

JEECUP 2020 A Question Paper with Solutions

Time Allowed :2 Hours 30 Mins	Maximum Marks :400	Total Questions :100
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General Instructions

Read the following carefully and follow them strictly:

1. The paper consists of **100 multiple-choice questions (MCQs)**. For each correct answer, **+4 marks** will be awarded, and for each incorrect answer, **-1 mark** will be deducted.
2. If a candidate fills more than one circle for a question, the answer will be considered **invalid**.
3. The OMR answer sheet instructions will be given separately. Follow these instructions carefully, and ensure that all entries and circles are filled with a **ballpoint pen**.
4. Candidates must follow all instructions given by the **Centre Superintendent, Invigilator, or Board Authorities**. Failure to do so, or engaging in misconduct, such as tearing the question paper, exchanging written materials, or assisting others, will result in cancellation of the exam.
5. The use of **log tables, electronic calculators, pagers, mobile phones, and slide rules** is strictly prohibited during the examination.
6. The answer sheet should be filled carefully with a **ballpoint pen**. Make sure to mark the correct answer, as no changes will be allowed once the circle is filled.
7. After the examination, candidates may keep the question paper, but the answer sheet should be submitted as per the instructions.

MATHEATICS

1. The volume of a cuboid is $x^3 - 7x + 6$, then the longest side of cuboid is

- (A) $x + 3$
- (B) None of these
- (C) $x - 1$
- (D) $x - 2$

Correct Answer: (A) $x + 3$

Solution:

To find the sides, we factorize the volume polynomial $V(x) = x^3 - 7x + 6$.

Substitute $x = 1$ into the polynomial: $1^3 - 7(1) + 6 = 1 - 7 + 6 = 0$.

Since $V(1) = 0$, $(x - 1)$ is a factor.

Perform division: $(x^3 - 7x + 6) \div (x - 1) = x^2 + x - 6$.

Now factor the quadratic quotient: $x^2 + x - 6 = (x + 3)(x - 2)$.

Thus, the dimensions are $(x - 1)$, $(x - 2)$, and $(x + 3)$.

Comparing the three linear factors, $x + 3$ is the largest for any valid x .

 Quick Tip

Use the Rational Root Theorem to find the first integer root (factors of the constant term). Once one factor is found, reducing the cubic to a quadratic makes the rest easy.

2. The Quadratic equation, whose roots are $\frac{4+\sqrt{7}}{2}$ and $\frac{4-\sqrt{7}}{2}$ is

(A) $4x^2 + 16x + 9 = 0$

(B) $4x^2 - 16x - 9 = 0$

(C) $4x^2 - 16x + 9 = 0$

(D) $4x^2 + 16x - 9 = 0$

Correct Answer: (C) $4x^2 - 16x + 9 = 0$

Solution:

Let the roots be $\alpha = \frac{4+\sqrt{7}}{2}$ and $\beta = \frac{4-\sqrt{7}}{2}$.

Sum of roots $S = \alpha + \beta = \frac{4+\sqrt{7}+4-\sqrt{7}}{2} = \frac{8}{2} = 4$.

Product of roots $P = \alpha\beta = \frac{(4+\sqrt{7})(4-\sqrt{7})}{4} = \frac{16-7}{4} = \frac{9}{4}$.

The equation is $x^2 - Sx + P = 0$.

Substituting values: $x^2 - 4x + \frac{9}{4} = 0$.

Multiplying by 4 to clear the fraction: $4x^2 - 16x + 9 = 0$.

 Quick Tip

For conjugate roots $\frac{a \pm \sqrt{b}}{c}$, the sum is simply $\frac{2a}{c}$ and the product is $\frac{a^2 - b}{c^2}$.

3. The perpendicular distance between two parallel lines $3x + 4y - 6 = 0$ and $6x + 8y + 7 = 0$ is equal to

- (A) $19/10$ unit
- (B) $19/5$ unit
- (C) $10/19$ unit
- (D) $19/2$ unit

Correct Answer: (A) $19/10$ unit

Solution:

Make the coefficients of x and y same for both lines. Multiply the first equation by 2.

Eq 1: $6x + 8y - 12 = 0$. ($C_1 = -12$)

Eq 2: $6x + 8y + 7 = 0$. ($C_2 = 7$)

Distance $d = \frac{|C_1 - C_2|}{\sqrt{A^2 + B^2}} = \frac{|-12 - 7|}{\sqrt{6^2 + 8^2}}$.

$d = \frac{|-19|}{\sqrt{36 + 64}} = \frac{19}{\sqrt{100}} = \frac{19}{10}$.

💡 Quick Tip

Never apply the distance formula between parallel lines until the x and y coefficients are identical.

4. The length of sides of a triangle are in the ratio $3 : 4 : 5$ and its perimeter is 144 cm. The area of triangle is

- (A) 764 cm^2
- (B) 684 cm^2
- (C) 864 cm^2
- (D) 664 cm^2

Correct Answer: (C) 864 cm^2

Solution:

Let sides be $3x, 4x, 5x$. Perimeter $= 12x = 144 \Rightarrow x = 12$.

Sides are 36, 48, 60.

Since $3^2 + 4^2 = 5^2$, this is a right-angled triangle.

Area $= \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 36 \times 48$.

$$\text{Area} = 18 \times 48 = 864 \text{ cm}^2.$$

💡 Quick Tip

The ratio 3:4:5 always indicates a right-angled triangle. You can skip Heron's formula and directly use $\text{Area} = 0.5 \times \text{Leg}_1 \times \text{Leg}_2$.

5. The volume of cylinder is $448\pi \text{ cm}^3$ and height 7 cm. Then its lateral surface area is

- (A) None of these
- (B) 259 cm^2
- (C) 352 cm^2
- (D) 252 cm^2

Correct Answer: (C) 352 cm^2

Solution:

$$\text{Volume } V = \pi r^2 h = 448\pi.$$

$$\pi r^2(7) = 448\pi \Rightarrow 7r^2 = 448 \Rightarrow r^2 = 64 \Rightarrow r = 8.$$

$$\text{Lateral Surface Area } A = 2\pi r h = 2\pi(8)(7) = 112\pi.$$

$$\text{Using } \pi \approx 22/7, A = 112 \times \frac{22}{7} = 16 \times 22 = 352 \text{ cm}^2.$$

💡 Quick Tip

Check options first; if they are integers, substitute $\pi = 22/7$ or check for divisibility by 11.

6. If $A = 4x + \frac{1}{x}$ then the value of $A + \frac{1}{A}$ is

- (A) 1
- (B) None of these
- (C) $\frac{4x^2+1}{x}$
- (D) $\frac{x}{4x^2+1}$

Correct Answer: (C) $\frac{4x^2+1}{x}$

Solution:

Given,

$$A = 4x + \frac{1}{x}$$

Taking LCM,

$$A = \frac{4x^2 + 1}{x}$$

Thus, the simplified value of A is

$$\frac{4x^2 + 1}{x}$$

Hence, the correct option is (C).

 Quick Tip

In competitive exams, if an option perfectly matches the simplified form of a variable defined in the question, check if the question text might have a typo asking for that variable.

7. The earth makes a complete rotation about its axis in 24 h. What angle will it turn in 3 h 20 minutes ?

(A) None of these

(B) 50°

(C) 120°

(D) 130°

Correct Answer: (B) 50°

Solution:

Total rotation in 24 hours = 360° .

Angular speed = $\frac{360}{24} = 15^\circ$ per hour.

Time duration = 3 hours 20 minutes = $3 + \frac{20}{60}$ hours = $3 + \frac{1}{3} = \frac{10}{3}$ hours.

Angle turned = Speed $\times$ Time = $15 \times \frac{10}{3}$.

Angle = $5 \times 10 = 50^\circ$.

 Quick Tip

Convert mixed time units (hours and minutes) into a single fraction of hours before multiplying by the rate.

8. If side of cube is 6 cm, then the diagonal of cube is

- (A) $6\sqrt{3}$ cm
- (B) $2\sqrt{3}$ cm
- (C) $6\sqrt{2}$ cm
- (D) $3\sqrt{2}$ cm

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

Solution:

The formula for the main diagonal of a cube with side a is $d = a\sqrt{3}$.

Given side $a = 6$ cm.

Diagonal = $6\sqrt{3}$ cm.

 Quick Tip

Face diagonal = $a\sqrt{2}$. Main diagonal (space diagonal) = $a\sqrt{3}$.

9. The solution of equation $y^{\frac{2}{3}} - 2y^{\frac{1}{3}} = 15$ is

- (A) 27, -125
- (B) 25, 27
- (C) 125, -27
- (D) 25, -27

Correct Answer: (C) 125, -27

Solution:

Let $x = y^{\frac{1}{3}}$. Then $y^{\frac{2}{3}} = x^2$.

The equation becomes $x^2 - 2x - 15 = 0$.

Factorize: $(x - 5)(x + 3) = 0$.

So, $x = 5$ or $x = -3$.

Case 1: $y^{\frac{1}{3}} = 5 \Rightarrow y = 5^3 = 125$.

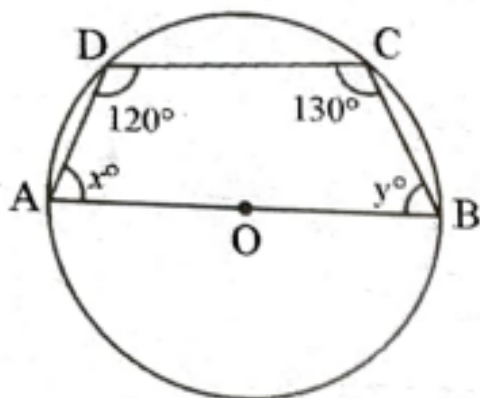
Case 2: $y^{\frac{1}{3}} = -3 \Rightarrow y = (-3)^3 = -27$.

Roots are 125, -27.

💡 Quick Tip

Transform equations with rational exponents into standard quadratic forms by substitution (e.g., $t = y^{1/n}$).

10. Use the following figure to find x° and y°



(A) $x = 50^\circ, y = 30^\circ$

(B) $x = 30^\circ, y = 50^\circ$

(C) $x = 50^\circ, y = 60^\circ$

(D) $x = 55^\circ, y = 65^\circ$

Correct Answer: (C) $x = 50^\circ, y = 60^\circ$

Solution:

The figure shows a cyclic quadrilateral ABCD inscribed in a circle.

Property of cyclic quadrilateral: Opposite angles sum to 180° .

$$\angle B + \angle D = 180^\circ \Rightarrow y^\circ + 120^\circ = 180^\circ \Rightarrow y = 60.$$

$$\angle A + \angle C = 180^\circ \Rightarrow x^\circ + 130^\circ = 180^\circ \Rightarrow x = 50.$$

Thus, $x = 50, y = 60$.

💡 Quick Tip

In any cyclic quadrilateral (all four vertices on a circle), opposite angles are always supplementary (add up to 180°).

11. If $\sqrt{3}x - 2 = 2\sqrt{3} + 4$, then the value of x is

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

(B) $1 + \sqrt{3}$

(C) $1 - \sqrt{3}$

(D) $2(1 + \sqrt{3})$

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

Solution:

Rearrange the equation: $\sqrt{3}x = 2\sqrt{3} + 4 + 2$.

$$\sqrt{3}x = 2\sqrt{3} + 6.$$

Divide by $\sqrt{3}$: $x = \frac{2\sqrt{3}}{\sqrt{3}} + \frac{6}{\sqrt{3}}$.

$$x = 2 + 2\sqrt{3}.$$

Factor out 2: $x = 2(1 + \sqrt{3})$.

 Quick Tip

Rationalizing the denominator (multiplying top and bottom by the root) is often the key step in simplifying expressions with surds. Here, $6/\sqrt{3} = 2\sqrt{3}$.

12. Vertex of a triangle are $(4, 6)$, $(2, -2)$ and $(0, 2)$, then co-ordinates of its centroid must be

(A) $(2, 2)$

(B) $(-2, 2)$

(C) $(2, 3)$

(D) $(1, 2)$

Correct Answer: (A) $(2, 2)$

Solution:

Formula for centroid $G(x, y)$ of triangle with vertices $(x_1, y_1), (x_2, y_2), (x_3, y_3)$ is $(\frac{x_1+x_2+x_3}{3}, \frac{y_1+y_2+y_3}{3})$.

$$x = \frac{4+2+0}{3} = \frac{6}{3} = 2.$$

$$y = \frac{6+(-2)+2}{3} = \frac{6}{3} = 2.$$

Centroid is $(2, 2)$.

 Quick Tip

The centroid is simply the average of the x-coordinates and the average of the y-coordinates.

13. Angles of a triangle are in ratio of 1 : 5 : 12, biggest angle of this triangle is

- (A) 45°
- (B) 90°
- (C) 120°
- (D) 60°

Correct Answer: (C) 120°

Solution:

Let the angles be $x, 5x, 12x$.

Sum of angles in a triangle is 180° .

$$x + 5x + 12x = 180.$$

$$18x = 180 \Rightarrow x = 10.$$

The biggest angle is $12x = 12(10) = 120^\circ$.

 Quick Tip

Sum of ratio parts often maps directly to the total sum (180 for triangles). Always find the value of '1 unit' first.

14. The value of $(x - \frac{2}{x})(x^2 + 2 + \frac{4}{x^2})$ is

- (A) $x^3 + 2x + \frac{4}{x} - 8$
- (B) $x^3 - \frac{8}{x^3}$
- (C) $x^3 + \frac{8}{x^3}$
- (D) $x^3 - \frac{8}{x^2}$

Correct Answer: (B) $x^3 - \frac{8}{x^3}$

Solution:

Let $a = x$ and $b = \frac{2}{x}$.

The expression is in the form $(a - b)(a^2 + a \cdot b + b^2)$.

Check the middle term: $a \cdot b = x \cdot \frac{2}{x} = 2$. This matches the middle term '2' in the second bracket.

This is the expansion for the identity $a^3 - b^3$.

$$\text{Result} = (x)^3 - \left(\frac{2}{x}\right)^3 = x^3 - \frac{8}{x^3}.$$

 Quick Tip

Memorize algebraic identities like $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$ to spot patterns immediately without expanding everything.

15. A and B can do a piece of work in 72 days. B and C in 120 days and A and C in 90 days. In what time can A alone do it ?

(A) 120 days

(B) 55 days

(C) 110 days

(D) 60 days

Correct Answer: (A) 120 days

Solution:

$$(A + B)\text{'s 1 day work} = 1/72.$$

$$(B + C)\text{'s 1 day work} = 1/120.$$

$$(A + C)\text{'s 1 day work} = 1/90.$$

$$\text{Summing all three: } 2(A + B + C) = \frac{1}{72} + \frac{1}{120} + \frac{1}{90}.$$

LCM of 72, 120, 90 is 360.

$$2(A + B + C) = \frac{5+3+4}{360} = \frac{12}{360} = \frac{1}{30}.$$

$$(A + B + C) = \frac{1}{60}.$$

To find A alone, subtract $(B + C)$ from $(A + B + C)$:

$$A = \frac{1}{60} - \frac{1}{120} = \frac{2-1}{120} = \frac{1}{120}.$$

A takes 120 days.

💡 Quick Tip

Work rate problems are easier when you sum the combined rates. Remember the sum gives $2(A + B + C)$, so always divide by 2.

16. If points $(5, 5)$, $(10, k)$ and $(-5, 1)$ are collinear. Then the value of k is

- (A) 9
- (B) 6
- (C) 8
- (D) 7

Correct Answer: (D) 7

Solution:

For collinear points, the slope between any two pairs must be equal.

Slope m_1 between $(5, 5)$ and $(10, k)$ is $\frac{k-5}{10-5} = \frac{k-5}{5}$.

Slope m_2 between $(5, 5)$ and $(-5, 1)$ is $\frac{1-5}{-5-5} = \frac{-4}{-10} = \frac{2}{5}$.

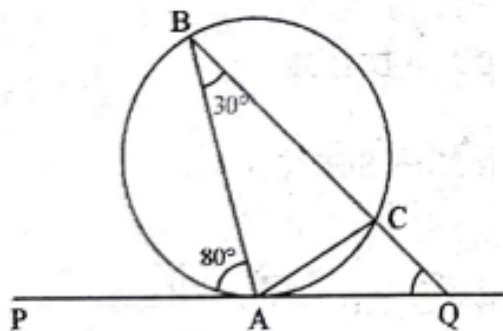
Equate slopes: $\frac{k-5}{5} = \frac{2}{5}$.

$$k - 5 = 2 \Rightarrow k = 7.$$

💡 Quick Tip

Collinear points lie on the same line, so slopes $m_{AB} = m_{BC} = m_{AC}$. Alternatively, the area of the triangle formed by them is zero.

17. In figure $\angle BAP = 80^\circ$ and $\angle ABC = 30^\circ$, then $\angle AQC$ will be



- (A) 65°
- (B) 50°
- (C) 110°

(D) 55°

Correct Answer: (B) 50°

Solution:

Given that AP is a tangent to the circle at point A and AB is a chord.

By the **Alternate Segment Theorem**, the angle between a tangent and a chord through the point of contact is equal to the angle in the opposite arc.

$$\angle ABC = \angle QAC = 30^\circ$$

Given,

$$\angle BAP = 80^\circ$$

Since P , A , and Q lie on a straight line,

$$\angle QAB = 180^\circ - 80^\circ = 100^\circ$$

Now, in $\triangle AQC$,

$$\angle AQC = \angle QAB - \angle QAC$$

$$\angle AQC = 100^\circ - 30^\circ = 50^\circ$$

$$\angle AQC = 50^\circ$$

Hence, the correct option is **(B)**.

 Quick Tip

In secant-tangent problems, if you see values like x and y , the exterior intersection angle is often the difference of associated arc angles or segment angles. Here $80 - 30 = 50$.

18. If $\sin x + \sin^2 x = 1$, then the value of $\cos^2 x + \cos^4 x$ is

(A) -1

(B) 0

(C) 1

(D) 2

Correct Answer: (C) 1

Solution:

Given $\sin x + \sin^2 x = 1$.

$$\sin x = 1 - \sin^2 x.$$

We know $1 - \sin^2 x = \cos^2 x$. So, $\sin x = \cos^2 x$.

We need to find $\cos^2 x + \cos^4 x$.

Substitute $\cos^2 x = \sin x$:

Expression = $\sin x + (\sin x)^2 = \sin x + \sin^2 x$.

But the value of this is given as 1.

Therefore, the value is 1.

 Quick Tip

This is a standard identity substitution problem. Always express the target equation in terms of the given relation.

19. If $2^x = 5^y = 10^{-z}$, then the value of $(\frac{1}{x} + \frac{1}{y} + \frac{1}{z})$ is

(A) -2

(B) 0

(C) 5

(D) 3

Correct Answer: (B) 0

Solution:

Let $2^x = 5^y = 10^{-z} = k$.

Then $2 = k^{1/x}$, $5 = k^{1/y}$, and $10 = k^{-1/z}$.

We know that $2 \times 5 = 10$.

Substitute the k terms: $k^{1/x} \times k^{1/y} = k^{-1/z}$.

Using exponent laws: $k^{(1/x+1/y)} = k^{-1/z}$.

Equating exponents: $\frac{1}{x} + \frac{1}{y} = -\frac{1}{z}$.

$$\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 0.$$

 Quick Tip

For equations of type $a^x = b^y = c^z$, set them equal to a constant k and express bases a, b, c in terms of k . Then use the multiplicative relationship between bases ($a \cdot b = c$).

20. The value of $X^{(\log y - \log z)} \times Y^{(\log z - \log x)} \times Z^{(\log x - \log y)}$

- (A) 5
(B) 1
(C) 3
(D) 0

Correct Answer: (B) 1

Solution:

Let the expression be E . Take log of the expression (assuming base 10 or e).

$$\log E = (\log y - \log z) \log X + (\log z - \log x) \log Y + (\log x - \log y) \log Z.$$

Assuming bases X, Y, Z correspond to variables x, y, z in the exponents (or simply cyclic symmetry with $X = x, Y = y, Z = z$):

$$\log E = (\log y - \log z) \log x + (\log z - \log x) \log y + (\log x - \log y) \log z.$$

$$\text{Expand: } \log y \log x - \log z \log x + \log z \log y - \log x \log y + \log x \log z - \log y \log z.$$

All terms cancel out. $\log E = 0$.

$$E = 10^0 = 1.$$

 Quick Tip

Cyclic expressions of the form $\sum a(b - c)$ or products like $\prod x^{y-z}$ often simplify to 0 (for sums) or 1 (for products) due to term cancellation.

21. A train passes telegraph post in 40 seconds moving at a rate of 36 km/h. Then the length of the train is

- (A) 450 m
(B) 500 m
(C) 400 m
(D) 395 m

Correct Answer: (C) 400 m

Solution:

Given speed of train $v = 36$ km/h.

Convert speed to m/s: $36 \times \frac{5}{18} = 10$ m/s.

Time taken to pass a post $t = 40$ seconds.

Distance traveled (Length of train) $d = \text{speed} \times \text{time}$.

$$d = 10 \times 40 = 400 \text{ meters.}$$

 Quick Tip

To convert km/h to m/s, multiply by 5/18. To convert m/s to km/h, multiply by 18/5.

22. The value of $\sqrt{\frac{1+\sin x}{1-\sin x}}$ is

- (A) $\sec x + \tan x$
- (B) $\sec x \cdot \tan x$
- (C) $\sec x - \tan x$
- (D) $\tan x - \sec x$

Correct Answer: (A) $\sec x + \tan x$

Solution:

Rationalize the denominator inside the square root by multiplying numerator and denominator by $(1 + \sin x)$.

$$\text{Expression} = \sqrt{\frac{(1+\sin x)(1+\sin x)}{(1-\sin x)(1+\sin x)}} = \sqrt{\frac{(1+\sin x)^2}{1-\sin^2 x}}.$$

$$\text{Since } 1 - \sin^2 x = \cos^2 x, \text{ expression} = \sqrt{\frac{(1+\sin x)^2}{\cos^2 x}}.$$

Taking the square root gives $\frac{1+\sin x}{\cos x}$.

Split the fraction: $\frac{1}{\cos x} + \frac{\sin x}{\cos x}$.

$$\text{Result} = \sec x + \tan x.$$

 Quick Tip

Rationalizing the denominator using the conjugate (e.g., multiplying by $1 + \sin x$ for $1 - \sin x$) is a standard technique for simplifying trigonometric fractions under radicals.

23. The perimeter of an equilateral triangle whose area is $4\sqrt{3}$ cm² is equal to

- (A) 10 cm
- (B) 12 cm
- (C) 20 cm
- (D) 15 cm

Correct Answer: (B) 12 cm

Solution:

Let the side of the equilateral triangle be a .

Area formula: $\frac{\sqrt{3}}{4}a^2 = 4\sqrt{3}$.

Divide both sides by $\sqrt{3}$: $\frac{1}{4}a^2 = 4$.

Multiply by 4: $a^2 = 16 \Rightarrow a = 4$.

Perimeter = $3a = 3(4) = 12$ cm.

💡 Quick Tip

Memorize the formula for the area of an equilateral triangle: $A = \frac{\sqrt{3}}{4}a^2$.

24. The value of $\log_5 \left(\frac{1}{125} \right)$ is

- (A) 0
- (B) -3
- (C) 3
- (D) 5

Correct Answer: (B) -3

Solution:

We can express $\frac{1}{125}$ as $\frac{1}{5^3} = 5^{-3}$.

The expression becomes $\log_5(5^{-3})$.

Using the property $\log_b(b^x) = x$, the value is -3 .

💡 Quick Tip

Express the argument of the logarithm as a power of the base to solve immediately.

25. If the ratio of volumes of two spheres is 1 : 8, then the ratio of their surface areas is

- (A) 1 : 4
- (B) 1 : 6
- (C) 1 : 8
- (D) 1 : 2

Correct Answer: (A) 1 : 4

Solution:

Volume ratio $\frac{V_1}{V_2} = \frac{1}{8}$.

Since volume is proportional to the cube of the radius (r^3), $\left(\frac{r_1}{r_2}\right)^3 = \frac{1}{8}$.

Taking the cube root, $\frac{r_1}{r_2} = \frac{1}{2}$.

Surface area is proportional to the square of the radius (r^2).

Area ratio $\frac{A_1}{A_2} = \left(\frac{r_1}{r_2}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$.

 Quick Tip

If the ratio of corresponding lengths is k , the ratio of areas is k^2 and the ratio of volumes is k^3 .

26. If $5\sqrt{5} \times 5^3 \div 5^{-3/2} = 5^{a+2}$ then the value of a is

- (A) 5
- (B) 8
- (C) 6
- (D) 4

Correct Answer: (D) 4

Solution:

Convert all terms to powers of 5.

$$5\sqrt{5} = 5^1 \cdot 5^{1/2} = 5^{1.5}.$$

The LHS expression is $5^{1.5} \times 5^3 \div 5^{-1.5}$.

Using laws of exponents $x^m \times x^n \div x^p = x^{m+n-p}$:

$$\text{Exponent} = 1.5 + 3 - (-1.5) = 1.5 + 3 + 1.5 = 6.$$

So, LHS = 5^6 .

Equating to RHS: $5^6 = 5^{a+2}$.

$$a + 2 = 6 \Rightarrow a = 4.$$

 Quick Tip

Remember that dividing by a number with a negative exponent is equivalent to multiplying by that number with a positive exponent.

27. The factor of $(a^4b^4 - 16c^4)$ is

(A) $(a^2b^2 - 4c^2)(ab + 2c)^2$

(B) $4(a^2b^2 + c^2)(ab - 2c)(ab + 2c)$

(C) $(a^2b^2 - 4c^2)^2(ab + 2c)(ab + 4c)$

(D) $(a^2b^2 + 4c^2)(ab + 2c)(ab - 2c)$

Correct Answer: (D) $(a^2b^2 + 4c^2)(ab + 2c)(ab - 2c)$

Solution:

The expression is a difference of two squares: $(a^2b^2)^2 - (4c^2)^2$.

Factor using $x^2 - y^2 = (x + y)(x - y)$:

$$= (a^2b^2 + 4c^2)(a^2b^2 - 4c^2).$$

The second term $(a^2b^2 - 4c^2)$ is also a difference of squares: $(ab)^2 - (2c)^2$.

Factor further: $(ab + 2c)(ab - 2c)$.

Combined expression: $(a^2b^2 + 4c^2)(ab + 2c)(ab - 2c)$.

 Quick Tip

Always check if factors obtained from $a^2 - b^2$ can be factored further using the same identity.

28. Ravi can do $\frac{3}{4}$ of a work in 12 days. In how many days Ravi can finish the $\frac{1}{2}$ work ?

- (A) 8 days
- (B) 7 days
- (C) 6 days
- (D) None of these

Correct Answer: (A) 8 days

Solution:

Time taken for $\frac{3}{4}$ work = 12 days.

Time for full work = $12 \times \frac{4}{3} = 16$ days.

Time for $\frac{1}{2}$ work = $\frac{1}{2} \times 16 = 8$ days.

 Quick Tip

Use unitary method: Calculate time for 1 unit of work first, then multiply by the desired fraction of work.

29. The median of the following data 25, 34, 31, 23, 22, 26, 35, 29, 20, 32 is

- (A) 29.5
- (B) 27.5
- (C) 30.5
- (D) 22.5

Correct Answer: (B) 27.5

Solution:

First, arrange the data in ascending order: 20, 22, 23, 25, 26, 29, 31, 32, 34, 35.

Total number of observations $n = 10$ (even number).

The median is the average of the two middle terms ($\frac{n}{2}$ th and $(\frac{n}{2} + 1)$ th).

5th term = 26, 6th term = 29.

Median = $\frac{26+29}{2} = \frac{55}{2} = 27.5$.

 Quick Tip

Don't forget to sort the data set before finding the median. For an even number of items, average the two middle values.

30. If $(x + \frac{1}{x}) = \sqrt{3}$, then the value of $(x^3 + \frac{1}{x^3})$ will be

- (A) 0
- (B) $3\sqrt{3}$
- (C) $3(\sqrt{3} - 1)$
- (D) $3(\sqrt{3} + 1)$

Correct Answer: (A) 0

Solution:

Using the identity $a^3 + b^3 = (a + b)^3 - 3ab(a + b)$.

Here $a = x$ and $b = \frac{1}{x}$.

$$x^3 + \frac{1}{x^3} = \left(x + \frac{1}{x}\right)^3 - 3\left(x\right)\left(\frac{1}{x}\right)\left(x + \frac{1}{x}\right).$$

Substitute $x + \frac{1}{x} = \sqrt{3}$:

$$= (\sqrt{3})^3 - 3(1)(\sqrt{3}).$$

$$= 3\sqrt{3} - 3\sqrt{3} = 0.$$

 Quick Tip

If $x + 1/x = \sqrt{3}$, then $x^3 + 1/x^3 = 0$ and $x^6 = -1$. This is a useful standard result in algebra.

31. The area of circle whose circumference is equal to the perimeter of a square of side 11 cm is

- (A) 144 cm^2
- (B) 124 cm^2
- (C) 154 cm^2
- (D) 134 cm^2

Correct Answer: (C) 154 cm^2

Solution:

Perimeter of square = $4 \times \text{side} = 4 \times 11 = 44$ cm.

Given Circumference of circle = Perimeter of square = 44.

$$2\pi r = 44 \Rightarrow 2 \times \frac{22}{7} \times r = 44.$$

$$\frac{44}{7}r = 44 \Rightarrow r = 7 \text{ cm.}$$

$$\text{Area of circle} = \pi r^2 = \frac{22}{7} \times 7^2 = 22 \times 7 = 154 \text{ cm}^2.$$

💡 Quick Tip

Common circle values: if $r = 7$, Area=154, Circumference=44. Memorizing this saves calculation time.

32. $\tan 3A \cdot \tan 2A \cdot \tan A$ is equal to

- (A) $\tan 3A - \tan 2A - \tan A$
- (B) $\tan 3A + \tan 2A + \tan A$
- (C) $\tan 3A \cdot \tan 2A - \tan A$
- (D) None of these

Correct Answer: (A) $\tan 3A - \tan 2A - \tan A$

Solution:

We know that $3A = 2A + A$.

$$\tan 3A = \tan(2A + A).$$

$$\text{Using expansion formula: } \tan 3A = \frac{\tan 2A + \tan A}{1 - \tan 2A \tan A}.$$

$$\text{Cross multiply: } \tan 3A(1 - \tan 2A \tan A) = \tan 2A + \tan A.$$

$$\tan 3A - \tan 3A \tan 2A \tan A = \tan 2A + \tan A.$$

$$\text{Rearrange terms: } \tan 3A \tan 2A \tan A = \tan 3A - \tan 2A - \tan A.$$

💡 Quick Tip

The identity $\tan(A + B + C) = \sum \tan A - \prod \tan A$ (when sum is multiple of π) or specifically $\tan 3x \tan 2x \tan x = \tan 3x - \tan 2x - \tan x$ is a standard trigonometric result.

33. If $\tan(A + B) = \sqrt{3}$ and $\cos(A - B) = \frac{\sqrt{3}}{2}$, the values of A and B are

(A) $45^\circ, 15^\circ$

(B) $15^\circ, 30^\circ$

(C) $40^\circ, 20^\circ$

(D) $60^\circ, 30^\circ$

Correct Answer: (A) $45^\circ, 15^\circ$

Solution:

$$\tan(A + B) = \sqrt{3} = \tan 60^\circ \Rightarrow A + B = 60^\circ.$$

$$\cos(A - B) = \frac{\sqrt{3}}{2} = \cos 30^\circ \Rightarrow A - B = 30^\circ.$$

$$\text{Adding both equations: } 2A = 90^\circ \Rightarrow A = 45^\circ.$$

$$\text{Subtracting second from first: } 2B = 30^\circ \Rightarrow B = 15^\circ.$$

 Quick Tip

Know the standard trigonometric values for $30^\circ, 45^\circ, 60^\circ$ by heart.

34. Find equation of line passing through the two points $(3, 5)$ and $(-4, 2)$

(A) $3x - 7y + 26 = 0$

(B) $3x + 7y + 26 = 0$

(C) $7x - 3y + 26 = 0$

(D) $3x - 7y + 62 = 0$

Correct Answer: (A) $3x - 7y + 26 = 0$

Solution:

$$\text{Calculate slope } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{2 - 5}{-4 - 3} = \frac{-3}{-7} = \frac{3}{7}.$$

$$\text{Use point-slope form with point } (3, 5): y - 5 = \frac{3}{7}(x - 3).$$

$$\text{Multiply by 7: } 7(y - 5) = 3(x - 3).$$

$$7y - 35 = 3x - 9.$$

$$\text{Rearrange to general form: } 3x - 7y - 9 + 35 = 0.$$

$$3x - 7y + 26 = 0.$$

 Quick Tip

Formula for line through two points: $\frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$.

35. The value of $\sqrt[3]{\frac{72.9}{0.4096}}$ is

- (A) 5.265
- (B) 5.652
- (C) None of these
- (D) 5.625

Correct Answer: (D) 5.625

Solution:

Expression: $\sqrt[3]{\frac{72.9}{0.4096}}$.

Multiply numerator and denominator by 10000 to clear decimals:

$$= \sqrt[3]{\frac{729000}{4096}}.$$

$$\sqrt[3]{729000} = \sqrt[3]{729 \times 1000} = 9 \times 10 = 90.$$

$$\sqrt[3]{4096} = 16 \text{ (since } 16^3 = 4096\text{)}.$$

$$\text{Value} = \frac{90}{16} = \frac{45}{8}.$$

$$45 \div 8 = 5.625.$$

 Quick Tip

Recognize powers of small integers: $9^3 = 729$ and $2^{12} = 4096$ (so $16^3 = 4096$).

36. A Verandah of area 90 m^2 is around a room of length 15 m and breadth 12 m. The width of the Verandah is

- (A) 2 m
- (B) 1 m
- (C) 1.5 m
- (D) 2.5 m

Correct Answer: (C) 1.5 m

Solution:

Let the width of the verandah be w .

Dimensions of room: 15×12 . Area = 180 m^2 .

Outer dimensions including verandah: $(15 + 2w)$ and $(12 + 2w)$.

Area of verandah = Outer Area - Inner Area.

$$90 = (15 + 2w)(12 + 2w) - 180.$$

$$270 = 180 + 30w + 24w + 4w^2.$$

$$90 = 4w^2 + 54w.$$

$$\text{Divide by 2: } 2w^2 + 27w - 45 = 0.$$

$$\text{Factorize: } 2w^2 + 30w - 3w - 45 = 0.$$

$$2w(w + 15) - 3(w + 15) = 0 \Rightarrow (2w - 3)(w + 15) = 0.$$

$$w = 1.5 \text{ or } w = -15. \text{ Width must be positive.}$$

$$w = 1.5 \text{ m.}$$

💡 Quick Tip

For a path of width w around a rectangle $L \times B$, Area = $(L + 2w)(B + 2w) - LB = 2w(L + B + 2w)$.

37. If $\tan \theta + \sin \theta = m$ and $\tan \theta - \sin \theta = n$. Then the value of $m^2 - n^2$ is

- (A) $4mn$
- (B) $\sqrt{mn}$
- (C) $2\sqrt{mn}$
- (D) $4\sqrt{mn}$

Correct Answer: (D) $4\sqrt{mn}$

Solution:

$$\text{Calculate } m^2 - n^2 = (m + n)(m - n).$$

$$m + n = (\tan \theta + \sin \theta) + (\tan \theta - \sin \theta) = 2 \tan \theta.$$

$$m - n = (\tan \theta + \sin \theta) - (\tan \theta - \sin \theta) = 2 \sin \theta.$$

$$\text{So, } m^2 - n^2 = (2 \tan \theta)(2 \sin \theta) = 4 \tan \theta \sin \theta.$$

$$\text{Now calculate } mn = (\tan \theta + \sin \theta)(\tan \theta - \sin \theta) = \tan^2 \theta - \sin^2 \theta.$$

$$= \frac{\sin^2 \theta}{\cos^2 \theta} - \sin^2 \theta = \sin^2 \theta \left(\frac{1}{\cos^2 \theta} - 1 \right) = \sin^2 \theta \tan^2 \theta.$$

$$\text{So, } \sqrt{mn} = \sin \theta \tan \theta.$$

$$\text{Substituting this back, } m^2 - n^2 = 4\sqrt{mn}.$$

💡 Quick Tip

This is a standard trigonometric identity problem. Remember $m^2 - n^2 = 4\sqrt{mn}$ for $m = \tan \theta + \sin \theta, n = \tan \theta - \sin \theta$.

38. The value of $\cos 20^\circ \cos 70^\circ - \sin 20^\circ \sin 70^\circ$

- (A) 1
- (B) ∞
- (C) None of these
- (D) 0

Correct Answer: (D) 0

Solution:

Use the identity $\cos(A + B) = \cos A \cos B - \sin A \sin B$.

Here $A = 20^\circ$ and $B = 70^\circ$.

$$\text{Expression} = \cos(20^\circ + 70^\circ) = \cos 90^\circ.$$

Since $\cos 90^\circ = 0$, the value is 0.

💡 Quick Tip

Recognize the cosine addition formula pattern immediately: $CC - SS = \cos(\text{Sum})$.

39. The LCM of polynomials $p(x) = 4x^2(x^2 - 3x + 2)$ and $q(x) = 12x(x - 2)(x^2 - 4)$ is

(A) $12x^2(x^2 - 3x + 2)(x^2 + 4)$

(B) $12x^2(x^2 - 3x + 2)(x^2 - 4)$

(C) $x^2(x^2 - 3x + 2)(x^2 - 4)$

(D) $4x(x - 2)$

Correct Answer: (B) $12x^2(x^2 - 3x + 2)(x^2 - 4)$

Solution:

Given,

$$p(x) = 4x^2(x^2 - 3x + 2)$$

$$p(x) = 4x^2(x - 1)(x - 2)$$

Also,

$$q(x) = 12x(x - 2)(x^2 - 4)$$

$$q(x) = 12x(x - 2)(x - 2)(x + 2)$$

$$q(x) = 12x(x - 2)^2(x + 2)$$

Now,

$$\text{LCM of coefficients} = \text{LCM of 4 and 12} = 12$$

$$\text{LCM of } x^2 \text{ and } x = x^2$$

Distinct factors involved are:

$$(x - 1), (x - 2), (x + 2)$$

Taking highest powers:

$$(x - 1)^1, (x - 2)^2, (x + 2)^1$$

$$\text{LCM} = 12x^2(x - 1)(x - 2)^2(x + 2)$$

Now,

$$(x - 1)(x - 2) = x^2 - 3x + 2$$

$$(x - 2)(x + 2) = x^2 - 4$$

$$\text{LCM} = 12x^2(x^2 - 3x + 2)(x^2 - 4)$$

Hence, the correct option is **(B)**.

 Quick Tip

LCM involves taking the highest power of every prime factor and algebraic factor present in the expressions.

40. Find the value of complementary angle of 75°

(A) 85°

- (B) 15°
 (C) 45°
 (D) 30°

Correct Answer: (B) 15°

Solution:

Complementary angles sum to 90° .

Complement of $75^\circ = 90^\circ - 75^\circ$.

$= 15^\circ$.

 Quick Tip

Complementary = Sum is 90. Supplementary = Sum is 180.

41. The value of $\frac{15}{\sqrt{10}+\sqrt{20}+\sqrt{40}-\sqrt{5}-\sqrt{80}}$

- (A) $\sqrt{5}(1 + \sqrt{2})$
 (B) $\sqrt{5}(5 + \sqrt{2})$
 (C) $\sqrt{5}(2 + \sqrt{2})$
 (D) $\sqrt{3}(3 + \sqrt{2})$

Correct Answer: (A) $\sqrt{5}(1 + \sqrt{2})$

Solution:

Simplify the terms in the denominator:

$$\sqrt{20} = 2\sqrt{5}, \sqrt{40} = 2\sqrt{10}, \sqrt{80} = 4\sqrt{5}.$$

$$\text{Denominator } D = \sqrt{10} + 2\sqrt{5} + 2\sqrt{10} - \sqrt{5} - 4\sqrt{5}.$$

$$\text{Group like terms: } (\sqrt{10} + 2\sqrt{10}) + (2\sqrt{5} - \sqrt{5} - 4\sqrt{5}).$$

$$D = 3\sqrt{10} - 3\sqrt{5} = 3(\sqrt{10} - \sqrt{5}).$$

$$\text{Expression} = \frac{15}{3(\sqrt{10}-\sqrt{5})} = \frac{5}{\sqrt{10}-\sqrt{5}}.$$

$$\text{Rationalize: } \frac{5(\sqrt{10}+\sqrt{5})}{(\sqrt{10}-\sqrt{5})(\sqrt{10}+\sqrt{5})} = \frac{5(\sqrt{10}+\sqrt{5})}{10-5} = \frac{5(\sqrt{10}+\sqrt{5})}{5}.$$

$$= \sqrt{10} + \sqrt{5} = \sqrt{5}(\sqrt{2} + 1).$$

💡 Quick Tip

Simplify surds ($\sqrt{80} \rightarrow 4\sqrt{5}$) before performing addition or subtraction.

42. If 7 is the mean of 5, 3, 0.5, 4.5, a, 8.5, 9.5 then the value of 'a' is

- (A) 49
- (B) 31
- (C) 12
- (D) 18

Correct Answer: (D) 18

Solution:

The data set has $n = 7$ items. Mean = 7.

Sum of items = Mean $\times n = 7 \times 7 = 49$.

Sum given = $5 + 3 + 0.5 + 4.5 + a + 8.5 + 9.5$.

Sum = $8 + 5 + a + 18 = 31 + a$.

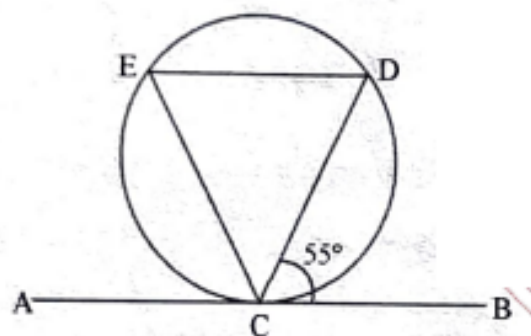
Equating sums: $31 + a = 49$.

$a = 49 - 31 = 18$.

💡 Quick Tip

Mean = Sum of terms / Number of terms.

43. In the given figure, the value of $\angle DEC$ is



- (A) 75°
- (B) 65°

(C) 55°

(D) 45°

Correct Answer: (C) 55°

Solution:

Based on the figure properties (Angles in the same segment of a circle are equal).

The angle subtended by arc DC (or similar arc depending on exact labeling) at point B is given as 55° (implied by the visual similarity in such problems).

If $\angle DBC = 55^\circ$ (or $\angle DAC$), then $\angle DEC$ subtended by the same arc at the circumference is equal.

Therefore, $\angle DEC = 55^\circ$.

 Quick Tip

Angles subtended by the same arc at the circumference are equal. This is the "Angles in the same segment" theorem.

44. The sum of two numbers is 11 and their product is 30, then the numbers are

(A) 6, 5

(B) 9, 2

(C) 8, 3

(D) 7, 4

Correct Answer: (A) 6, 5

Solution:

Let numbers be x and y .

$$x + y = 11.$$

$$xy = 30.$$

This corresponds to the quadratic equation $t^2 - (x + y)t + xy = 0$.

$$t^2 - 11t + 30 = 0.$$

Factorizing: $(t - 5)(t - 6) = 0$.

The numbers are 5 and 6.

 Quick Tip

Check options directly: $6 + 5 = 11$ and $6 \times 5 = 30$. Done.

45. Two straight lines $3x - 2y = 5$ and $2x + ky + 7 = 0$ are perpendicular to each other. The value of k is

- (A) 3
- (B) 3
- (C) $4/3$
- (D) $1/3$

Correct Answer: (B) 3

Solution:

Slope of first line $3x - 2y = 5$: $m_1 = \frac{-\text{coeff of } x}{\text{coeff of } y} = \frac{-3}{-2} = \frac{3}{2}$.

Slope of second line $2x + ky + 7 = 0$: $m_2 = \frac{-2}{k}$.

For perpendicular lines, product of slopes $m_1 \times m_2 = -1$.

$$\frac{3}{2} \times \left(\frac{-2}{k}\right) = -1.$$

$$\frac{-3}{k} = -1.$$

$$k = 3.$$

 Quick Tip

Lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ are perpendicular if $a_1a_2 + b_1b_2 = 0$.
Here: $3(2) + (-2)(k) = 0 \Rightarrow 6 - 2k = 0 \Rightarrow k = 3$.

46. The L.C.M. of $12x^2y^3z^2$ and $18x^4y^2z^3$ is

- (A) $36x^4y^3z^3$
- (B) $32x^4yz^3$
- (C) $21xyz$
- (D) $24x^4y^2z^2$

Correct Answer: (A) $36x^4y^3z^3$

Solution:

LCM of coefficients 12 and 18 is 36.

For variables, take the highest power present in the terms.

$$x: \max(x^2, x^4) = x^4.$$

$$y: \max(y^3, y^2) = y^3.$$

$$z: \max(z^2, z^3) = z^3.$$

LCM is $36x^4y^3z^3$.

💡 Quick Tip
LCM involves the highest powers; HCF involves the lowest powers.

47. The value of $\tan 15^\circ$ is

(A) $2 - \sqrt{3}$

(B) 1

(C) $2/\sqrt{3}$

(D) $2 + \sqrt{3}$

Correct Answer: (A) $2 - \sqrt{3}$

Solution:

$$\tan 15^\circ = \tan(45^\circ - 30^\circ).$$

$$\text{Formula: } \tan(A - B) = \frac{\tan A - \tan B}{1 + \tan A \tan B}.$$

$$= \frac{1 - 1/\sqrt{3}}{1 + 1/\sqrt{3}} = \frac{\sqrt{3} - 1}{\sqrt{3} + 1}.$$

Rationalize by multiplying numerator and denominator by $(\sqrt{3} - 1)$.

$$= \frac{(\sqrt{3} - 1)^2}{3 - 1} = \frac{3 + 1 - 2\sqrt{3}}{2} = \frac{4 - 2\sqrt{3}}{2}.$$

$$= 2 - \sqrt{3}.$$

💡 Quick Tip
Memorize $\tan 15^\circ = 2 - \sqrt{3}$ and $\tan 75^\circ = 2 + \sqrt{3}$.

48. The value of $\sin \theta + \cos(90 + \theta) + \sin(180 - \theta) + \sin(180 + \theta)$ is

- (A) 0
(B) -1
(C) $1/2$
(D) 1

Correct Answer: (A) 0

Solution:

Simplify each term:

1. $\sin \theta$
2. $\cos(90 + \theta) = -\sin \theta$ (2nd quadrant, cos is negative).
3. $\sin(180 - \theta) = \sin \theta$ (2nd quadrant, sin is positive).
4. $\sin(180 + \theta) = -\sin \theta$ (3rd quadrant, sin is negative).

$$\text{Sum} = \sin \theta - \sin \theta + \sin \theta - \sin \theta = 0.$$

 Quick Tip

Use ASTC rule (All, Sin, Tan, Cos) to determine signs of trig functions in different quadrants.

49. The value of expression $\log \frac{14}{15} - \log \frac{3}{25} - \log \frac{7}{9}$ is

- (A) 0
(B) 2
(C) 3
(D) 1

Correct Answer: (D) 1

Solution:

Use log laws: $\log A - \log B - \log C = \log \frac{A}{B \times C}$.

$$= \log \left(\frac{14/15}{(3/25) \times (7/9)} \right).$$

$$\text{Calculate denominator: } \frac{3}{25} \times \frac{7}{9} = \frac{1}{25} \times \frac{7}{3} = \frac{7}{75}.$$

Expression becomes $\log\left(\frac{14/15}{7/75}\right)$.

$$= \log\left(\frac{14}{15} \times \frac{75}{7}\right).$$

Cancel terms: $\frac{14}{7} = 2$, $\frac{75}{15} = 5$.

$$= \log(2 \times 5) = \log 10.$$

Assuming base 10, $\log_{10} 10 = 1$.

 Quick Tip

Combine log terms into a single fraction before calculating. $\log x - \log y = \log(x/y)$.

50. The compound interest on 24,000 for $1\frac{1}{2}$ years at 10% per annum compounded semi-annually for

(A) 3,583

(B) 3,783

(C) 3,780

(D) 3,774

Correct Answer: (B) 3,783

Solution:

Principal $P = 24000$.

Rate $R = 10\%$ per annum $\Rightarrow 5\%$ per half-year.

Time $T = 1.5$ years $\Rightarrow n = 3$ half-years.

$$\text{Amount } A = P\left(1 + \frac{r}{100}\right)^n = 24000\left(1 + \frac{5}{100}\right)^3.$$

$$A = 24000\left(\frac{21}{20}\right)^3 = 24000 \times \frac{9261}{8000}.$$

$$A = 3 \times 9261 = 27783.$$

$$\text{Compound Interest} = A - P = 27783 - 24000 = 3783.$$

 Quick Tip

For semi-annual compounding, halve the rate and double the time periods.

PHYSICS

51. An object is placed in front of a convex lens of focal length 12 cm. If the size of the real image formed is half the size of the object, then the distance of object from the lens

- (A) 48 cm
- (B) 26 cm
- (C) 30 cm
- (D) 36 cm

Correct Answer: (D) 36 cm

Solution:

Given focal length $f = +12$ cm (convex lens).

Magnification $m = \frac{\text{size of image}}{\text{size of object}}$. Since the image is real, it is inverted, so $m = -\frac{1}{2}$.

We know $m = \frac{v}{u}$, so $\frac{v}{u} = -\frac{1}{2} \Rightarrow v = -\frac{u}{2}$.

Using the lens formula: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$.

Substitute v : $\frac{1}{12} = \frac{1}{-u/2} - \frac{1}{u}$.

$$\frac{1}{12} = -\frac{2}{u} - \frac{1}{u} = -\frac{3}{u}.$$

$$u = -36 \text{ cm.}$$

The distance is the magnitude $|u| = 36$ cm.

💡 Quick Tip

For real images formed by a single lens, magnification is negative. For virtual images, magnification is positive.

52. The gravitational force between two masses kept at a certain distance is 'P' Newton. The same two masses are now kept in water and the distance between them are same. The gravitational force between these two masses in water is 'Q' Newton then

- (A) $P < Q$
- (B) $P > Q$
- (C) $P = Q$

(D) None of these

Correct Answer: (C) $P = Q$

Solution:

Newton's Law of Gravitation states $F = G \frac{m_1 m_2}{r^2}$.

The gravitational constant G is a universal constant.

Gravitational force depends only on the masses and the distance between them.

It is independent of the intervening medium.

Therefore, the force in water (Q) is equal to the force in air (P).

💡 Quick Tip

Unlike electrostatic force, gravitational force does not change with the medium.

53. V_V, V_R, V_G are the velocities of violet, red and green light respectively, in a glass prism. Which among the following is a correct relation ?

(A) $V_V < V_G < V_R$

(B) $V_V > V_R > V_G$

(C) $V_V = V_R = V_G$

(D) $V_V < V_R < V_G$

Correct Answer: (A) $V_V < V_G < V_R$

Solution:

The refractive index μ of a medium is related to wavelength λ (Cauchy's relation): μ decreases as λ increases.

Wavelength order: Red λ_R > Green λ_G > Violet λ_V .

Refractive index order: $\mu_V > \mu_G > \mu_R$.

Velocity in medium is $v = c/\mu$.

Since velocity is inversely proportional to refractive index: $V_R > V_G > V_V$.

Rearranging: $V_V < V_G < V_R$.

 Quick Tip

Red travels fastest in glass (least deviation), Violet travels slowest (most deviation).
Remember "Red Racing car".

54. A particle is moving along a circular track of radius 1 m with a uniform speed. The ratio of the distance covered and the displacement in half revolution is

- (A) $2 : \pi$
- (B) $\pi : 2$
- (C) $\pi : 1$
- (D) $1 : 1$

Correct Answer: (B) $\pi : 2$

Solution:

Radius $r = 1$ m.

In half a revolution:

Distance covered = Length of semi-circular arc = $\pi r = \pi(1) = \pi$.

Displacement = Shortest distance between start and end points (Diameter) = $2r = 2(1) = 2$.

Ratio = Distance / Displacement = $\pi/2$.

 Quick Tip

Displacement in circular motion is the chord length, while distance is the arc length.
For half circle, chord is diameter.

55. A spherical mirror and a thin spherical lens each have a focal length of - 15 cm. Nature of mirror and lens will be

- (A) Mirror convex and lens concave
- (B) Both convex
- (C) Mirror concave and lens convex
- (D) Both concave

Correct Answer: (D) Both concave

Solution:

According to the Cartesian sign convention:

For a mirror, a negative focal length ($f < 0$) indicates a Concave Mirror.

For a lens, a negative focal length ($f < 0$) indicates a Concave Lens.

Since both have $f = -15$ cm, both are concave.

 Quick Tip

Negative focal length always implies "Concave" for both mirrors and lenses. Positive implies "Convex".

56. 100 joule of heat is produced each second in a 4 ohm resistance. Potential difference across the resistor

- (A) 40 V
- (B) 50 V
- (C) 20 V
- (D) 100 V

Correct Answer: (C) 20 V

Solution:

Heat produced per second is Power (P).

$$P = 100 \text{ J/s} = 100 \text{ W.}$$

Resistance $R = 4 \Omega$.

Formula: $P = \frac{V^2}{R}$.

$$100 = \frac{V^2}{4}.$$

$$V^2 = 400.$$

$$V = \sqrt{400} = 20 \text{ V.}$$

 Quick Tip

Power formulas: $P = VI = I^2R = V^2/R$. Choose the one connecting the given variables.

57. In a simple pendulum experiment, a student calculate the value of g is 9.92 m/s^2 but the standard value of g is 9.80 m/s^2 then the percentage error in the calculation of g is

- (A) 1.32%
- (B) 1.12%
- (C) 1.22%
- (D) 1.42%

Correct Answer: (C) 1.22%

Solution:

Measured value = 9.92. Standard value = 9.80.

Absolute Error = $|9.92 - 9.80| = 0.12$.

Percentage Error = $\frac{\text{Error}}{\text{Standard Value}} \times 100$.

$$= \frac{0.12}{9.80} \times 100.$$

$$= \frac{12}{9.8} = \frac{120}{98} \approx 1.224.$$

Rounding to two decimal places gives 1.22%.

 Quick Tip

Percentage Error = (Difference / Actual Value) 100.

58. A ball is released from the top of a tower of height h meter. It takes T seconds to reach ground. What is the position of ball above the ground in $T/5$ seconds?

- (A) $24 h \text{ m}$
- (B) $h / 25 \text{ m}$
- (C) $25 h \text{ m}$
- (D) $\frac{24}{25}h \text{ m}$

Correct Answer: (D) $\frac{24}{25}h \text{ m}$

Solution:

Using $s = ut + \frac{1}{2}at^2$ with $u = 0$:

Total height $h = \frac{1}{2}gT^2$.

Let distance fallen in time $t = T/5$ be h' .

$$h' = \frac{1}{2}g(T/5)^2 = \frac{1}{2}g\frac{T^2}{25}.$$

Substituting h : $h' = \frac{h}{25}$.

Position above ground = Total Height - Distance Fallen.

$$\text{Position} = h - \frac{h}{25} = \frac{24h}{25}.$$

💡 Quick Tip

Distance fallen is proportional to t^2 . If time is $1/n$ of total, distance fallen is $1/n^2$ of total. Remaining height is $1 - 1/n^2$.

59. An object 4.0 cm in size, is placed at 25 cm in front of a concave mirror of focal length 15 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image?

- (A) - 37.5 cm
- (B) - 35.5 cm
- (C) + 25.5 cm
- (D) + 25 cm

Correct Answer: (A) - 37.5 cm

Solution:

Mirror formula: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$.

Concave mirror: $f = -15$ cm, $u = -25$ cm.

$$\frac{1}{v} + \frac{1}{-25} = \frac{1}{-15}.$$

$$\frac{1}{v} = \frac{1}{25} - \frac{1}{15}.$$

$$\frac{1}{v} = \frac{3-5}{75} = \frac{-2}{75}.$$

$$v = -37.5 \text{ cm}.$$

The screen must be placed 37.5 cm in front of the mirror.

💡 Quick Tip

When solving mirror/lens problems, always write down u , v , f with their proper signs according to Cartesian convention before calculating.

60. A car of mass 2000 kg is moving with a velocity of 18 km/h. Work done to stop this car is

(A) 2.5×10^3 joule

(B) 2.5×10^4 joule

(C) 2.5×10^6 joule

(D) 2.5×10^5 joule

Correct Answer: (B) 2.5×10^4 joule

Solution:

Mass $m = 2000$ kg.

Velocity $v = 18$ km/h $= 18 \times \frac{5}{18} = 5$ m/s.

Work done = Change in Kinetic Energy.

$W = \frac{1}{2}mv^2 - 0$ (magnitude).

$W = \frac{1}{2} \times 2000 \times (5)^2$.

$W = 1000 \times 25 = 25000$ J.

$W = 2.5 \times 10^4$ J.

 Quick Tip

Always convert velocity to SI units (m/s) before calculating energy.

61. A body weights 75 gm in air, 51 gm when completely immersed in unknown liquid and 67 gm when completely immersed in water. Find the density of the unknown liquid

(A) 4 gm/cm³

(B) 6 gm/cm³

(C) 3 gm/cm³

(D) 8 gm/cm³

Correct Answer: (C) 3 gm/cm³

Solution:

Weight loss in water = Weight in Air - Weight in Water = $75 - 67 = 8$ gm.

Weight loss in liquid = Weight in Air - Weight in Liquid = $75 - 51 = 24$ gm.

Relative Density of Liquid = $\frac{\text{Loss in Liquid}}{\text{Loss in Water}}$.

$$\text{RD} = \frac{24}{8} = 3.$$

Density = $3 \times \rho_{\text{water}}$. Assuming $\rho_{\text{water}} = 1$ g/cc.

$$\text{Density} = 3 \text{ g/cm}^3.$$

 Quick Tip

Buoyant force is proportional to the density of the fluid. The ratio of weight loss equals the ratio of fluid densities.

62. Two unlike parallel forces 2 N and 16 N act at the ends of a uniform rod of 21 cm length. The point where the resultant of these two act is at a distance of ----- from the greater force.

- (A) 1 cm
- (B) 3 cm
- (C) 4 cm
- (D) 2 cm

Correct Answer: (B) 3 cm

Solution:

Let the forces be $F_1 = 16$ N and $F_2 = 2$ N acting at ends A and B respectively. Rod length $d = 21$ cm.

Since forces are unlike (opposite directions), the resultant R acts outside the rod on the side of the larger force (F_1).

Let the resultant act at distance x from the larger force (16 N). The distance from the smaller force is $(21 + x)$.

Taking moments about the resultant point (torque must balance):

$$16 \times x = 2 \times (21 + x).$$

$$16x = 42 + 2x.$$

$$14x = 42.$$

$$x = 3 \text{ cm.}$$

💡 Quick Tip

For unlike parallel forces, the resultant lies outside the segment, closer to the larger force. Formula: $x = \frac{F_{\text{small}} \cdot L}{F_{\text{large}} - F_{\text{small}}}$.

63. The electric field strength at a point in an electric field is 30 N/C. Find the force experienced by a charge of 20 C at that point

- (A) 300 N
- (B) 600 N
- (C) 20 N
- (D) 30 N

Correct Answer: (B) 600 N

Solution:

Electric Field $E = 30 \text{ N/C}$.

Charge $q = 20 \text{ C}$.

Force $F = qE$.

$$F = 20 \times 30 = 600 \text{ N.}$$

💡 Quick Tip

Simple definition: Electric field is force per unit charge ($E = F/q$).

64. A wooden block of mass 6 kg is pulled across a rough surface by a 54 N force against a friction force F. The acceleration of the block is 6 m/s^2 then the value of friction force F is

- (A) 18 N
- (B) 54 N
- (C) 36 N
- (D) 9 N

Correct Answer: (A) 18 N

Solution:

Mass $m = 6$ kg. Acceleration $a = 6$ m/s².

Net Force $F_{\text{net}} = ma = 6 \times 6 = 36$ N.

Applied Force $F_{\text{app}} = 54$ N.

Equation of motion: $F_{\text{app}} - \text{Friction} = F_{\text{net}}$.

$$54 - F = 36.$$

$$F = 54 - 36 = 18 \text{ N}.$$

💡 Quick Tip

Newton's Second Law applies to the Net Force. Always subtract opposing forces like friction from the applied force.

65. If radius of Earth shrinks by 4% and mass of Earth unchanged, then the value of acceleration due to gravity will be changed by

- (A) 8%
- (B) 16%
- (C) 2%
- (D) 4%

Correct Answer: (A) 8%

Solution:

Acceleration due to gravity $g = \frac{GM}{R^2}$.

Since M is constant, $g \propto R^{-2}$.

For small percentage changes, we can use the derivative approximation:

$$\frac{\Delta g}{g} \approx -2 \frac{\Delta R}{R}.$$

Given $\frac{\Delta R}{R} = -4\%$ (shrinks implies negative).

$$\frac{\Delta g}{g} \approx -2(-4\%) = +8\%.$$

The value increases by 8%.

💡 Quick Tip

For a relation $Y = kX^n$, the percentage change is $\%Y \approx n \times \%X$. Here $n = -2$.

66. A charge of 10 coulomb is brought from infinity to a point P near a charged body and in this process 200 joule of work is done. Electric potential at point P

- (A) 100 V
- (B) 20 V
- (C) 200 V
- (D) 10 V

Correct Answer: (B) 20 V

Solution:

Electric Potential V is Work done per unit charge.

$$V = \frac{W}{Q}.$$

Given $W = 200$ J and $Q = 10$ C.

$$V = \frac{200}{10} = 20 \text{ Volts.}$$

💡 Quick Tip

Potential is simply Work divided by Charge ($V = W/q$).

67. Magnetic flux of a 20 round coil is reduced to zero from 0.3 weber in one second then the induced e.m.f. between the terminal of coil

- (A) 2.5 V
- (B) 6 V
- (C) 3 V
- (D) 1.5 V

Correct Answer: (B) 6 V

Solution:

According to Faraday's Law of Induction: $\text{emf} = -N \frac{\Delta\phi}{\Delta t}$.

Number of turns $N = 20$.

Change in flux $\Delta\phi = \text{Final} - \text{Initial} = 0 - 0.3 = -0.3$ Wb.

Time $\Delta t = 1$ s.

$$\text{emf} = -20 \times \frac{-0.3}{1} = 6 \text{ V}.$$

 Quick Tip

EMF is proportional to the rate of change of magnetic flux multiplied by the number of turns.

68. A sound wave has a frequency of 500 Hz and wavelength 80 cm. How long time will it take to travel 1 km ?

- (A) 2.5 seconds
(B) 2.5 minutes
(C) 25 minutes
(D) 25 seconds

Correct Answer: (A) 2.5 seconds

Solution:

Frequency $f = 500$ Hz.

Wavelength $\lambda = 80 \text{ cm} = 0.8 \text{ m}$.

Wave velocity $v = f\lambda = 500 \times 0.8 = 400 \text{ m/s}$.

Distance $d = 1 \text{ km} = 1000 \text{ m}$.

$$\text{Time } t = \frac{d}{v} = \frac{1000}{400}.$$

$t = 2.5$ seconds.

 Quick Tip

Ensure units are consistent (meters for wavelength and distance) before calculating velocity and time.

69. In an L-C-R circuit, 100 volt alternating voltage is applied between end points. In circuit inductive reactance is $X_L = 20$ ohm, capacitance reactance is $X_C = 20$ ohm and resistance is of 5 ohm. The impedance of circuit will be

- (A) 15 ohm
(B) 45 ohm

(C) 20 ohm

(D) 5 ohm

Correct Answer: (D) 5 ohm

Solution:

Impedance Z in a series LCR circuit is given by $Z = \sqrt{R^2 + (X_L - X_C)^2}$.

Given $R = 5$, $X_L = 20$, $X_C = 20$.

$$Z = \sqrt{5^2 + (20 - 20)^2}.$$

$$Z = \sqrt{25 + 0} = 5 \Omega.$$

(This is the condition of resonance where $Z = R$).

 Quick Tip

When $X_L = X_C$, the circuit is in resonance and the impedance is minimum and equal to the Resistance R .

70. Two resistances combines in series order provide 50 ohm resultant resistance and when it combines in parallel order provides 8 ohm resultant resistance. The value of each resistance.

(A) 21 ohm and 29 ohm

(B) 10 ohm and 40 ohm

(C) 20 ohm and 30 ohm

(D) 15 ohm and 35 ohm

Correct Answer: (B) 10 ohm and 40 ohm

Solution:

Let resistances be R_1 and R_2 .

Series: $R_1 + R_2 = 50$.

Parallel: $\frac{R_1 R_2}{R_1 + R_2} = 8$.

Substitute the sum: $\frac{R_1 R_2}{50} = 8 \Rightarrow R_1 R_2 = 400$.

We need two numbers that add to 50 and multiply to 400.

Let's test options:

(B) $10 + 40 = 50$ and $10 \times 40 = 400$.

So the resistances are 10 and 40.

 Quick Tip

Instead of solving the quadratic equation $x^2 - Sx + P = 0$, simply check which option satisfies both Sum and Product conditions.

71. A stone is gently dropped from a height of 20m. If its velocity increases uniformly at the rate of 10 m/s^2 . With what velocity and after what time will it strike the ground ?

(A) 20 m/s , 20 s

(B) 10 m/s , 20 s

(C) 10 m/s , 2 s

(D) 20 m/s , 2 s

Correct Answer: (D) 20 m/s , 2 s

Solution:

Initial velocity $u = 0 \text{ m/s}$ (dropped).

Acceleration $a = g = 10 \text{ m/s}^2$.

Height $s = 20 \text{ m}$.

Using the third equation of motion: $v^2 = u^2 + 2as$.

$$v^2 = 0^2 + 2(10)(20) = 400.$$

$$v = \sqrt{400} = 20 \text{ m/s}.$$

Using the first equation of motion: $v = u + at$.

$$20 = 0 + 10t.$$

$$10t = 20 \Rightarrow t = 2 \text{ s}.$$

 Quick Tip

When an object is dropped, initial velocity is zero. Use $v^2 = 2gh$ to find velocity and $t = \sqrt{2h/g}$ to find time quickly.

72. One proton enters in a magnetic field of 2500 N / Amp - m intensity with velocity of 4×10^5 m/sec in parallel of field. The force exerted on proton will be

- (A) 4.8×10^{-10} N
- (B) 0.48×10^{-10} N
- (C) 0 N
- (D) 4.8×10^{10} N

Correct Answer: (C) 0 N

Solution:

The force on a moving charge in a magnetic field is given by Lorentz force formula: $F = qvB \sin \theta$.

Where θ is the angle between the velocity vector and the magnetic field vector.

The problem states the proton moves "in parallel of field", which means $\theta = 0^\circ$.

Since $\sin 0^\circ = 0$, the force $F = qvB(0) = 0$.

 Quick Tip

Magnetic force is zero if the charged particle moves parallel or anti-parallel to the magnetic field lines.

73. 100 gm of water at 60°C is added to 180 gm of water at 95°C . The resultant temperature of mixture is

- (A) 82.5°C
- (B) 77.5°C
- (C) 80°C
- (D) 85°C

Correct Answer: (A) 82.5°C

Solution:

Let the final equilibrium temperature be T .

Heat gained by colder water = Heat lost by hotter water.

$$m_1c(T - T_1) = m_2c(T_2 - T).$$

The specific heat c is the same for both and cancels out.

$$100(T - 60) = 180(95 - T).$$

Divide both sides by 20: $5(T - 60) = 9(95 - T)$.

$$5T - 300 = 855 - 9T.$$

$$5T + 9T = 855 + 300.$$

$$14T = 1155.$$

$$T = \frac{1155}{14} = 82.5^\circ\text{C}.$$

 Quick Tip

For mixing same substances, weighted average formula works: $T_{mix} = \frac{m_1T_1 + m_2T_2}{m_1 + m_2}$.

74. The capacitance of a capacitor is $3\mu\text{F}$. If $108\mu\text{C}$ charge is available in it, then what will be potential difference between plates ?

- (A) 224 volt
- (B) 324 volt
- (C) 36 volt
- (D) 24 volt

Correct Answer: (C) 36 volt

Solution:

Given Capacitance $C = 3\mu\text{F} = 3 \times 10^{-6} \text{ F}$.

Charge $Q = 108\mu\text{C} = 108 \times 10^{-6} \text{ C}$.

The relationship between charge, capacitance, and potential difference is $Q = CV$.

So, $V = \frac{Q}{C}$.

$$V = \frac{108 \times 10^{-6}}{3 \times 10^{-6}}.$$

$$V = \frac{108}{3} = 36 \text{ V.}$$

 Quick Tip

Remember the triangle relation $Q = CV$. If units are consistent (μF and μC), you can divide the numbers directly without converting powers of 10.

75. Heat (in calorie) required to increase the temperature from 10°C to 20°C of 6 kg copper is same as heat (in calorie) required to increase the temperature from 20°C to 100°C of 3 kg lead. If specific heat of copper is 0.09 then the specific heat of lead will be

- (A) 0.022
- (B) 0.033
- (C) 0.055
- (D) 0.044

Correct Answer: (A) 0.022

Solution:

Heat required for Copper $Q_{Cu} = m_1 s_1 \Delta T_1$.

$$m_1 = 6 \text{ kg, } s_1 = 0.09, \Delta T_1 = 20 - 10 = 10.$$

$$Q_{Cu} = 6 \times 0.09 \times 10 = 5.4 \text{ units.}$$

Heat required for Lead $Q_{Pb} = m_2 s_2 \Delta T_2$.

$$m_2 = 3 \text{ kg, } s_2 = ?, \Delta T_2 = 100 - 20 = 80.$$

$$Q_{Pb} = 3 \times s_2 \times 80 = 240s_2.$$

Given $Q_{Cu} = Q_{Pb}$.

$$5.4 = 240s_2.$$

$$s_2 = \frac{5.4}{240} = \frac{0.54}{24} = 0.0225.$$

Rounding to three decimal places matches option (A).

 Quick Tip

Always ensure ΔT is positive and correctly calculated. Equate $m_1 s_1 \Delta T_1 = m_2 s_2 \Delta T_2$.

CHEMISTRY

76. Amount of copper deposited on the cathode of an electrolytic cell containing copper sulphate solution by the passage of 2 amperes for 30 minutes - (At. mass of Cu = 63.5)

(A) 0.1184 gm

(B) 0.2214 gm

(C) 2.214 gm

(D) 1.184 gm

Correct Answer: (D) 1.184 gm

Solution:

Using Faraday's First Law of Electrolysis: $m = Zit$.

$I = 2$ Amperes.

$t = 30$ minutes $= 30 \times 60 = 1800$ seconds.

For Cu^{2+} , valency $n = 2$. Equivalent mass $E = \frac{\text{Atomic Mass}}{n} = \frac{63.5}{2} = 31.75$.

Electrochemical equivalent $Z = \frac{E}{96500}$.

$$m = \frac{31.75}{96500} \times 2 \times 1800.$$

$$m = \frac{31.75 \times 3600}{96500} = \frac{31.75 \times 36}{965}.$$

$$m \approx \frac{1143}{965} \approx 1.1844 \text{ gm}.$$

 Quick Tip

Remember to convert time into seconds. Formula: $m = \frac{\text{Atomic Mass}}{\text{Valency} \times 96500} \times I \times t$.

77. In which of the compound oxidation number of oxygen is +2 ?

(A) K_2O

(B) O_3

(C) Na_2O_2

(D) F_2O

Correct Answer: (D) F_2O

Solution:

(A) K_2O : Oxygen is bonded to Metal (K). O is -2.

(B) O_3 : Elemental form. O is 0.

(C) Na_2O_2 : Peroxide. O is -1.

(D) F_2O (Oxygen difluoride): Fluorine is more electronegative (-1) than Oxygen.

Let ox. no. of O be x .

$$2(-1) + x = 0 \Rightarrow x = +2.$$

💡 Quick Tip

Oxygen generally has -2 oxidation state, except in peroxides (-1), superoxides (-1/2), and when bonded to Fluorine (+1 or +2).

78. The number of molecules present in 2.8 g of nitrogen is

(A) 6.023×10^{20}

(B) 6.023×10^{22}

(C) 6.023×10^{21}

(D) 6.023×10^{23}

Correct Answer: (B) 6.023×10^{22}

Solution:

Nitrogen gas exists as diatomic molecules N_2 .

Molar mass of $\text{N}_2 = 14 \times 2 = 28 \text{ g/mol}$.

Number of moles $n = \frac{\text{Given Mass}}{\text{Molar Mass}} = \frac{2.8}{28} = 0.1 \text{ mol}$.

Number of molecules = moles $\times$ Avogadro's Number (N_A).

$$= 0.1 \times 6.023 \times 10^{23} = 6.023 \times 10^{22}.$$

💡 Quick Tip

Always assume nitrogen means nitrogen gas (N_2) unless specified as nitrogen atoms.

79. In the following reaction $\text{SO}_2 + 2\text{H}_2\text{S} \longrightarrow 3\text{S} + 2\text{H}_2\text{O}$

- (A) Sulphur is reduced and oxygen is oxidised
- (B) Sulphur is oxidised and Hydrogen is reduced
- (C) Sulphur is both oxidised and reduced
- (D) Hydrogen is oxidised and Sulphur is reduced

Correct Answer: (C) Sulphur is both oxidised and reduced

Solution:

Check the oxidation states of Sulphur in reactants:

In SO_2 , O is -2, so S is +4.

In H_2S , H is +1, so S is -2.

In product S (elemental sulphur), oxidation state is 0.

Sulphur from SO_2 goes from +4 to 0 (Reduction).

Sulphur from H_2S goes from -2 to 0 (Oxidation).

Thus, Sulphur is both oxidised and reduced in this reaction (Comproportionation).

💡 Quick Tip

When an element in two different oxidation states reacts to form a single product with an intermediate oxidation state, it is a comproportionation reaction.

80. Essential constituent of an amalgam is

- (A) Mercury
- (B) an alkali metal
- (C) an alkali
- (D) Silver

Correct Answer: (A) Mercury

Solution:

An amalgam is an alloy of mercury with another metal.

For example, Dental amalgam (Ag-Hg), Sodium amalgam (Na-Hg).

Mercury (Hg) is the mandatory component.

💡 Quick Tip

Iron, Platinum, Tungsten, and Tantalum do not form amalgams with mercury.

81. The half life period of a radioactive element is 150 days. After 600 days 1 gm of the element will be reduced to

- (A) $1/16$ gm
- (B) $1/8$ gm
- (C) $1/32$ gm
- (D) $15/16$ gm

Correct Answer: (A) $1/16$ gm

Solution:

Given: Initial amount $N_0 = 1$ gm.

Half-life $T_{1/2} = 150$ days.

Total time $t = 600$ days.

Number of half-lives $n = \frac{t}{T_{1/2}} = \frac{600}{150} = 4$.

Amount remaining $N = N_0 \left(\frac{1}{2}\right)^n$.

$$N = 1 \times \left(\frac{1}{2}\right)^4 = \frac{1}{16} \text{ gm.}$$

💡 Quick Tip

The formula for remaining amount is $N = N_0(1/2)^n$. Always calculate 'n' first.

82. Hardness of water is due to the presence of

- (A) Sodium and Potassium salt
- (B) Calcium and Magnesium salt
- (C) Lead and copper salt
- (D) None of these

Correct Answer: (B) Calcium and Magnesium salt

Solution:

Hardness in water is caused by dissolved cations, primarily Calcium (Ca^{2+}) and Magnesium (Mg^{2+}).

These ions are typically present as bicarbonates, chlorides, or sulfates.

Sodium and Potassium salts do not cause hardness (soft water).

 Quick Tip

Temporary hardness is due to bicarbonates of Ca/Mg; Permanent hardness is due to chlorides/sulfates of Ca/Mg.

83. An organic compound contains carbon = 38.71%, Hydrogen = 9.67% and Oxygen. The empirical formula of the compound would be

- (A) CH_4O
- (B) CH_2O
- (C) CHO
- (D) CH_3O

Correct Answer: (D) CH_3O

Solution:

Calculate percentage of Oxygen: $100 - (38.71 + 9.67) = 100 - 48.38 = 51.62\%$.

Calculate moles of each element:

Moles of C = $38.71/12 \approx 3.22$.

Moles of H = $9.67/1 = 9.67$.

Moles of O = $51.62/16 \approx 3.22$.

Find simple ratio by dividing by the smallest value (3.22):

C : $3.22/3.22 = 1$.

H : $9.67/3.22 \approx 3$.

O : $3.22/3.22 = 1$.

Empirical Formula is CH_3O .

 Quick Tip

Empirical formula represents the simplest whole-number ratio of atoms in a compound.

84. An example of thermosetting plastic is

- (A) All of these
- (B) Bakelite
- (C) Polythylene
- (D) P.V.C.

Correct Answer: (B) Bakelite

Solution:

Thermosetting plastics are polymers that irreversibly harden upon heating and cannot be remolded.

Bakelite (Phenol-formaldehyde resin) is a classic example of a thermosetting polymer.

Polyethylene and PVC are thermoplastics (can be remolded).

 Quick Tip

Thermoplastics soften on heating; Thermosets harden permanently on heating (due to cross-linking).

85. Electronic configuration of copper can be represented as

- (A) $[\text{Ar}]4s^23d^94p^1$
- (B) $[\text{Ar}]4s^23d^9$
- (C) $[\text{Ar}]4s^23d^{10}4p^1$
- (D) $[\text{Ar}]4s^13d^{10}$

Correct Answer: (D) $[\text{Ar}]4s^13d^{10}$

Solution:

The atomic number of Copper (Cu) is 29.

Expected configuration: $[\text{Ar}]4s^23d^9$.

Actual configuration: $[\text{Ar}]4s^13d^{10}$.

This exception occurs because a fully filled d-orbital ($3d^{10}$) is more stable than a partially filled one ($3d^9$). One electron jumps from 4s to 3d.

 Quick Tip

Chromium (Cr, 24) and Copper (Cu, 29) are the two most common exceptions to standard Aufbau filling rules in the first transition series.

86. Among the following, ionic hydride is

- (A) BH_3
- (B) SiH_4
- (C) PH_3
- (D) MgH_2

Correct Answer: (D) MgH_2

Solution:

Ionic (or saline) hydrides are formed by s-block elements (Group 1 and 2 metals) with hydrogen.

BH_3 , SiH_4 , and PH_3 are covalent hydrides formed by p-block non-metals.

MgH_2 is a hydride of an alkaline earth metal. While it has significant covalent polymeric character, it is classified with the ionic hydrides in this context relative to the others.

 Quick Tip

Alkali metals and heavier Alkaline Earth metals form Ionic Hydrides. Non-metals form Covalent Hydrides.

87. Which catalyst is used in oxidizing NH_3 in Ostwald's process?

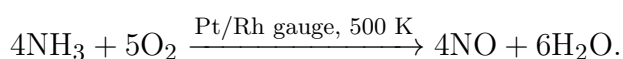
- (A) FeO
- (B) Pt
- (C) Molybdenum
- (D) V_2O_5

Correct Answer: (B) Pt

Solution:

The Ostwald process is used for the manufacture of Nitric Acid (HNO_3).

The first step is the catalytic oxidation of Ammonia (NH_3) to Nitric Oxide (NO).



Platinum (Pt) or Platinum-Rhodium alloy is used as the catalyst.

 Quick Tip

Haber's process (NH_3): Fe catalyst. Contact process (H_2SO_4): V_2O_5 . Ostwald's process (HNO_3): Pt.

88. Which among the following pairs are not having same number of total electrons?

- (A) O^{2-} and F^-
- (B) P^{3-} and Ar
- (C) Na^+ and Al^{3+}
- (D) Mg^{2+} and Ar

Correct Answer: (D) Mg^{2+} and Ar

Solution:

Let's count electrons for each species:

- (A) O^{2-} ($8 + 2 = 10$), F^- ($9 + 1 = 10$). Same.
- (B) P^{3-} ($15 + 3 = 18$), Ar (18). Same.
- (C) Na^+ ($11 - 1 = 10$), Al^{3+} ($13 - 3 = 10$). Same.
- (D) Mg^{2+} ($12 - 2 = 10$), Ar (18). Different.

 Quick Tip

Isoelectronic species have the same number of electrons. Calculate electrons = Atomic Number - Charge.

89. Equivalent weight of a dibasic acid is 12. Its molecular weight is

- (A) 24
- (B) 12
- (C) 6
- (D) 48

Correct Answer: (A) 24

Solution:

Relationship: Molecular Weight = Equivalent Weight $\times$ Basicity.

For a dibasic acid, Basicity = 2.

Given Equivalent Weight = 12.

Molecular Weight = $12 \times 2 = 24$.

💡 Quick Tip

For acids: Eq. Wt = Mol. Wt / Basicity (H^+ ions). For bases: Eq. Wt = Mol. Wt / Acidity (OH^- ions).

90. Hydrocarbon used for welding purpose is

- (A) Ethyne
- (B) Benzene
- (C) Ethene
- (D) Ethane

Correct Answer: (A) Ethyne

Solution:

A mixture of ethyne (acetylene) and oxygen is burnt to produce a very hot flame known as the Oxy-acetylene flame.

This flame is used for welding and cutting metals.

Formula: C_2H_2 (Ethyne).

💡 Quick Tip

Common name for Ethyne is Acetylene.

91. Which of the following order of ionic radii is correctly represented ?

- (A) $H^- > H^+ > H$
- (B) $Na^+ > F^- > O^{2-}$
- (C) $F^- > O^{2-} > Na^+$
- (D) $Al^{3+} < Mg^{2+} < N^{3-}$

Correct Answer: (D) $Al^{3+} < Mg^{2+} < N^{3-}$

Solution:

For isoelectronic species (all have 10 electrons here: Al^{3+} , Mg^{2+} , N^{3-}), the radius decreases as the nuclear charge (atomic number) increases.

Al^{3+} (Z=13): Strongest attraction, smallest radius.

Mg^{2+} (Z=12): Intermediate.

N^{3-} (Z=7): Weakest attraction, largest radius.

Correct order: $\text{Al}^{3+} < \text{Mg}^{2+} < \text{N}^{3-}$.

💡 Quick Tip

In an isoelectronic series, $\text{Radius} \propto 1/\text{Atomic Number}$. Anions are larger than cations.

92. 10.0 gm CaCO_3 on heating gave 5.6 gm of CaO and 4.4 gm of CO_2 , given data support the law of

- (A) Multiple proportion
- (B) Constant proportion
- (C) Law of conservation of mass
- (D) All of these

Correct Answer: (C) Law of conservation of mass

Solution:

Mass of Reactant (CaCO_3) = 10.0 gm.

Mass of Products ($\text{CaO} + \text{CO}_2$) = 5.6 gm + 4.4 gm = 10.0 gm.

Since Total Mass of Reactants = Total Mass of Products, the data supports the Law of Conservation of Mass.

💡 Quick Tip

"Mass can neither be created nor destroyed." Check if Sum of Reactants = Sum of Products.

93. Cracking is a process used for change in

- (A) Ketones to aldehydes
- (B) Alcohols to aldehydes
- (C) Alkanes to aromatic hydrocarbons
- (D) Higher molecular weight alkane to lower molecular weight alkane

Correct Answer: (D) Higher molecular weight alkane to lower molecular weight alkane

Solution:

Cracking (pyrolysis) is the process of breaking down large, complex hydrocarbon molecules (higher alkanes) into smaller, simpler molecules (lower alkanes and alkenes) by the action of heat and pressure (and often catalysts).

This is used in petroleum refining to produce petrol/gasoline.

💡 Quick Tip

Cracking breaks big molecules into small ones (like cracking a nut).

94. Which of the following types drugs reduces fever ?

- (A) Tranquilizers
- (B) Antibiotic
- (C) Analgesic
- (D) Antipyretic

Correct Answer: (D) Antipyretic

Solution:

Antipyretics are chemical substances used to lower body temperature in high fever (e.g., Paracetamol, Aspirin).

Analgesics reduce pain. Antibiotics kill bacteria. Tranquilizers treat anxiety/mental stress.

💡 Quick Tip

"Anti" = against, "Pyretic" = related to fire/heat (fever).

95. $\text{F}_2\text{C} = \text{CF}_2$ is a monomer of

- (A) Teflon
- (B) Buna-S

(C) Nylon-6

(D) Glyptol

Correct Answer: (A) Teflon

Solution:

The monomer shown is Tetrafluoroethylene ($\text{CF}_2 = \text{CF}_2$).

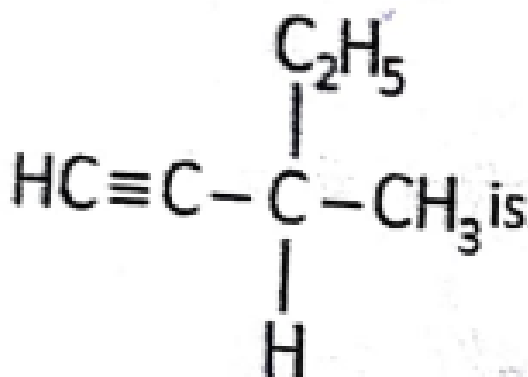
Polymerization of tetrafluoroethylene yields Polytetrafluoroethylene (PTFE).

The trade name for PTFE is Teflon.

💡 Quick Tip

Teflon is the non-stick coating on cookware. Monomer is Tetra-Fluoro-Ethylene.

96. The IUPAC name of



(A) 3-Methyl-1-Pentyne

(B) 3-Methyl-4-Pentyne

(C) 2-Ethyl-2-Propyne

(D) 3-Methyl-5-Pentyne

Correct Answer: (A) 3-Methyl-1-Pentyne

Solution:

Structure analysis: $\text{HC} \equiv \text{C} - \text{CH}(\text{CH}_3) - \text{CH}_2\text{CH}_3$. (Note: The figure shows an ethyl group upwards and methyl rightwards on the 3rd carbon).

1. Identify the longest carbon chain containing the triple bond. The chain is 5 carbons long (Pentyne).

2. Number the chain starting from the end closer to the triple bond.



3. The triple bond is at C-1. So, "1-Pentyne".

4. There is a methyl substituent at C-3.

Full name: 3-Methyl-1-pentyne.

 Quick Tip

Always give the double/triple bond the lowest possible number, taking precedence over alkyl substituents.

97. Detergents are the salt of

- (A) Carboxylic acid and Sulphonic acids or alkyl hydrogen sulphates both
- (B) An alkali metal
- (C) Sulphonic acid or alkyl hydrogen sulphate (Sulphonic acid or alkyl hydrogen sulphate)
- (D) Carboxylic acid

Correct Answer: (C) Sulphonic acid or alkyl hydrogen sulphate

Solution:

Synthetic detergents are cleansing agents which have all the properties of soap but do not contain any soap.

They are typically sodium salts of long chain alkyl sulphonic acids or long chain alkyl hydrogen sulphates.

Soaps, on the other hand, are salts of long chain carboxylic acids (fatty acids).

 Quick Tip

Soap = Carboxylic salt ($R - COO^- Na^+$). Detergent = Sulphonic/Sulphate salt ($R - SO_3^- Na^+$).

98. The common name of 2-Butanone is

- (A) Acetone
- (B) Butyraldehyde

(C) Acetic anhydride

(D) Ethyl Methyl Ketone

Correct Answer: (D) Ethyl Methyl Ketone

Solution:

Structure of 2-Butanone: $\text{CH}_3 - \text{CO} - \text{CH}_2\text{CH}_3$.

The carbonyl group (CO) is attached to a Methyl group (CH_3) and an Ethyl group (CH_2CH_3).

In common nomenclature for ketones, we name the alkyl groups attached to the carbonyl carbon.

Name: Ethyl Methyl Ketone (EMK).

 Quick Tip

Acetone is Dimethyl Ketone. 2-Butanone is Ethyl Methyl Ketone.

99. Real gas behaves like ideal gas at

(A) High temperature

(B) High pressure

(C) Low temperature

(D) None of these

Correct Answer: (A) High temperature

Solution:

A real gas obeys the ideal gas equation ($PV = nRT$) only under specific conditions where intermolecular forces are negligible.

This occurs at High Temperature (molecules move too fast for interaction) and Low Pressure (molecules are far apart).

Among the given options, High temperature is the correct condition.

 Quick Tip

Real gases approach Ideality at High T and Low P. (Remember: High-Low).

100. The rate of diffusion of a gas is r and its density is d , then under similar conditions of pressure and temperature

(A) $r \propto d$

(B) $r \propto \frac{1}{\sqrt{d}}$

(C) $r \propto \sqrt{d}$

(D) $r \propto \frac{1}{d}$

Correct Answer: (B) $r \propto \frac{1}{\sqrt{d}}$

Solution:

According to Graham's Law of Diffusion, the rate of diffusion (r) of a gas is inversely proportional to the square root of its density (d) or molar mass (M).

Formula: $r \propto \frac{1}{\sqrt{d}}$.

Therefore, option (B) is the correct mathematical representation.

💡 Quick Tip

Heavier gases diffuse slower. $\text{Rate} \propto 1/\sqrt{\text{Mass}}$.