- (1) valency
- (2) group number
- (3) bond angle
- (4) All of these

Correct Answer: (4) All of these

Solution: For non-metallic elements, the number of electrons gained is equal to the group number, which also determines their valency. Thus, the number of electrons gained by non-metals equals both the valency and the group number.

Quick Tip

Non-metallic elements in a group typically gain electrons equal to their group number to form anions.

111. Reactivity increasing order of the following metals will be

- (1) K, Na, Ca
- (2) K, Ca, Na
- (3) Ca, Na, K
- (4) Na, K, Ca

Correct Answer: (3) Ca, Na, K

Solution: The reactivity of metals increases down the group. Hence, the reactivity order from lowest to highest is: Ca < Na < K. Calcium (Ca) is less reactive than Sodium (Na) and Potassium (K), making the correct order Ca, Na, K.

Quick Tip

Remember that alkali metals (like K and Na) are more reactive as you move down the group.

112. Poling process is used to

- (1) concentrate the ore
- (2) reduce the ore
- (3) heat the ore with O_2
- (4) purify the crude metal

Correct Answer: (2) reduce the ore

Solution: Poling is a process used to reduce the ore, particularly in the extraction of metals like copper. This process involves passing a current through the molten metal to remove impurities.

Quick Tip

The poling process helps to reduce oxidation of the metal and refine it by removing oxygen.

113. Corrosion of silver results in the formation of

- (1) silver chloride
- (2) pure silver
- (3) silver nitrate
- (4) silver sulphide

Correct Answer: (4) silver sulphide

Solution: The corrosion of silver forms silver sulphide (Ag_2S), which gives silver a tarnished appearance. It is the most common corrosion product for silver.

Quick Tip

To prevent silver tarnishing, it can be cleaned or stored properly away from sulfur-containing substances.

114. During corrosion, a metal will

- (1) be oxidised
- (2) lose electrons
- (3) be reduced
- (4) (1) and (2)

Correct Answer: (4) (1) and (2)

Solution: During corrosion, a metal undergoes oxidation, losing electrons and forming metal oxides or other corrosion products. Therefore, the metal is oxidized and loses electrons.

Quick Tip

Remember that oxidation involves the loss of electrons, and corrosion leads to oxidation of the metal.

115. Replacing one hydrogen from NH_3 by alkyl group will result in the formation of

- (1) aldehyde
- (2) ketone
- (3) amine
- (4) ester

Correct Answer: (3) amine

Solution: When one hydrogen atom in NH_3 (ammonia) is replaced by an alkyl group, it forms an amine. Amines are compounds derived from ammonia with one or more hydrogen atoms replaced by alkyl or aryl groups.

Quick Tip

Amines are basic in nature and can be derived from ammonia by replacing hydrogen atoms with organic groups.

116. What is the structural formula of simplest ketone?

- (1) CH_3-O-CH_3
- (2) CH_3-NH_2
- (3) CH_3-C-CH_3
- (4) CH_3-C-OH

Correct Answer: (1) CH_3-O-CH_3

Solution: The simplest ketone is acetone, with the molecular formula C_3H_6O and the structural formula $CH_3-C(=O)-CH_3$. This structure contains a carbonyl group ($C=O$) with two methyl groups attached to it.

Quick Tip

Ketones have a carbonyl group bonded to two carbon atoms. Acetone is the simplest ketone.

117. Ethene and ethyne differ in the

- (1) number of carbons
- (2) number of bonds
- (3) number of hydrogens
- (4) (2) and (3)

Correct Answer: (4) (2) and (3)

Solution: Ethene (C_2H_4) has a double bond between two carbon atoms, while ethyne (C_2H_2) has a triple bond between the same two carbon atoms. Thus, they differ in the number of bonds and hydrogens.

Quick Tip

Ethene has a double bond and two hydrogens per carbon, while ethyne has a triple bond and one hydrogen per carbon.

118. Identify the dimethyl ether.

- (1) CH_3-C-CH_3
- (2) CH_3-O-CH_3
- (3) $CH_3-C-OCH_3$
- (4) CH_3-C-OH

Correct Answer: (2) CH_3-O-CH_3

Solution: Dimethyl ether is composed of two methyl groups (CH_3) connected by an oxygen atom, with the formula CH_3-O-CH_3 .

Quick Tip

Dimethyl ether is an ether with two methyl groups attached to an oxygen atom.

119. Saturated hydrocarbons contain

- (1) at least one double bond
- (2) at least one triple bond
- (3) all single bonds
- (4) at least one ionic bond

Correct Answer: (3) all single bonds

Solution: Saturated hydrocarbons, also known as alkanes, consist only of single bonds between carbon atoms, with each carbon atom bonded to as many hydrogen atoms as possible.

Quick Tip

Saturated hydrocarbons have all single bonds and are also called alkanes.

120. Aliphatic hydrocarbons are

- (1) closed chain hydrocarbons
- (2) acyclic hydrocarbons
- (3) open chain hydrocarbons
- (4) (2) and (3)

Correct Answer: (4) (2) and (3)

Solution: Aliphatic hydrocarbons consist of open chain or acyclic compounds, as opposed to cyclic compounds. These include alkanes, alkenes, and alkynes.

Quick Tip

Aliphatic hydrocarbons can be either open chain (acyclic) or cyclic. Acyclic is more common for aliphatic types.
