TEST CODE : 112002

IIT - JEE

Batch – Growth (May) | Minor Test-02

Time: 3 Hours | Test Date: 23rd June 2024 | Maximum Marks: 300

Name of the Candidate: ______________________________ Roll No.______________

Centre of Examination (in Capitals):____

Candidate's Signature:____________________ Invigilator's Signature:____________________

READ THE INSTRUCTIONS CAREFULLY

1. The candidates should not write their Roll Number anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.

2. This Test Booklet consists of 90 questions.

3. This question paper is divided into three parts **PART A - MATHEMATICS, PART B - PHYSICS** and **PART C - CHEMISTRY** having 30 questions each and every **PART** has two sections.

(i) **Section-I** contains 20 multiple choice questions with only one correct option. Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

(ii) **Section-II** contains 10 questions the answer to only 5 questions, is an INTEGERAL VALUE.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

4. No candidate is allowed to carry any textual material, printed or written, bits of papers, mobile phone any electronic device etc., except the Identity Card inside the examination hall/room.

5. Rough work is to be done on the space provided for this purpose in the Test Booklet only.

6. On completion of the test, the candidate must hand over the Answer Sheet to the invigilator on duty in the Room/Hall. However, the candidate is allowed to take away this Test Booklet with them.

7. For the numerical based question in section II of Mathematics, Physics, Chemistry the answer should be in whole number only.

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TEST SYLLABUS

Batch – Growth (May) | Minor Test-02

23rd June 2024

Mathematics: FOM-2 (Linear Inequalities Wavy Curve Method, Rational Inequalities Irrational Inequalities, Modulus Inequalities Logarithmic and Exponential Inequality)

Physics: Basic Mathematics (Vector), Units and Dimension

Chemistry: Mole Concept and Concentration Terms-2 (Percentage Composition, Stoichiometric Calculations, Limiting reagent and Concentration, terms Equivalent Concept)

Useful Data Chemistry:

Gas Constant	R	$= 8.314\,JK^{-1}mol^{-1}$
		$= 0.0821\,Lit\ atm\ K^{-1}mol^{-1}$
		$= 1.987 \approx 2\ Cal\ K^{-1}mol^{-1}$
Avogadro's Number	N_a	$= 6.023 \times 10^{23}$
Planck's Constant	h	$= 6.626 \times 10^{-34}\,Js$
		$= 6.25 \times 10^{-27}\,erg.s$
1 Faraday		$= 96500$ Coulomb
1 calorie		$= 4.2$ Joule
1 amu		$= 1.66 \times 10^{-27}\,kg$
1 eV		$= 1.6 \times 10^{-19}\,J$

Atomic No:
H = 1, D = 1, Li = 3, Na = 11, K = 19, Rb = 37, Cs = 55, F = 9, Ca = 20, He = 2, O = 8, Au = 79.

Atomic Masses:
He = 4, Mg = 24, C = 12, O = 16, N = 14, P = 31, Br = 80, Cu = 63.5, Fe = 56, Mn = 55, Pb = 207, Au = 197, Ag = 108, F = 19, H = 2, Cl = 35.5, Sn = 118.6

Useful Data Physics:
Acceleration due to gravity $g = 10\ m/s^2$

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PART-A: MATHEMATICS

SECTION-I

1. Solution set for $2x+1 \geqslant 0$ is

(A) $\left(-\frac{1}{2}, \infty\right)$

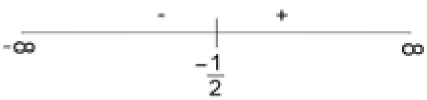
(B) $\left[-\frac{1}{2}, \infty\right)$

(C) $\left(-\infty, -\frac{1}{2}\right]$

(D) $(-\infty, -1, 2)$

Ans. (B)

Sol.



$\chi \in \left[\frac{-1}{2}, \infty\right)$

2. Solve for x: $-4 < 3x - 1 \leq 8$.

(A) $(-1, 3]$

(B) $(-1, 3)$

(C) $[-1, 3)$

(D) [–1, 3]

Ans. (A)

Sol. $-4 < 3x - 1 \leq 8$

$-3 < 3x \leq 9$

$-1 < x \leq 3$

3. Solve: $(x-1)(5-x) \geqslant 0$.

(A) (1,5)

(B) (1,5]

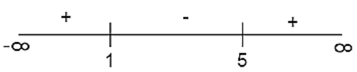
(C) [1,5]

(D) [1,5)

Ans. (C)

Sol. $(x-1)(5-x) \geqslant 0$

$(x-1)(x-5) \leq 0$



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4. Solve for x: $\frac{(x-1)(x-2)}{(x-3)} \geqslant 0$.

(A) $(1,2)\cup(3,\infty)$

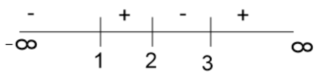
(B) $(1,2)\cup[3,\infty)$

(C) $[1,2)\cup[3,\infty)$

(D) $[1,2]\cup(3,\infty)$

Ans. (D)

Sol.



$x \in [1,2]\cup(3,\infty)$

5. Solve $(x-1)(1-x)(x-3) \geqslant 0$.

(A) $(-\infty,3]$

(B) $(-\infty,3)$

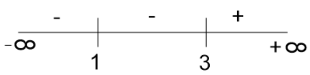
(C) $(-\infty,3]-\{1\}$

(D) $(-\infty,3)\cup\{1\}$

Ans. (A)

Sol. $(x-1)(1-x)(x-3) \geqslant 0$

$\Rightarrow (x-1)^2(x-3) \leq 0$



$\Rightarrow x \in (-\infty,3]$

6. Solve: $\frac{|x|-1}{(x-2)} \geqslant 0$.

(A) $[-1,1]\cup(2,\infty)$

(B) $(-1,1)\cup(2,\infty)$

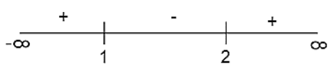
(C) $[-1,2)$

(D) $(1,2)$

Ans. (A)

Sol. Case 1, $x \geq 0$

$\frac{x-1}{x-2} \geqslant 0$



$x \in [0,1]\cup(2,\infty)$ ...(1)

Case 2, $x < 0$

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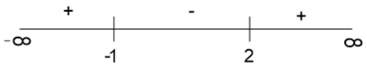
$$\frac{-x-1}{x-2} > 0$$

$$\frac{x+1}{x-2} \le 0$$



$x \in [-1, 0)$ ...(2)

7. For which x, $|x-2| < 3$.

(A) [– 1, 5}

(B) [2, ∞)

(C) ($-\infty$,3)

(D) (–1, 5)

Ans. (D)

Sol. $\Rightarrow |x-2| < 3 \Rightarrow -3 < (x-2) < 3$

$-1 < x < 5$

8. If $3^{x+1} = 6^{\log_2 3}$, then x is

(A) 3

(B) 2

(C) $\log_3 2$

(D) $\log_2 3$

Ans. (D)

Sol. $3^{x+1} = 2^{\log_2 3} \times 3^{\log_2 3} = 3 \times 3^{\log_2 3}$

$\therefore\ 3^x = 3^{\log_2 3} \ \Rightarrow\ x = \log_2 3$

9. If $\log_{0.3}(x-1) < \log_{0.09}(x-1)$, then x lies in the interval

(A) (2, ∞)

(B) (–2, –1)

(C) (1, 2)

(D) none of these

Ans. (A)

Sol. First, we note that for the functions involved in the given inequality to be defined (x – 1) must be greater than 0, that is, x > 1.

Now, $\log_{0.3}(x-1) < \log_{0.09}(x-1) \Rightarrow \log_{03}(x-1) < \log_{(03)^2}(x-1)$

$$\Rightarrow \log_{0.3}(x-1) < \frac{1}{2}\log_{03}(x-1) \Rightarrow 2\log_{0.3}(x-1) < \log_{0.3}(x-1)$$

$$\Rightarrow \log_{03}(x-1)^2 < \log_{03}(x-1) \Rightarrow (x-1)^2 > x-1$$

[Note that the inequality is reversed because the base of the logarithms lies between 0 and 1]

$\Rightarrow (x-1)^2 - (x-1) > 0$

$\Rightarrow (x-1)(x-2) > 0$ ...(i)

Since x > 1, therefore the inequality (i) will hold if x > 2.

Hence, x lies in the interval (2, ∞).

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10. Solution of $2^{x+2}=3^{x+2}$ is a

(A) The positive even number

(B) Negative even number

(C) Irrational Number

(D) None of these

Ans. (B)

Sol. Only x = -2 satisfies the equation.

11. Solve $e^{2x}-e^{x}=56$

(A) ln 8

(B) ln 9

(C) ln 6

(D) ln 5

Ans. (A)

Sol. $e^{2x}-e^{x}=56$

$e^{2x}-e^{x}-56=0$

$(e^{x}+7)(e^{x}-8)=0$

$e^{x}+7=0$ or $e^{x}-8=0$

$e^{x}=-7$: $e^{x}=8$

Not possible : $x=\ln 8$

12. $\left(\frac{1}{3}\right)^{x+3}=3^{3x+9}$, then x is

(A) 3

(B) 2

(C) 3

(D) -3

Ans. (D)

Sol. $3^{-x-3}=3^{3x+9}$

$\Rightarrow 3x+9=-x-3$

$\Rightarrow 4x=-12$

$x=-3$

13. The solution set of the inequation $\log_{1/3}\left(x^2+x+1\right)+1>0$ is

(A) $(-\infty,-2)\cup(1,+\infty)$

(B) [– 1, 2]

(C) (–2, 1)

(D) $(-\infty,+\infty)$

Ans. (C)

Sol. $\log_{\frac{1}{3}}\left(x^2+x+1\right)>-1$

$\log_{\frac{1}{3}}\left(x^2+x+1\right)>\log_{\frac{1}{3}}\left(\frac{1}{3}\right)^{-1}$

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$\Rightarrow x^2 + x + 1 < \left(\frac{1}{3}\right)^{-1}$

$\Rightarrow x^2 + x - 2 < 0$

$(x+2)(x-1) < 0$

$$\underset{-\infty}{} \overset{+}{\longrightarrow} \underset{-2}{|} \overset{-}{\longrightarrow} \underset{1}{|} \overset{+}{\longrightarrow} \underset{\infty}{}$$

$x \in (-2, 1)$

14. Find x if $\sqrt{3-x} < 2$.

(A) $(-1, 3)$

(B) $[-1, 3)$

(C) $(-1, 3]$

(D) $[-1, 3]$

Ans. (C)

Sol. $\sqrt{3-x} < 0 \Rightarrow x \leqslant 3$

$\sqrt{3-x} < 2$

On squaring

$3 - x \langle 4 \Rightarrow x \rangle - 1.$

15. Solution set of $\sqrt{\frac{2x-1}{x-4}} < 2$.

(A) $\left(-\infty, \frac{1}{2}\right] \cup \left(\frac{15}{2}, \infty\right)$

(B) $\left(-\infty, \frac{3}{2}\right] \cup \left[\frac{7}{2}, \infty^{\infty}\right)$

(C) $\left(\frac{1}{2}, \frac{11}{2}\right)$

(D) $\left(-\infty, -\frac{11}{2}\right) \cup (3)$

Ans. (A)

Sol. $\frac{2x-1}{x-4} \geqslant 0$

$\frac{2x-1}{x-4} < 4 \Rightarrow \frac{2x-1-4x+16}{x-4} < 0$

$\frac{-2x+15}{x-4} \Big\langle 0 \Rightarrow \frac{2x-15}{x-4} \Big\rangle 0$

$$\underset{-\infty}{} \overset{+}{\longrightarrow} \underset{4}{|} \overset{-}{\longrightarrow} \underset{\frac{15}{2}}{|} \overset{+}{\longrightarrow} \underset{\infty}{}$$

$x \in (-\infty, 4) \cup \left(\frac{15}{2}, \infty\right)$ ...(ii)

Common region is $(-\infty, 1/2] \cup \left(\frac{15}{2}, \infty\right)$

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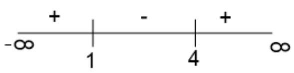
16. Find x, if $\frac{(e^{2x}+1)(x-1)}{(x-4)}<0$.

(A) (1, 4)
(B) [1, 4]
(C) [1, 4)
(D) (1, 4]

Ans. (A)

Sol. $\frac{(e^{2x}+1)(x-1)}{(x-4)}<0$

$\Rightarrow \frac{x-1}{x-4}<0 \quad (e^{2x}+1>0)$



$x \in (1,4)$

17. $(|x|+1)(x^2+2x+4)(x-2)\le 0$ then x is

(A) $(-\infty,-1]$
(B) $(-\infty,1]$
(C) $(-\infty,2]$
(D) $(-\infty,3)$

Ans. (C)

Sol. $(|x|+1)(x^2+2x+4)(x-2)\le 0$

$|x|+1>0 \ \forall x \in R$

$x^2+2x+4=(x+1)^2+3>0 \ \forall \ x$

$\therefore x-2\le 0$

$\Rightarrow x\le 2$

$\Rightarrow x\in(-\infty,2]$

18. Integral value of m for which $9^m+3^{3-2m}=28$ is

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

Ans. (D)

Sol. $9^m+3^{3-2m}=28$

$3^{2m}+3^3\cdot 3^{-2m}=28$

$3^{2m}+\frac{27}{3^{2m}}-28=0$

$(3^{2m})^2-28(3^{2m})+27=0$

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$(3^{2m}-27)(3^{2m}-1)=0$

$3^{2m}-27=0$ or $3^{2m}-1=0$

$3^{2m}=3^3$ or $3^{2m}=3^0$

$2m=3$ or $2m=0$

$\therefore m=\frac{3}{2}$ or 0

19. $|x-2|+|x+3|=|2x+1|$ then x is

(A) $(-\infty,-3]\cup[2,\infty)$

(B) $[-\infty,2]$

(C) $(-\infty,-3)\cup\left(-\frac{1}{2},\infty\right)$

(D) $\left(-\infty,-\frac{1}{2}\right)\cup\{5\}$

Ans. (A)

Sol. $|a|+|b|=|a+b|$

$\Rightarrow a\cdot b\geqslant 0$

$\therefore (x-2)(x+3)\geqslant 0$

$x\in(-\infty,-3]\cup[2,\infty)$

20. Solve for x, $\frac{e^x-1}{x-2}\leq 0$.

(A) [0, 2)

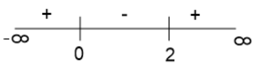
(B) [1, 2)

(C) (0, 2]

(D) (1, 2)

Ans. (A)

Sol. $e^x-1=0\Rightarrow x=0$



$x\in[0,2)$

SECTION-II

21. Number of integral solution of $\sqrt{x^2-4}\leqslant 0$.

Ans. (2)

Sol. $x^2-4=0$

$x=+2,-2$

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22. Number of prime numbers in the solution set of $(x-4)(x-9) \le 0$.

Ans. (2)

Sol.

$\chi \in [4, 9]$

Prime = 5, 7

23. The least integral solution of 2x – 5 > 0.

Ans. (3)

Sol. $2x-5>0$

$\Rightarrow x > \frac{5}{2}$

$\Rightarrow$ Least integer greater than is 3.

24. The number of values of x for which $e^{2x} - 4 = 0$.

Ans. (1)

Sol. $(e^x)^2 - (2)^2 = 0$

$(e^x + 2)(e^x - 2) = 0$

$e^x = -2 \rightarrow$ not possible.

$e^x = 2$ exist for only one value of x.

25. Find number of solutions of $\log_{x-5}(5-x) = 1$.

Ans. (0)

Sol. $5 - x > 0 \Rightarrow x < 5$ ...(i)

$x - 5 > 0 \Rightarrow x > 5$ ...(ii)

and x – 5 = 1

$\log_{x-5}(5-x) = 1$

$\Rightarrow 5 - x = x - 5$

$2x = 10$

$x = 5$

Therefore, no solution.

26. Number of non-negative integral solution of $|x| < 3$.

Ans. (3)

Sol. $|x| < 3$

$\Rightarrow -3 < x < 3$

$\Rightarrow x = -2, -1, 0, 1, 2$ (integral solutions)

$\Rightarrow$ non-negative integral values $= 0, 1, 2$

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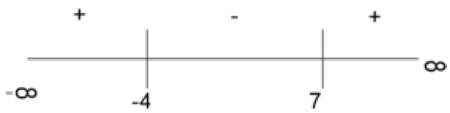
27. Largest integral value of x for $(x+4)(x-7)<0$.

Ans. (6)

Sol.



$x \in (-4, 7)$

28. Number of values of x for which $|2x+1|+|3x+4|+|2x+11|<0$.

Ans. (0)

Sol. $|2x+1|+|3x+4|+|2x+11|$ is

Always positive (No solution)

29. Largest integral value of x for $\sqrt{x-1}<2$.

Ans. (4)

Sol. $\sqrt{x-1}<2$

$x-1>0 \Rightarrow x>1$

$x-1<4 \Rightarrow x<5$

$\therefore x=4$ (largest integral value of x)

30. Number of integral values of x satisfying $\log_{1/2}(x-2)>1$.

Ans. (0)

Sol. $\log_{1/2}(x-2)>1$

$x-2>0 \Rightarrow x>2$

$x-2<1/2 \Rightarrow x<2.5$

No integral solution.

PART-B: PHYSICS

SECTION-I

31. In the relation $\frac{dy}{dt}=2\omega\sin(\omega t+\phi_0)$, the dimensional formula for $\omega t+\phi_0$ is

(A) MLT

(B) MLT^0

(C) ML^0T

(D) $M^0L^0T^0$

Ans. (D)

Sol. Dimension less quantity.

32. Two displacement vectors $\vec{A}$ and $\vec{B}$ have magnitudes of 5 meters and 12 meters, respectively. They act along the same line. What is the magnitude of the resultant vector when they are added together?

(A) 7 meters

(B) 12 meters

(C) 17 meters

(D) 60 meters

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Ans. (C)

Sol. When two vectors act along the same line, their magnitudes add up directly. So, to find the magnitude of the resultant vector, we simply add the magnitudes of the two vectors:

$|\vec{R}| = |\vec{A} + |\vec{B}|$

Given that $|\vec{A}| = 5$ meters and $|\vec{B}| = 12$ meters:

$|\vec{R}| = 5\text{ m} + 12\text{ m} = 17\text{ m}$

33. Consider a cylindrical tank with radius R and height H. The volume (V) of the tank can be expressed in terms of R and H as $V = k \cdot R^a \cdot H^b$.

Where k is a dimensionless constant, and a and b are exponents to be determined. Which of the following statements about the exponents a and b is true?

(A) a = 2 and b = 1

(B) a = 1 and b = 2

(C) a = 2 and b = 2

(D) a = 1 and b = 1

Ans. (A)

Sol. To determine the exponents a and b using dimensional analysis, let's analyze the dimensions of the variables involved:

Volume (V) has dimensions of length cubed (L^3).

Radius (R) has dimensions of length (L).

Height (H) also has dimensions of length (L).

We can express these dimensions as:

$[V] = L^3$

$[R] = L$

$[H] = L$

Now, let's substitute these dimensions into the expression for volume:

$L^3 = k \cdot (L)^a \cdot (L)^b$

Simplifying, we get: $L^3 = k \cdot L^{a+b}$

For both sides of the equation to have the same dimensions, the exponent of L on the right side must be 3. Therefore, a + b = 3.

Since we have only one equation and two unknowns, we cannot determine the values of a and b uniquely. However, based on empirical knowledge of the geometry of a cylinder, we know that the volume is proportional to both the square of the radius and the height.

34. Consider two vectors $\vec{A}$ and $\vec{B}$ in a 3-dimensional space. The magnitudes of $\vec{A}$ and $\vec{B}$ are 3 units and 4 units, respectively. The angle between $\vec{A}$ and $\vec{B}$ is $\frac{\pi}{3}$ radians. What are the scalar values of the dot product and vector product of $\vec{A}$ and $\vec{B}$, respectively?

(A) Dot product: 10, Vector product 2

(B) Dot product: 12, Vector product: 6

(C) Dot product: 6, Vector product: $6\sqrt{3}$

(D) Dot product: 12, Vector product 2

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Ans. (C)

Sol. Let's first calculate the dot product of $\vec{A}$ and $\vec{B}$. The dot product is given by:

$$\vec{A}\cdot\vec{B} = |\vec{A}\cdot|\vec{B}|\cdot\cos(\theta)$$

Given that $|\vec{A}| = 3, |\vec{B}| = 4$, and $\theta = \frac{\pi}{3}$, we can substitute these values into the formula:

$$\vec{A}\cdot\vec{B} = 3\cdot 4\cdot\cos\left(\frac{\pi}{3}\right)$$

$$\vec{A}\cdot\vec{B} = 12\cdot\frac{1}{2}$$

So, the dot product of $\vec{A}$ and $\vec{B}$ is 6.

Next, let's calculate the vector product (cross product) of $\vec{A}$ and $\vec{B}$. The magnitude of the vector product is given by:

$$|\vec{A}\times\vec{B}| = |\vec{A}|\cdot|\vec{B}|\cdot\sin(\theta)$$

Given the same values as above, we can calculate:

$$|\vec{A}\times\vec{B}| = 3\cdot 4\cdot\sin\left(\frac{\pi}{3}\right)$$

$$|\vec{A}\times\vec{B}| = 12\cdot\frac{\sqrt{3}}{2} = 6\sqrt{3}$$

35. A particle moves in a straight line. Its position vector $\vec{r}$ at time t is given by $\vec{r} = (3t^2 + 2t + 1)\hat{i}$ meters, where $\hat{i}$ is the unit vector in the direction of motion. What is the velocity of the particle at t = 2 seconds Given $\vec{v} = \frac{d\vec{r}}{dt}$?

(A) $(20\hat{i})\ m/s$

(B) $(14\hat{i})\ m/s$

(C) $(22\hat{i})\ m/s$

(D) $(26\ \hat{i})\ m/s$

Ans. (B)

Sol. To find the velocity of the particle, we need to differentiate the position vector $\vec{r}$ with respect to time I. The velocity vector $\vec{v}$ is the fate of change of the position vector $\vec{r}$ with respect to time.

Given: $\vec{r} = (3t^2 + 2t + 1)\hat{i}$, we can differentiate $\vec{r}$ with respect to t to find $\vec{v}$:

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{1}{d}\left[(3t^2 + 2t + 1)\hat{i}\right]$$

$$\vec{v} = (6t + 2)\hat{i}$$

To find the velocity at t = 2 seconds, we substitute t = 2 into the expression for $\hat{i}$:

$$\vec{v} = (6(2) + 2)\hat{i} = (12 + 2)\hat{i} = (14\hat{i})$$

Therefore, the velocity of the particle at t = 2 seconds is $(14\hat{i})\ m/s$.

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36. If the velocity of light C, the universal gravitational constant G, and Planck's constant h are chosen as fundamental units, the dimensions of mass in this system are

(A) $h^{\frac{1}{2}}C^{\frac{1}{2}}G^{-\frac{1}{2}}$

(B) $h^{-1}C^{-1}G$

(C) hCG^{-1}

(D) hCG

Ans. (A)

Sol. $ML^0T^0 = C^a G^b h^c$

$= (LT^{-1})^a (M^{-1}L^3T^{-2})^b (ML^2T^{-1})^c$

$= M^{-b+c} L^{a+3b+2c} T^{-a-2b-c}$

-b + c = 1

a + 3b + 2c = 0

a + 2b + c = 0

$\Rightarrow 2c = 1, \quad c = \frac{1}{2}$

$\Rightarrow b = \frac{-1}{2}$

$\Rightarrow a = \frac{1}{2}$

37. The time dependence of a physical quantity P is given by $P = P_0e^{-\alpha t^2}$, where α is a constant and t is time. Then constant α is/has

(A) Dimensionless

(B) Dimensions of T^{-2}

(C) Dimensions of P

(D) Dimensions of T^2

Ans. (B)

Sol. αt^2 has to be dimension less quantity.

38. 'Calorie' is the unit of

(A) Resistance

(B) Power

(C) Energy

(D) Torque

Ans. (C)

Sol. A calorie is a unit of energy that indicated the potential energy in food.

39. Dimensions of $\frac{1}{\mu_0\varepsilon_0}$, where symbols have their usual meaning, are?

[Given, Dimension of μ_0 and ε_0]

(A) $\left[L^{-1}\ T\right]$

(B) $\left[L^{-1}\ T^2\right]$

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(C) $\left[L^2\ T^{-2}\right]$

(D) $\left[LT^{-1}\right]$

Ans. (C)

Sol. Since $\frac{1}{\sqrt{\varepsilon_0\mu_0}}$ represents velocity of light in vacuum.

Therefore, $\frac{1}{\varepsilon_0\mu_0}$ represents $(LT^{-1})^2 = L^2\ T^{-2}$.

40. In the formula $X = 5YZ^2$, X and Z have dimensions of capacitance and magnetic field, respectively. What are the dimensions of Y in SI units?

[Given, Dimension of capacitance = $M^{-1}L^{-2}T^4A^2$. Dimension of magnetic field $= MT^{-2}A^{-1}$]

(A) $\left[M^{-3}\ L^{-2}\ T^8\ A^4\right]$

(B) $\left[M^{-1}\ L^{-2}\ T^4\ A^2\right]$

(C) $\left[M^{-2}\ L^0\ T^{-4}\ A^{-2}\right]$

(D) $\left[M^{-2}\ L^{-2}\ T^6\ A^3\right]$

Ans. (A)

Sol. Given equation: $X = 5YZ^2$

Dimensions of X (same as of capacitance) $= \left[M^{-1}\ L^{-2}\ T^4\ A^2\right]$

Dimensions of Z (same as of magnetic field) $= \left[M\,T^{-2}\ A^{-1}\right]$

Therefore, $Y = \frac{X}{5Z^2}$

Dimensions of $[Y] = \frac{\left[M^{-1}\ L^{-2}\ T^4\ A^2\right]}{\left[M^2\ T^{-4}\ A^{-2}\right]}$

$= \left[M^{-3}\ L^{-2}\ T^8\ A^4\right]$

41. Given that $Y = a\sin\alpha x + bt + ct^2\cos\alpha x$ If unit of Y is y then unit of abc is same as that of

(A) y

(B) $\frac{y}{t}$

(C) $\left(\frac{y}{t}\right)^2$

(D) $\left(\frac{y}{t}\right)^3$

Ans. (D)

Sol. Conceptual

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42. The density of a material in SI units is 128 kg/m^3. In certain units in which the unit of length is 25 cm and the unit of mass is 50 g, the numerical value of density of the material in this system of units is _______.

(A) 20

(B) 40

(C) 80

(D) 100

Ans. (B)

Sol. $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$

$= \frac{[M]}{[L^3]}$

$= [ML^{-2}]$

$\text{Now, } 128 \text{ kg m}^{-2} = h\left[\frac{50}{1000}\right] \times \left[\frac{25}{100}\right]^{-3}$

$\Rightarrow 128 = h\left[\frac{1}{20}\right]\left[\frac{1}{4}\right]$

$= h \times \frac{1}{20} \times (4)^3$

$\Rightarrow h = \frac{128 \times 20}{64} = 40 \text{ unit}$

43. Consider two vectors $\vec{A}$ and $\vec{B}$ in a 2-dimensional space. The components of $\vec{A}$ are $A_x = 3$ and $A_y = 4$, and the components of $\vec{B}$ are $B_x = 5$ and $B_y = 6$. What is the value of the dot product of $\vec{A}$ and $\vec{B}$?

(A) 39

(B) 42

(C) 45

(D) 48

Ans. (A)

Sol. The dot product (scalar product) of two vectors $\vec{A}$ and $\vec{B}$ in 2-dimensional space is given by:

$\vec{A} \cdot \vec{B} = A_x \cdot B_x + A_y \cdot B_y$

Given the components of $\vec{A}$ and $\vec{B}$, we can substitute them into the formula:

$\vec{A} \cdot \vec{B} = (3 \cdot 5) + (4 \cdot 6)$

$\vec{A} \cdot \vec{B} = 15 + 24$

$\vec{A} \cdot \vec{B} = 39$

Therefore, the scalar value of the dot product of $\vec{A}$ and $\vec{B}$ is 39.

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44. Consider two displacement vectors $\vec{A}$ and $\vec{B}$. The magnitude of $\vec{A}$ is 8 meters, and the magnitude of $\vec{B}$ is 15 meters. The angle between $\vec{A}$ and $\vec{B}$ is $\frac{\pi}{4}$ radians. What is the closest magnitude of the resultant vector when $\vec{A}$ and $\vec{B}$ are subtracted together?

(A) 9 meters

(B) 10 meters

(C) 11 meters

(D) 12 meters

Ans. (B)

Sol. Using the law of cosines:

$$|\vec{R}|^2 = (8)^2 + (15)^2 - 2(8)(15)\cos\left(\frac{\pi}{4}\right)$$

$$|\vec{R}|^2 = 64 + 225 - 240\left(\frac{\sqrt{2}}{2}\right)$$

$$|\vec{R}|^2 = 289 - 120\sqrt{2}$$

$$|\vec{R}| = \sqrt{289 - 120\sqrt{2}}$$

$$|\vec{R}| \approx 9.81$$

Therefore, the magnitude of the resultant vector when $\vec{A}$ and $\vec{B}$ are added together is approximately 9.81 meters.

45. Out of the following pair, which one does NOT have identical dimensions is

(A) angular momentum and Planck and constant

(B) impulse and momentum

(C) moment of inertia and moment of a force

(D) work and torque

Ans. (C)

Sol. We have $I = mr^2$, therefore, $[I] = [ML^2]$ and $\vec{\tau} =$ moment of force $= \vec{r} \times \vec{F}$.

Therefore, $[\vec{\tau}] = [L][MLT^{-1}] = [MLT^{-1}]$.

46. Two vectors $\vec{A}$ and $\vec{B}$ are given by $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 2\hat{i} - 5\hat{j}$, where $\hat{i}$ and $\hat{j}$ are the unit vectors in the x and y directions, respectively. What is the magnitude of the resultant vector when $\vec{A}$ is added to $\vec{B}$?

(A) $\sqrt{10}$

(B) $\sqrt{13}$

(C) $\sqrt{20}$

(D) $\sqrt{26}$

Ans. (D)

Sol. To find the magnitude of the resultant vector when $\vec{A}$ is added to $\vec{B}$, we can use the formula for the magnitude of a vector:

$$|\vec{R}| = \sqrt{(R_x)^2 + (R_y)^2}$$

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where R_2 and R_3 are the x and y components of the resultant vector $\vec{R}$.

Given $\vec{A} = 3\hat{i} + 4\hat{j}$ and $\vec{B} = 2\hat{i} - 5\hat{j}$. we can add the vectors component-wise to find $\vec{R}$.

$\vec{R} = \vec{A} + \vec{B} = \left(3\hat{i} + 4\hat{j}\right) + \left(2\hat{i} - 5\hat{j}\right) = (3+2)\hat{i} + (4-5)\hat{j} = 5\hat{i} - \hat{j}$

Now, we can find the magnitude of $\vec{R}$.

$|\vec{R}| = \sqrt{(5)^2 + (-1)^2}$

$|\vec{R}| = \sqrt{25+1}$

$|\vec{R}| = \sqrt{26}$

47. Magnitude of two vectors $\vec{A}$ and $\vec{B}$ are given by $|\vec{A}| = 4$ and $|\vec{B}| = 6$ and angle between them is $\frac{2\pi}{3}$. What is the magnitude of the resultant vector s?

(A) $\sqrt{28}$

(B) $\sqrt{10}$

(C) $\sqrt{17}$

(D) $\sqrt{26}$

Ans. (A)

Sol. $|\vec{r}| = \sqrt{A^2 + B^2 + 2AB\cos\theta}$

$= \sqrt{16 + 36 + 2 \text{ x } 4 \text{ x } 6 \text{ x} \left(\frac{-1}{2}\right)} = \sqrt{52-24} = \sqrt{28}$

48. Let $\vec{A} = \left(\hat{i} + \hat{j}\right)$ and $\vec{B} = \left(2\hat{i} - \hat{j}\right)$. The magnitude of a coplanar vector $\vec{C}$ such that $\vec{A}\cdot\vec{C} = \vec{B}\cdot\vec{C} = \vec{A}\cdot\vec{B}$, is given by

(A) $\sqrt{\frac{10}{9}}$

(B) $\sqrt{\frac{5}{9}}$

(C) $\sqrt{\frac{20}{9}}$

(D) $\sqrt{\frac{9}{12}}$

Ans. (B)

Sol. Given, $\vec{A} = \left(\hat{i} + \hat{j}\right)$ and $\vec{B} = \left(2\hat{i} - \hat{j}\right)$.

Therefore, $\vec{A}\cdot\vec{B} - \left(\hat{i} + \hat{j}\right)\cdot\left(2\hat{i} - \hat{j}\right) = 2 - 1 = 1$ Let coplanar vector $\vec{C}$ be $\left(x\hat{i} + y\hat{j}\right)$. Now,

$\vec{A}\cdot\vec{C} = \left(\hat{i} + \hat{j}\right)\cdot\left(x\hat{i} + y\hat{j}\right) = x + y = 1$

$\vec{B}\cdot\vec{C} = \left(2\hat{i} - \hat{j}\right)\cdot\left(x\hat{i} + y\hat{j}\right) = 2x - y = 1$

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Adding eqns. (1) and (2), we get

$$(x+y)+(2x-y)=1+1 \Rightarrow 3x=2 \Rightarrow x=\frac{2}{3}$$

and $x+y=1 \Rightarrow y=1-x=1-\frac{2}{3}=\frac{1}{3} \Rightarrow y=\frac{1}{3}$

Thus, $\vec{C}=\frac{2}{3}\hat{i}+\frac{1}{3}\hat{j} \Rightarrow |\vec{C}|=\left[\left(\frac{2}{3}\right)^2+\left(\frac{1}{3}\right)^2\right]^{\frac{1}{2}}$

$$\Rightarrow |\vec{C}|=\left(\frac{1}{9}+\frac{4}{9}\right)^{\frac{1}{2}}=\sqrt{\frac{5}{9}}$$

49. Choose the option that corresponds to the dimensions of power.

(A) $M^{-1}\ L^{-3}\ T^{3}$

(B) $M\ L^{2}\ T^{-3}$

(C) $M^{-1}\ L^{-3}\ T^{3}$

(D) $ML^{-3}\ T^{-2}$

Ans. (B)

Sol. $P=\frac{\text{work done}}{\text{Time}}=\frac{ML^2T^{-2}}{T}=ML^2T^{-3}$

50. A, B, C and D are four different physical quantities having different dimensions. None of them is dimensionless. But we know that the equation $AD=C\ln(BD)$ holds true. Then, which combination is not a meaningful quantity?

(A) $\frac{1}{B}-\frac{AD^2}{C}$

(B) $A^2-B^2C^2$

(C) $\frac{A}{B}-C$

(D) $\frac{A-C}{D}$

Ans. (D)

Sol. We have AD = Cln (BD)

That is, [B] [D] is dimensionless or $[B]=\frac{1}{[D]}$ and [A] [D] = [C].

If the dimensions of two quantities that are being added/ subtracted do not match, then that option is meaningless.

Option 1: $\frac{1}{B}-\frac{AD^2}{C}$

Option 2: $[A]^2-\frac{1}{[D]^2}[A]^2[D]^2$

Option 3: $\frac{[A]}{[B]}-[A][D]=\frac{[A]}{[B]}-\frac{[A]}{[B]}$

Option 4: $\frac{[A]}{[D]}-\frac{[C]}{[D]}$

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SECTION-II

51. The position vector of a particle moving in a plane is given by $r(t) = 4t^2\hat{i} + 3t\hat{j}$. where t is the time in seconds and $\hat{i}$ and $\hat{j}$ are unit vectors along the x and y axes respectively. Find the rate of change of the velocity vector with respect to time when t = 2 seconds, If velocity is rate of change of position $\vec{v} = \frac{d\vec{r}}{dt}$.

Ans. (8)

Sol. Given the position vector $r(t) = 4t^2\hat{i} + 3t\hat{j}$, the velocity vector v(t) is the first derivative of the position vector with respect to time:

$$v(t) = \frac{dr}{dt} - \frac{d}{dt}(4t^2\hat{i} + 3t\hat{j})$$

Differentiating each component separately:

$$\frac{d}{d}(4t^2)\hat{i} = 8t\hat{i}$$

$$\frac{d}{d}(3t)\hat{j} = 3\hat{j}$$

So, the velocity vector $v(t) = 8t\hat{i} + 3\hat{j}$.

To find the rate of change of the velocity vector with respect to time, we differentiate the velocity vector with respect to time again:

$$\frac{dv}{dt} = \frac{d}{dt}(8t\hat{i} + 3\hat{j})$$

Differentiating each component:

$$\frac{d}{dt}(8t)\hat{i} = 8\hat{i}$$

$$\frac{d}{di}(3)\hat{j} = 0$$

So, the rate of change of the velocity vector with respect to time is $\frac{dv}{dt} = 8\hat{i}$.

When t = 2 seconds, the rate of change of the velocity vector is $\frac{dv}{dt} = 8\hat{i}$ which is 8 m/sec^2 in the x direction.

52. Two vectors are given by $a = 4\hat{i} + 3\hat{j}$ and $b = -2\hat{i} + 5\hat{j}$. Calculate the scalar (dot) product of a and b.

Ans. (7)

Sol. The scalar (dot) product of two vectors a and b is given by:

$$a \cdot b = (4)(-2) + (3)(5)$$

$$a \cdot b = -8 + 15$$

$$a \cdot b = 7$$

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53. In the relation $p = \frac{a}{\beta} e^{-\frac{az}{k\theta}}$, p is pressure, Z is distance, k is Boltzmann constant and θ is the temperature. The dimensional formula of β will be $M^0L^mT^0$ answer the value of m.

Ans. (2)

Sol. In the given equation, $\frac{az}{k\theta}$ should be dimensionless

$$\therefore a = \frac{k\theta}{z}$$

$$\Rightarrow a = \frac{ML^2T^{-2}K^{-1}XK}{L} = MLT^{-2}$$

and $p = \frac{a}{\beta}$

$$\Rightarrow \beta = \frac{a}{p} = \frac{MLT^{-2}}{ML^{-1}T^{-2}} = M^0L^2T^0$$

54. The dimension of viscosity is $M^xL^{-1}\ T^{-1}$. Find the value of x.

Ans. (1)

Sol. From Stokes' law, we have

$$\eta = -\frac{\frac{F}{A}}{\frac{dv}{dx}} \text{ or } \eta = -\frac{F \cdot dx}{ddv} = -\frac{M^2 \cdot T^{-1}L}{L' \cdot T^{-1}}$$

$$\Rightarrow \eta = ML^{-1}\ T^{-1}$$

55. The dimensional formula of Gravitational constant is $M^{-1}L^XT^{-2}$. Find the value of x.

Ans. (3)

Sol. $F = \frac{GM_1M_2}{R^2}$

$$\Rightarrow G = \frac{FR^2}{M_1M_2}$$

$$\Rightarrow G = \frac{MLT^{-2}L^2}{M^2}$$

$$\Rightarrow G = M^{-1}L^3T^{-2}$$

Thus, x = 3

56. The dimension of work done in M, L and T is given as $M^xL^2T^{-2}$. Find the value of x.

Ans. (1)

Sol. Since work done (w) = F × S

= $[MLT^{-2}] \times [L]$

= ML^2T^{-2}

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57. Given two vectors $a = 3\hat{i} - 2\hat{j}$ and $b = 4\hat{i} + 5\hat{j}$. Calculate the scalar (dot) product of a and b.

Ans. (2)

Sol. The scalar (dot) product of two vectors a and b is given by:

$a \cdot b = (3)(4) + (-2)(5)$

$a \cdot b = 12 - 10$

$a \cdot b = 2$

Therefore, the scalar product of a and b is 2.

58. If $\frac{\alpha}{t^2} = FV$ and if dimension of $\alpha = M^x L^y T^z$. Then find the value of x + y + z. (F = Force, V = Velocity)

Ans. (2)

Sol. $\alpha = FVt^2$

$= (MLT^{-2} LT^{-1}T^2)$

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

$\therefore$ x = 1, y = 2, z = -1

x + y + z = 1 + 2 – 1 = 2

59. Expression for time in terms of G (universal gravitational constant), h (Planck constant) and c (speed of light) is proportional to $\sqrt{\frac{Gh}{c^x}}$. Find the value of x.

Ans. (5)

Sol. $\sqrt{\frac{Gh}{c^5}}$

Dimension of time, t = [T]

Now,

$t \,\alpha\, G^p h^q c^r$

$t = k\, G^p\, h^q\, c^r$

Dimension of Gravitational constant, $G = \left[M^{-1}\ L^3\ T^{-1}\right]$ Dimension of Planck's constant, $h = \left[ML^2\ T^{-1}\right]$

Dimension of speed of light, $c = \left[LT^{-1}\right]$. Put the Dimensions in Eq. (1), we get

$\left[T\right] = \left[M^{-p+q}\right]\left[L^{3p+2q+\eta}\right]\left[T^{-2p-\gamma-1}\right]$

On comparing the power of both sides, we get

$-p + q = 0 \Rightarrow p = q$

$3p + 2q + r = 0 \Rightarrow 5p + r = 0$

$-2p - q - r = 1 \Rightarrow -3p - r = 1$

On solving the above Eq. (2), (3) and (4), we get

$p = q = \frac{1}{2}$ and $r = \frac{-5}{2}$

Put these values in Eq. (1), we get $t = G^{1/2}h^{1/2}c^{-5/2}$

$t = k\sqrt{\frac{Gh}{c^5}}$, where k = constant

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60. If $A = 2\hat{i} - 3\hat{j} + 7\hat{k}$, $B = \hat{i} + 2\hat{k}$ and $C = \hat{j} - \hat{k}$ find $A \cdot (B \times C)$.

Ans. (0)

Sol. A, B and C are coplanar.

PART-C: CHEMISTRY

SECTION-I

61. If 1.5 moles of oxygen combine with Al to form Al_2O_3 the weight of Al used in the reaction is

(A) 27 g

(B) 40.5 g

(C) 54 g

(D) 81 g

Ans. (C)

Sol. $2Al + \frac{3}{2}O_2 \longrightarrow Al_2O_3$

1.5 mole O_2 completely reaction with 2 mole (54 gm) of Al.

62. The volume of oxygen at 0°C and 1 atm which can be produced by decomposition of 245 gm of potassium chlorate ($KClO_3$) is (Given: K = 39, Cl = 35.5)

(A) 22.4 lit

(B) 11.2 lit

(C) 67.2 lit

(D) 44.8 lit

Ans. (C)

Sol. $\underset{2mol}{2KClO_3} \xrightarrow{\Delta} 2KCl + \underset{3mol}{3O_2}$

(molar mass of $KClO_3$ = 122.5)

Moles of $KClO_3 = \frac{245}{122.5} = 2$

2 mole of $KClO_3$ on decomposition give 3 mole of O_2.

Given mole of $KClO_3$ = 2, moles of O_2 obtained = 3

Volume of O_2 at NTP = 3 × 22.4 = 67.2 lit.

63. 1.38 gm of silver carbonate on being strongly heated yields a residue weighing

[Molar mass of Ag = 108 g]

$Ag_2CO_3 \xrightarrow[\Delta]{} 2Ag + CO_2 + O_2$

(A) 1.08 g

(B) 2.16 g

(C) 1.16 g

(D) 2.48 g

Ans. (A)

Sol. According to reaction, residue is Ag

$Ag_2CO_3 \xrightarrow{\Delta} \underset{\text{Residue}}{Ag} + CO_2 + O_2$

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Ag atm is conserved

Applying POAC for Ag [Molar mass of Ag_2CO_3 = 276]

2 × moles of Ag_2CO_3 = 1 × moles of Ag

$$2\times\frac{1.38}{276}=\frac{\text{wt of Ag}}{108}$$

Weight of Ag = 1.08 g

64. The weight of oxygen on complete reaction with 10 gm Ca

(A) 8 g

(B) 16 g

(C) 4 g

(D) 40 g

Ans. (C)

Sol. $2Ca + O_2 \rightarrow 2CaO$ $\left[\text{Moles of Ca} = \frac{10}{40} = 0.25\right]$

Stoichiometric moles	2	1
Given moles	0.25	1/8

2 moles of Ca required 1 mol of O_2

0.25 moles of Ca required $\frac{1}{2}\times.25$ mole of O_2

$$\text{Mass of } O_2 = \frac{1}{2}\times.25\times32$$

= 4.00 g

65. The volume of CO_2 obtained at 0°C and 1 atm when 8 gm CH_4 is burnt with 64 gm of O_2,

(A) 5.6 lit

(B) 11.2 lit

(C) 1.12 lit

(D) 22.4 lit

Ans. (B)

Sol. $\text{Moles of } CH_4 = \frac{8}{16} = 0.5$

$$\text{Moles of } O_2 = \frac{64}{32} = 2$$

Given moles $\overset{0.5}{CH_{4(g)}} + \overset{2}{2O_{2(g)}} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$

1 mole of CH_4 combines with 2 mole O_2

0.5 mole of CH_4 combines with 1 mole of O_2

Limiting reagent is CH_4

∴ Moles of CO_2 formed = 0.5

Volume of CO_2 at STP = 0.5 × 22.4 lit

= 11.2 lit

66. Molarity of 1 gm H_2SO_4 solution in 1 lit water is nearly

(A) 0.1

(B) 0.20

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(C) 0.05

(D) 0.01

Ans. (D)

Sol. Molarity $= \dfrac{\text{wt. in gm}}{\text{Molar mass} \times \text{volume of sol. (lit)}}$

$M = \dfrac{1}{98 \times 1} = 0.01$

67. The amount of calcium oxide in gm is obtained on heating 100 gm of $CaCO_3(s)$

(A) 50 g

(B) 40 g

(C) 56 g

(D) 44 g

Ans. (C)

Sol. $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

Moles of $CaCO_3 = \dfrac{100}{100} = 1$

One mole of $CaCO_3$ on decomposition gave 1 mole of CaO.

Mass of CaO = 1 × 56 = 56 g

68. 1 gm of a metal carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of M_2CO_3 in g/mole

(A) 84.3

(B) 118.6

(C) 11.86

(D) 1186

Ans. (A)

Sol. Let molar mass of M_2CO_3 is M'

	M_2CO_3	$+ 2HCl \longrightarrow$	$2MCl + H_2O + CO_2$
Stoichiometric moles	1 mol	2 mol	1 mol
Given moles	$\dfrac{1}{M'}$ mole		0.01186

M_2CO_3 is limiting reagent

1 mole CO_2 is formed from 1 mole of M_2CO_3

0.01186 mole CO_2 is formed from 1 × 0.01186 mole of M_2CO_3

$\dfrac{1}{M'} = 0.01186$

$M' = \dfrac{1}{0.01186} = 84.3$

69. The moles of lead nitrate needed to produce 44.8 lt. of oxygen at 0°C and 1 atm according to following equation:

$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2 + O_2$

(A) 2

(B) 4

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(C) 1
(D) 6

Ans. (B)

Sol. Moles of $O_2 = \frac{44.8}{22.4} = 2$

1 mole O_2 is formed from 2 mole of $Pb(NO_3)_2$

2 mole O_2 is formed from 4 mole of $Pb(NO_3)_2$

70. The percentage of oxygen in calcium carbonate ($CaCO_3$)

(A) 48%
(B) 20%
(C) 12%
(D) 24%

Ans. (A)

Sol. Molecular mass of $CaCO_3$ = 100 u

Atomic mass of O = 16 u

Percentage of O $= \frac{3 \times 16}{100} \times 100 = 48\%$

71. 500 ml of glucose solution contains 18 gm glucose $\left[C_6H_{12}O_6\right]$. The concentration of solution is

(A) 0.1 M
(B) 0.2 M
(C) 2 M
(D) 1 M

Ans. (B)

Sol. $M = \frac{\text{wt. in gm}}{\text{Molar mass} \times \text{volume of Sol.(lt.)}} = \frac{18}{180 \times .5} = 0.2$

72. 12 gm of Mg will react with an acid to give

(A) 1 mole of O_2
(B) $\frac{1}{2}$ mole of H_2
(C) 1 mole of H_2
(D) 2 mole of H_2

Ans. (B)

Sol. $Mg + 2HCl \to MgCl_2 + H_2$

1 Mole of Mg give 1 mol H_2

Moles of Mg $= \frac{12}{24} = \frac{1}{2}$

$\therefore$ Moles of $H_2 = \frac{1}{2}$

73. How many liters of CO_2 at 0°C and 1 atm will be formed when 0.01 mole of H_2SO_4 reacts with excess of Na_2CO_3.

$Na_2CO_3 + H_2SO_4 \to Na_2SO_4 + CO_2 + H_2O$

(A) 22.4 lit
(B) 2.24 lit

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(C) 0.224 lit

(D) 1.12 lit

Ans. (C)

Sol. $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + H_2O$

Stoichiometric moles	1 mol	1 mol
Given moles	0.01 mole	0.01 mole

Moles of CO_2 formed = 0.01 mol

Volume of CO_2 at NTP = 22.4 × .01

= 0.224 lt.

74. What mass of Acetylene is obtained when 32 gm of calcium carbide is treated with H_2O according to following equation?

$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$

(A) 26 g

(B) 13 g

(C) 39 g

(D) 52 g

Ans. (B)

Sol. $CaC_2 + 2H_2O \rightarrow Ca(OH)_2 + C_2H_2$

1 mole of CaC_2 on hydrolysis give 1 mole C_2H_2

$\text{Moles of } CaC_2 = \frac{32}{64} = \frac{1}{2}$

$\text{Moles of } CaC_2 = \frac{1}{2}$

$\text{Moles of } C_2H_2 \text{ formed} = \frac{1}{2}$

$\text{Mass of } C_2H_2 = \frac{1}{2} \times 26 = 13 \text{ g}$

75. 4 mole of a sample of $CaCl_2$ and NaCl is treated to precipitate all the calcium as $CaCO_3$. This $CaCO_3$ is heated to convert all the Ca to CaO and the final mass of CaO is 84 gm. The no. of moles of $CaCl_2$ in original mixture is

(A) 2

(B) 1.5

(C) 3

(D) 1

Ans. (B)

Sol. $\underset{4\text{ mole}}{CaCl_2 + NaCl} \longrightarrow CaCO_3 \longrightarrow \underset{84\text{g}}{CaO}$

$\frac{84}{56} = 1.5 \text{ mole}$

Only Ca of $CaCl_2$ is converted into CaO

$\therefore$ No. of moles of $CaCl_2$ = moles of CaO = 1.5

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76. 230 gm of an aqueous solution contains 30 gm of urea. What is the concentration of the solution in terms of molality (molecular) wt. of urea = 60)

(A) 2.5 m

(B) 5 m

(C) 1.5 m

(D) 2 m

Ans. (A)

Sol. Mass of solute (urea) = 30 g

Mass of solvent = 230 – 30 = 200 g

$$\text{Molality (m)} = \frac{\text{wt. in g (solute)}}{\text{Molar mass} \times \text{wt. of solvent in kg}}$$

$$= \frac{30}{60 \times \frac{200}{1000}} = 2.5$$

77. 6 gm of alkaline earth metal gives 7.4 gm of its nitride. Atomic wt. of metal is

$$3M + N_2 \longrightarrow M_3N_2$$

(A) 12

(B) 20

(C) 40

(D) 149

Ans. (C)

Sol. Let alkaline earth metal is M (atomic mass is Y) and valency of element is 2, valency of nitride ion is 3.

$$3M + N_2 \longrightarrow M_3N_2$$

$$\frac{\text{moles of earth metal}}{3} = \frac{\text{moles of } M_3 N_2}{1}$$

$$\frac{6}{3 \times Y} = \frac{7.4}{3Y + 28}$$

Y = 40

78. For the reaction,

$$2A + B \rightarrow C$$

4 mole of A and excess of B will produce

(A) 4 mole of C

(B) 2.5 mole of C

(C) 2 mole of C

(D) 6.5 mole of C

Ans. (C)

Sol. 2 mole of A will gives 1 mole of C.

4 mole of A will gives 2 mole of C.

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79. Percentage of C in glucose $C_6H_{12}O_6$ is

(A) 20%

(B) 40%

(C) 80%

(D) 10%

Ans. (B)

Sol. $\%C \text{ in glucose} = \frac{72}{180} \times 100 = 40\%$

80. Which concentration term is temperature dependent?

(A) Molality

(B) Mole fraction

(C) Percentage by mass

(D) Molarity

Ans. (D)

Sol. Molarity is temperature dependent.

SECTION-II

81. 120 gm of urea is dissolved in with 1000 g of water to form a solution whose density is 1.12 g/ml. The molarity of urea in solution is [MM of urea = 60 g]

Ans. (2)

Sol. Mass of solution = 120 + 1000 = 1120 g

$\text{Volume of solution} = \frac{1120}{1.12}\text{mL} = 1 \text{ litre}$

$M = \frac{\text{wt. in g}}{\text{mol.wt} \times V(\text{lt.})} = \frac{120}{60 \times 1} = 2$

82. The percentage of C in the compound $C_2H_5NO_2$ is

Ans. (32%)

Sol. $\%C = \frac{2 \times 12}{75} \times 100 = 32\%$

83. If 108 gm Ag reacts with 32 gm of sulphur. The amount of Ag_2S formed (in g) will be [MM of Ag = 108 g]

Ans. (124 g)

Sol. $2Ag + S \rightarrow Ag_2S$

Given mole 1 1

$\text{Mole of Ag} = \frac{108}{108} = 1$

$\text{Mole of S} = \frac{32}{32} = 1$

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Ag is the limiting reagent

2 mol of Ag give 1 mole of Ag_2S

1 mol of Ag give $\frac{1}{2}$ mole of Ag_2S

Mass of Ag_2S from = $\frac{1}{2} \times 248$

= 124 g

84. How many moles of potassium chlorate are needed to produce 134.4 lit. oxygen at 0°C and 1 atm, on heating according to reaction

$2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

Ans. (4)

Sol. Moles of $O_2 = \frac{134.4}{22.4} = 6$

3 moles of O_2 is formed from 2 moles $KClO_3$

6 moles of O_2 is formed from $\frac{2}{3} \times 6 = 4$ moles of $KClO_3$.

85. K_2CO_3 was treated by a series of reagent so as to convert all of its carbon to 5 mole of $K_2Zn_3[Fe(CN)_6]_2$. Find the moles of K_2CO_3 needed to give the product.

Ans. (60)

Sol. $K_2CO_3 \xrightarrow[\text{steps}]{\text{several}} K_2Zn_3[Fe(CN)_6]_2$

Since C atom is conserved

Applying POAC for C

1 × moles of K_2CO_3 = 12 × moles of $K_2Zn_3[Fe(CN)_6]_2$

= 12 × 5

= 60

86. Assume carbon burns according to following equations

$2C_{(s)} + O_{2(g)} \longrightarrow 2CO_{(g)}$

When 12 gm carbon is burnt in 48 gm oxygen the mass of carbon monoxide produced (in g) is

Ans. (28)

Sol. $2C + O_2 \rightarrow 2CO$

mole of C $= \frac{12}{12} = 1$

mole of $O_2 = \frac{48}{32} = \frac{3}{2} = 1.5$

2 mole of C requires 1 mole of O_2

1 mole of C requires $\frac{1}{2}$ mole of O_2

Carbon is limiting reagent

Moles of CO formed = 1

Mass of CO = 1 × 28 = 28 g

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87. 1.5 mole of O_2 combine with Mg to form oxide MgO. The mass of Mg (in g) that has combined is

Ans. (72)

Sol. $2Mg + O_2 \rightarrow 2MgO$

1 mole O_2 combines with 2 mole of Mg

1.5 mol O_2 combines with 2 × 1.5 mol of Mg

Mole of Mg = 3

Mass of Mg = 3 × 24 = 72

88. An organic compound C_xH_y (molecular weight 26) contains 92.3% C and 7.7% H. The value of (x + y) is

Ans. (4)

Sol. $C : H = \frac{92.3}{12} : \frac{7.7}{1}$

C : H = 1 : 1

Empirical formula = CH

Molecular formula = $(CH)_n$

Where $n = \frac{\text{molecular formula mass}}{\text{Empirical formula mass}} = \frac{26}{13} = 2$

M.F. = $(CH)_2$ = C_2H_2

x + y = 4

89. 29.2% $\left(\frac{w}{w}\right)$ HCl solution has density of 1.25 g/ml. The molarity of HCl in solution

Ans. (10)

Sol. 100 g of solution contains 29.2 of HCl

$\text{Volume of sol.} = \frac{100}{1.25}\text{ ml}$

$$M = \frac{29.2}{36.5} \times \frac{1000}{\frac{100}{1.25}} = 10\text{ M}$$

90. 5 mole of H_2SO_4 is mixed with 2 mole of $Ca(OH)_2$. The maximum number of moles of $CaSO_4$ formed is

Ans. (2)

Sol. Given mole 2 5

$$Ca(OH)_2 + H_2SO_4 \longrightarrow CaSO_4 + 2H_2O$$

Limiting reagent is $Ca(OH)_2$

2 mol of $Ca(OH)_2$ give 2 mole of $CaSO_4$

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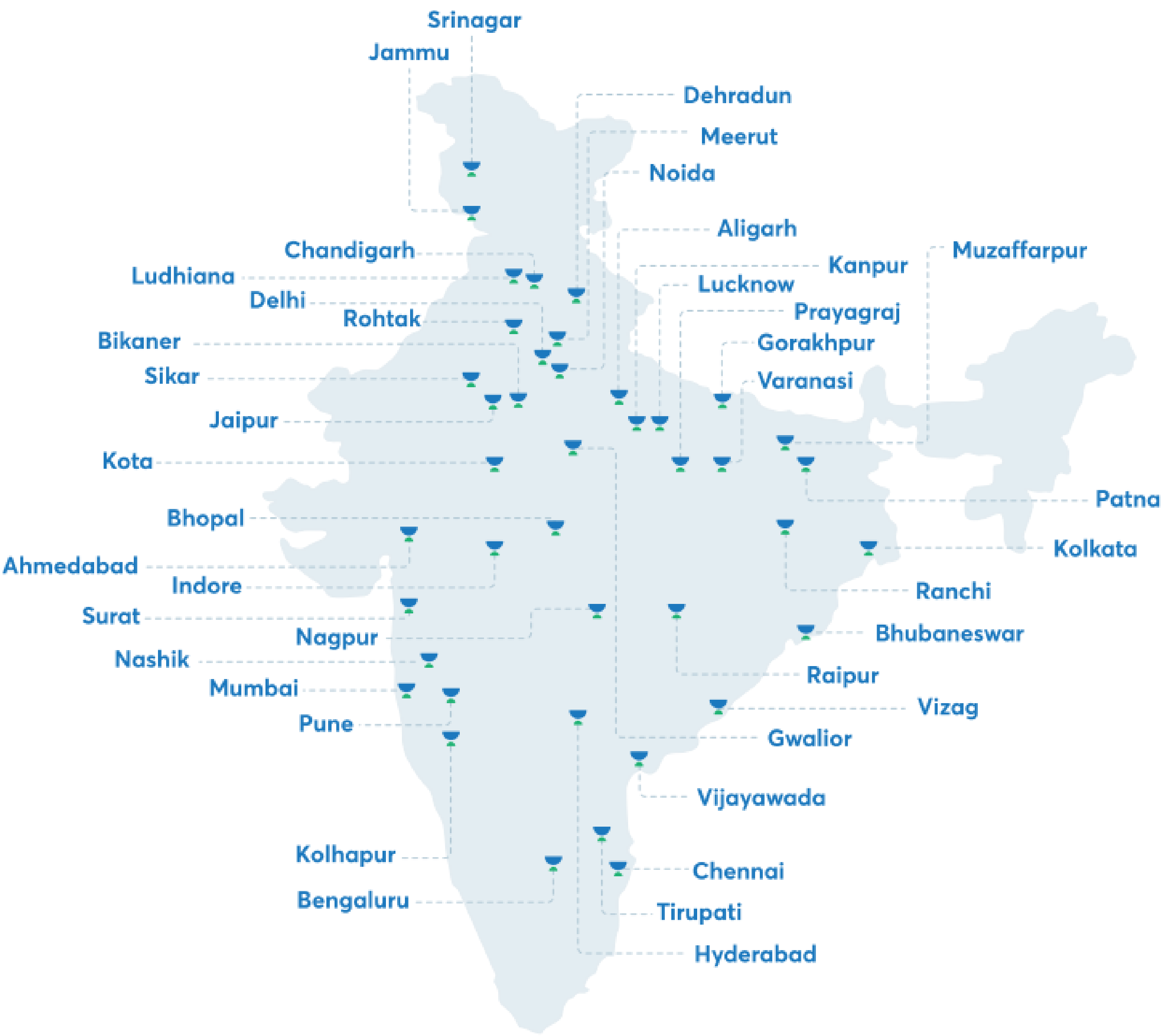

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