PART : MATHEMATICS

1. The value of $\frac{1\times 2^2+2\times 3^2+....+100\times(101)^2}{1^2\times 2+2^2\times 3+.....100^2\times 101}$ is

(1) $\frac{31}{30}$ (2) $\frac{305}{301}$ (3) $\frac{306}{305}$ (4) $\frac{32}{31}$

NTA (2)

Ans. (2)

Sol. $S_n = \frac{\Sigma n(n+1)^2}{\Sigma n^2(n+1)} = \frac{\Sigma n^3+\Sigma 2n^2+\Sigma n}{\Sigma n^3+\Sigma n^2}$

$$= \frac{\frac{(n(n+1))^2}{2}+\frac{2n(n+1)(2n+1)}{6}+\frac{n(n+1)}{2}}{\left(\frac{n(n+1)}{2}\right)^2+\frac{n(n+1)(2n+1)}{6}}$$

$$= \frac{\frac{n(n+1)}{2}+\frac{2(2n+1)}{3}+1}{\frac{n(n+1)}{2}+\frac{2n+1}{3}}$$

$$= \frac{2n^2+11n+10}{3n^2+7n+2} = \frac{(3n+5)(n+2)}{(3n+1)(n+2)}$$

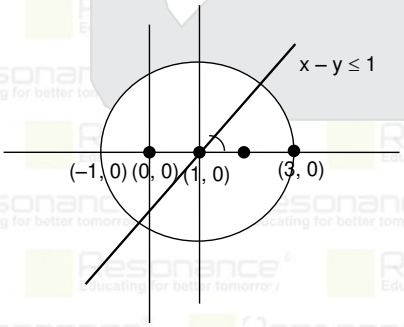
$S_n = \frac{3n+5}{3n+1} \Rightarrow S_{100} = \frac{305}{301}$

2. The area (in sq. units) of the region $S=\{z\in C:|z-1|\le 2:(z+\bar{z})+i(z-\bar{z})\le 2, Im(z)\ge 0\}$ is

(1) $\frac{7\pi}{4}$ (2) $\frac{7\pi}{3}$ (3) $\frac{17\pi}{8}$ (4) $\frac{3\pi}{2}$

NTA (4)

Ans. (4)



Sol.

$|z-1| \le 2 \Rightarrow (x-1)^2 + y^2 = 4$

$(z+\bar{z}) + i\,(z+\bar{z}) \le 2 \Rightarrow x - y \le 1$

$Im\,|z| \ge 0 \Rightarrow y \ge 0$

Area of region $= \frac{1}{2}(2)^2\left(\frac{3\pi}{4}\right) = \frac{3\pi}{2}$

3. Given that the inverse trigonometric function assume principal values only. Let x, y be any two real numbers in [–1, 1] such that $\cos^{-1}x - \sin^{-1}y = \alpha, \frac{-\pi}{2} \le \alpha \le \pi$.

Then, the minimum value of $x^2 + y^2 + 2xy\sin\alpha$ is

(1) 1/2 (2) 0 (3) –1/2 (4) –1

NTA (2)

Ans. (2)

Sol. $\cos^{-1}x - \sin^{-1}y = \alpha$

$\cos^{-1}x + \cos^{-1}y = \frac{\pi}{2} + \alpha$

taking cos : $xy - \sqrt{1-x^2}\sqrt{1-y^2} = -\sin\alpha$

$xy + \sin\alpha = \sqrt{1-x^2}\sqrt{1-y^2}$

square $x^2y^2 + 2xy\sin\alpha + \sin^2\alpha = 1 - x^2 - y^2 + x^2y^2$

$x^2 + y^2 + 2xy\sin\alpha = \cos^2\alpha$

$\therefore$ min value of $x^2 + y^2 + 2xy\sin\alpha = 0$

4. Let P be the point of intersection of the lines $\frac{x-2}{1} = \frac{y-4}{5} = \frac{z-2}{1}$ and $\frac{x-3}{2} = \frac{y-2}{3} = \frac{z-3}{2}$. Then, the shortest distance of P from the line $4x = 2y = z$ is

(1) $\frac{\sqrt{14}}{7}$ (2) $\frac{6\sqrt{14}}{7}$ (3) $\frac{3\sqrt{14}}{7}$ (4) $\frac{5\sqrt{14}}{7}$

NTA (3)

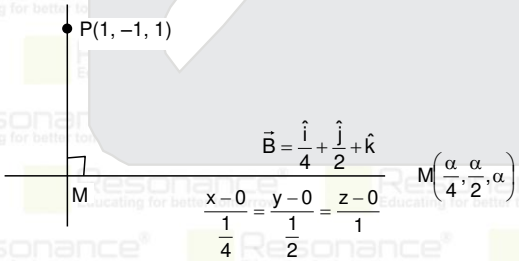
Ans. (3)

Sol. For point of intersection

$P(\lambda + 2, 5\lambda + 4, \lambda + 2)$ $(2\mu + 3, 3\mu + 2, 2\mu + 3)$

$\lambda + 2 = 2\mu + 3$, $5\lambda + 4 = 3\mu + 2$, $\lambda + 2 = 2\mu + 3$

$\lambda = -1$, $\mu = -1$ point P = Q (1, – 1, 1)



$\overrightarrow{PM}.\vec{B} = 0$

$\frac{1}{4}\left(\frac{\alpha}{4} - 1\right) + \frac{1}{2}\left(\frac{\alpha}{2} + 1\right) + 1(\alpha - 1) = 0 \Rightarrow \alpha = \frac{4}{7}$

$M = \left(\frac{1}{7}, \frac{2}{7}, \frac{4}{7}\right)$

Shortest distance PM = $\sqrt{\left(\frac{1}{7} - 1\right)^2 + \left(\frac{2}{7} + 1\right)^2 + \left(\frac{4}{7} - 1\right)^2} = \frac{3\sqrt{14}}{7}$

5. If the mean of the following probability distribution of randam variable X:

X	0	2	4	6	8
P(X)	a	2a	a + b	2b	3b

is $\frac{46}{9}$, then variance of the distribution is

(1) $\frac{581}{81}$ (2) $\frac{566}{81}$ (3) $\frac{151}{27}$ (4) $\frac{173}{27}$

NTA Ans. **(2)**

Reso Ans. **(2)**

Sol. $\because \Sigma P_L = 1 \Rightarrow 4a + 6b = 1$ .....(1)

$\bar{x} = \frac{46}{9} \Rightarrow \Sigma p_i x_i = \frac{46}{9} \Rightarrow 4a + 20b = \frac{23}{9}$ .....(2)

(1) and (2) $a = \frac{1}{12}, b = \frac{1}{3}$

variance $\Sigma p_i x_i^2 - (\bar{x})^2 = 24a + 280b - \left(\frac{46}{9}\right)^2$

$= \frac{566}{81}$

6. Let C be a circle with radius $\sqrt{10}$ units and centre at the origin. Let the line x + y = 2 intersects the circle C at the points P and Q. Let MN be chord of C of length 2 unit and slope –1. Then, a distance (in units) between the chord PQ and the chord MN is

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

NTA Ans. **(1)**

Reso Ans. **(1)**

Sol. Distance of centre from chord PQ = $\left|\frac{0+0-2}{\sqrt{1^2+1^2}}\right| = \sqrt{2}$

Let distt. of centre from chord MN = P

then length of chord $2 = 2\sqrt{10-p^2} \Rightarrow P = 3$

distance between chord = $3-\sqrt{2}$

7. Let $f(x)=3\sqrt{x-2}+\sqrt{4-x}$ be a real values function. If α and β are respectively the minimum, and the maximum values of f, then $\alpha^2 + 2\beta^2$ is equal to

(1) 38 (2) 24 (3) 44 (4) 42

Reso. **(4)**

NTA. **(4)**

Sol. $f'(x) = \frac{3}{2\sqrt{x-2}} - \frac{1}{2\sqrt{4-x}}$ $:f'(x) = 0 \Rightarrow x = \frac{19}{5} \in [2,4]$

$f(2) = \sqrt{2}$, $f\left(\frac{19}{5}\right) = 2\sqrt{5}$, $f(4) = 3\sqrt{2}$

$\therefore \alpha = \sqrt{2}$, $\beta = 2\sqrt{5}$

$\alpha^2 + 2\beta^2 = 2 + 40 = 42$

8. Let $A=\begin{bmatrix}1 & 2\\ 0 & 1\end{bmatrix}$ and $B = I + \text{adj}(A) + (adjA)^2 + \ldots.. + (adjA)^{10}$

Then, the sum of all the elements of the matrix B is :

(1) –110 (2) –88 (3) 22 (4) –124

NTA. **(2)**

Reso. **(2)**

Sol. $\text{adj}(A) = \begin{bmatrix}1 & -2\\ 0 & 1\end{bmatrix}$ $(\text{adj}(A))^2 = \begin{bmatrix}1 & -4\\ 0 & 1\end{bmatrix}$ $(\text{adj}(A))^r = \begin{bmatrix}1 & -2r\\ 0 & 1\end{bmatrix}$

$B = I + (\text{adj}A) + (\text{adj}A)^2 + \ldots\ldots\ldots + (\text{adj}A)^{10}$

$= \begin{bmatrix}11 & \sum_{r=0}^{10}(-2r)\\ 0 & 11\end{bmatrix} = \begin{bmatrix}11 & -110\\ 0 & 11\end{bmatrix}$

sum of element of B = – 88

9. Let y = y(x) be the solution of the differential equation $\left(x^2+4\right)^2 dy + \left(2x^3 y + 8xy - 2\right)dx = 0$. If y (0) = 0, then y(2) is equal to

(1) $\frac{\pi}{32}$ (2) $\frac{\pi}{16}$ (3) 2π (4) $\frac{\pi}{8}$

NTA. **(1)**

Reso. **(1)**

Sol. $\frac{dy}{dx} + \left(\frac{2x}{x^2+4}\right) y = \frac{2}{\left(x^2+4\right)^2}$

I.F. $= e^{\int \frac{2x}{x^2+4}dx} = e^{\ell n(x^2+4)} = x^2 + 4$

solution of differential equation $y(x^2 + 4) = \int \frac{2}{x^2+4}dx \Rightarrow y(x^2 + 4) = \tan^{-1}(x/2) + C$

But y(0) = 0 $\therefore$ c = 0

$y(x^2 + 4) = \tan^{-1}(x/2)$ at $x = 2 \rightarrow y = \frac{\pi/4}{8} = \frac{\pi}{32}$

10. Let three real numbers a, b, c be in the arithmetic progression and a + 1, b, c + 3 be in geometric progression. If a > 10 and the arithmetic mean of a, b and c is 8, then the cube of the geometric mean of a, b and c is

(1) 120 (2) 312 (3) 128 (4) 316

NTA. **(1)**

Reso. **(1)**

Sol. Given $b^2 = (a + 1)(a + 3)$ ……(1)

$2b = a + c$ ……(2)

$\frac{a+b+c}{3} = 8$ .....(3)

using (1), (2) and (3) a = 15, b = 8, c = 1

(abc) = 120

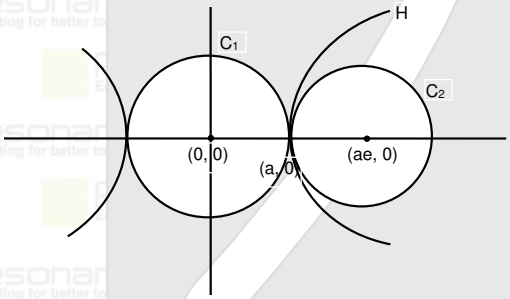
11. Consider a hyperbola H having centre at the origin and foci on the the x-axis. Let C_1 be the circle touching the hyperbola H. and having the centre at the origin. Let C_2 be the circle touching the hyperbola H at its vertex and having the centre at one of its foci. If areas (in sq. units) of C_1 and C_2 are 36π and 4π. respectively, then the length (in units) of latus rectum of H is.

(1) $\frac{11}{3}$ (2) $\frac{10}{3}$ (3) $\frac{14}{3}$ (4) $\frac{28}{3}$

Reso. **(4)**

NTA **(4)**

Sol.



$C_1 ; x^2 + y^2 = a^2$

$C_2 ; (x - ae^2) + y^2 = (ae - a)^2$

Given :

$\pi a^2 = 36\pi \Rightarrow a = 6$

and $\pi(ae - a)^2 = 4\pi \quad \Rightarrow \quad e - 1 = \frac{2}{6} \quad \Rightarrow \quad e = \frac{4}{3}$

$$e^2 = \frac{16}{9} \Rightarrow \frac{1+b^2}{a^2} = \frac{16}{9} \Rightarrow b^2 = 28$$

length of L.R. = $\frac{2b^2}{9} = \frac{2 \times 28}{6} = \frac{28}{3}$

12. Let $f(x) = \int_0^x (t + \sin(1-e^t))dt$.$x \in R$. Then $\lim\limits_{x\to 0} \frac{f(x)}{x^3}$ is equal to

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

Reso. **(3)**

NTA **(3)**

Sol. $\lim\limits_{x\to 0} \frac{f(x)}{x^3}$ (% form)

L.H.Rule

$$\lim_{x\to 0} \frac{f'(x)}{3x^2} = \lim_{x\to 0} \frac{x+\sin(1-e^x)}{3x^2} \text{ (% form)}$$

L.H.Rule

$$\lim_{x\to 0} \frac{1+\cos(1-e^x)(-e^x)}{6x} \text{ (% form)}$$

L.H.Rule

$$\lim_{x\to 0} \frac{0+(-e^x)\cos(1-e^x)+(-e^x)(-\sin(1-e^x))(-e^x)}{6}$$

$= -\frac{1}{6}$

13. If the coefficients of x^4, x^5 and x^6 in the expansion of $(1 + x)^n$ are in the arithmetic progression. Then the maximum value of n is.

(1) 7 (2) 21 (3) 28 (4) 14

Reso. **(4)**

NTA **(4)**

Sol. ${}^nC_4$, ${}^nC_5$, ${}^nC_6$ are in A.P.

$2({}^nC_5) = {}^nC_4 + {}^nC_6 \quad \Rightarrow \quad n^2 - 21n + 98 = 0$

$(n-14)(n-7) = 0 \quad \Rightarrow n = 7, 14$

maximum value of n = 14

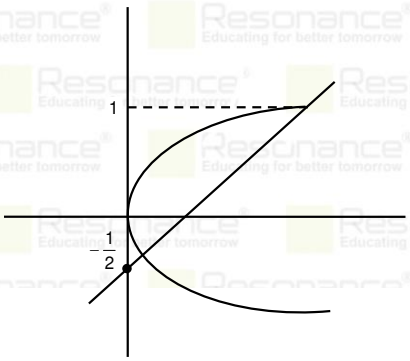
14. The area (in sq. units) of the region described by $\{(x, y) : y^2 \le 2x \text{ and } y \ge 4x - 1\}$

(1) $\frac{9}{32}$ (2) $\frac{11}{12}$ (3) $\frac{8}{9}$ (4) $\frac{11}{32}$

Reso. **(1)**

NTA **(1)**

Sol.



$$\text{Area} = \int_{-\frac{1}{2}}^{1} \left(\frac{y+1}{4} - \frac{y^2}{2}\right) dy$$

$$= \left(\frac{y^2}{8} + \frac{y}{4} - \frac{y^3}{6}\right)_{-\frac{1}{2}}^{1} = \frac{9}{32}$$

15. Let PQ be a chord of the parabola $y^2 = 12x$ and the midpoint of PQ be at (4,1) Then which of the following point lies on the line passing through the point P and Q.

(1) $\left(\frac{1}{2},-20\right)$ (2) (2,–9) (3) $\left(\frac{3}{2},-16\right)$ (4) (3, –3)

Reso. **(1)**

NTA **(1)**

Sol. chord whose mid point is given

$T = S_1$

$y(1) + (-12)\left(\frac{x+4}{2}\right) = 1^2 - 12 \times 4$

$y = 6x - 23$

Point $\left(\frac{1}{2}, -20\right)$ lies on chord.

16. For $\lambda > 0$ let θ be the angle between the vectors $\vec{a} = \hat{i} + \lambda\hat{j} - 3\hat{k}$ and $\vec{b} = 3\hat{i} - \hat{j} + 2\hat{k}$. If the vectors $\vec{a}+\vec{b}$ and $\vec{a}-\vec{b}$ are mutually perpendicular then the value of $(14\cos\theta)^2$ is equal to

(1) 50 (2) 25 (3) 20 (4) 40

Reso. **(2)**

NTA **(2)**

Sol. $(\vec{a}-\vec{b}).(\vec{a}+\vec{b}) = 0 \Rightarrow |a|^2 = |b|^2 \Rightarrow 1 + \lambda^2 + 9 = 9 + 1 + 4 \Rightarrow \lambda = 2$

and $\cos\theta = \frac{\vec{a}\,.\,\vec{b}}{|\vec{a}||\vec{b}|} \Rightarrow \cos\theta = \frac{-5}{14}$ Þ $(14\cos\theta)^2 = 25$

17. If the value of the integral $\int_{-1}^{1} \frac{\cos\alpha x}{1+3^x}dx$ is $\frac{2}{\pi}$. Then a value of α is

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

Reso. **(2)**

NTA. **(2)**

Sol. $I = \int_{-1}^{1} \frac{\cos\alpha x}{1+3^x}dx$ _____ (1)

use property V $\left(\int_a^b f(x)dx = \int_a^b f(a+b-x)dx\right)$

$I = \int_{-1}^{1} \frac{\cos\alpha x}{1+3^{-x}}dx$ _____(2)

(1) + (2)

$2I = \int_{-1}^{1} \cos(\alpha x)dx = \left(\frac{\sin(\alpha x)}{\alpha}\right)_{-1}^{1}$

$\Rightarrow \quad 2\left(\frac{2}{\pi}\right) = \frac{2\sin\alpha}{\alpha} \Rightarrow \frac{\sin\alpha}{\alpha} = \frac{2}{\pi} \Rightarrow \alpha = \frac{\pi}{2}$

18. Let $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = 2\hat{i} + 4\hat{j} - 5\hat{k}$ and $\vec{c} = x\hat{i} + 2\hat{j} + 3\hat{k}$, $x \in R$.

If $\vec{d}$ is the unit vector in the direction of $\vec{b} + \vec{c}$ such that $\vec{a} \cdot \vec{d} = 1$ Then $(\vec{a} \times \vec{b}) \cdot \vec{c}$ is equal to.

(1) 3 (2) 6 (3) 11 (4) 9

Reso. **(3)**

NTA. **(3)**

Sol. $\vec{d} = \lambda\left((2+x)\hat{i} + 6\hat{j} - 2\hat{k}\right)$

$\vec{a}.\vec{d} = 1 \Rightarrow \lambda\,(x + 6) = 1$ ____ (1)

and $|\vec{d}| = 1 \Rightarrow \lambda^2\,((x + 2)^2 + 36 + 4) = 1$ ____(2)

(1) and (2) : $x = 1$

$\vec{c} = \hat{i} + 2\hat{j} + 3\hat{k}$

$\vec{a} \times \vec{b} = -9\hat{i} + 7\hat{j} + 2\hat{k}$

$(\vec{a} \times \vec{b}).\vec{c} = -9 + 14 + 6 = 11$

19. Let a relation R on N × N be defined as : (x_1, y_1) R $(x_2.y_2)$ if and only if $x_1 \le x_2$ or $y_1 \le y_2$ Consider the two statements :

(I) R is reflexive but not symmetric

(II) R is transitive

Then which one of the following is true

(1) Both (I) and (II) are correct

(2) Only (I) is correct

(3) Only (II) is correct

(4) Neither (I) nor (II) is correct

Reso. **(2)**

NTA. **(2)**

Sol. Reflexive : (x_1, y_1) R $(x_1, y_1) \Rightarrow x_1 \le x_1$ or $y_1 \le y_1$ True

Symmetric : (x_1, y_1) R $(x_2, y_2) \Rightarrow x_1 \le x_2$ or $y_1 \le y_2$

But $x_2 \le x_1$ or $y_2 \le y_1$ not always true

$\therefore$ not symmetric

Transitive : (3, 5) R (4, 4) and (4, 4) R (2, 4)

But (3, 5) not related to (2, 4)

$\therefore$ not transitive

20. If the function

$$f(x)\begin{cases} \dfrac{72^{x}-9^{x}-8^{x}+1}{\sqrt{2}-\sqrt{1+\cos x}}, & x \neq 0 \\ a\log_e 2\log_e 3, & x = 0 \end{cases}$$

Is continuous at $x = 0$, then the value of a^2 equal to

(1) 1152 (2) 746 (3) 968 (4) 1250

Reso. **(1)**

NTA. **(1)**

Sol. Continuous at x = 0

$$\therefore f(0) = \lim_{x\to 0} f(x) = \lim_{x\to 0} \frac{72^x - 9^x - 8^x + 1}{\sqrt{2} - \sqrt{1+\cos x}}$$

$$f(0) = \lim_{x\to 0} \frac{(9^x - 1)(8^x - 1)}{\sqrt{2} - \sqrt{2}\cos\left(\frac{x}{2}\right)}$$

$$f(0) = \lim_{x\to 0} \frac{\left(\frac{9^x - 1}{x}\right)\left(\frac{8^x - 1}{x}\right)x^2}{\sqrt{2}\left(\frac{1-\cos\left(\frac{x}{2}\right)}{\left(\frac{x}{2}\right)^2}\right).\frac{x^2}{4}} \quad \Rightarrow \quad a\ell n2\ell n3 = \frac{\ell n9.\ell n8}{\sqrt{2}.\frac{1}{2}.\frac{1}{4}} \Rightarrow a = 24\sqrt{2}$$

$\Rightarrow$ $a^2 = 1152$

21. There are 4 men and 5 women in Group A, and 5 men and 4 women in Group B, If If 4 persons are selected from each group, then the number of way of selecting 4 men and 4 women is _____.

Reso. **(5626)**

NTA **(5626)**

Sol. A(4M) B (4W) $\rightarrow {}^4C_4\ {}^4C_4 = 1$

A(3M1W) B(1M, 3W) $\rightarrow ({}^4C_3.{}^5C_1)\ ({}^5C_1.{}^4C_3) = 400$

A(2M, 2W) B(2M, 2W) $\rightarrow ({}^4C_2.{}^5C_2)\ ({}^5C_2.{}^4C_2) = 3600$

A(1M, 3W) B(3M, 1W) $\rightarrow ({}^4C_1.{}^5C_3)\ ({}^5C_3.{}^4C_1) = 1600$

A(4W) B(4M) $\rightarrow {}^5C_4\ {}^5C_4 = 25$

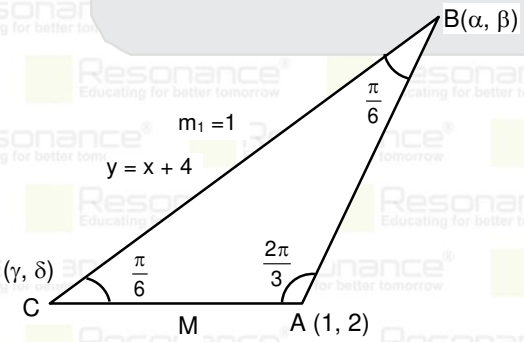
Total Number of ways = 5626

22. Consider a triangle ABC having the vertices A(1,2), B(α,β) and C(γ, δ) and angle $\angle ABC = \frac{\pi}{6}$ and $\angle BAC = \frac{2\pi}{3}$, If the point B and C lie on the line y = x + 4 then $\alpha^2+\gamma^2$ is equal to

Reso. **(14)**

NTA **(14)**

Sol.



Equation of line passing through P(1, 2) and making angle $\frac{\pi}{6}$ with y = x + 4 ____(1)

$y - 2 = m(x - 1)$ | $\tan\frac{\pi}{6} = \left|\frac{m - m_1}{1 + m m_1}\right| \pm \frac{1}{\sqrt{3}} = \frac{m-1}{1+m}$

$y - 2 = \left(2 \pm \sqrt{3}\right)(x-1)$ ___ (2) | $m = 2 \pm \sqrt{3}$

Solve (1) & (2)

$x + 4 - 2 = \left(2 \pm \sqrt{3}\right)(x-1)$

$x = \frac{4+\sqrt{3}}{1+\sqrt{3}} = \alpha$ and $x = \frac{4-\sqrt{3}}{1-\sqrt{3}} = \gamma$

$\therefore\ \alpha^2 + \gamma^2 = 14$

23. Let y = y(x) be the solution of the differential equation $(x + y + 2)^2\,dx = dy$, $y(0) = -2$. Let the maximum and minimum value of the function $y = y(x)$ in $\left[0, \frac{\pi}{3}\right]$ be α and β, respectively. If $(3\alpha + \pi)^2 + \beta^2 = \gamma + \delta\sqrt{3}, \gamma, \delta \in Z$, then $\gamma + \delta$ equals

Reso. **(31)**

NTA **(31)**

Sol. $\frac{dy}{dx} = (x + y + 2)^2$ (Let $x + y + 2 = 6 \Rightarrow 1 + \frac{dy}{dx} = \frac{dt}{dx}$)

$\frac{dt}{dx} - 1 = t^2 \Rightarrow \int \frac{dt}{1+t^2} = \int dx$

$\tan^{-1} = x + c \Rightarrow x + y + 2 = \tan(x + c)$

$\because\ y(0) = -2\ \therefore\ c = 0$

$y = \tan x - x - 2, \quad x \in \left[0, \frac{\pi}{3}\right]$

$\beta = \tan\theta - 0 - 2 = -2$

$\alpha = \sqrt{3} - \frac{\pi}{3} - 2 \Rightarrow 3\alpha + \pi = 3\sqrt{3} - 6$

$(3\alpha + \pi)^2 + \beta^2 = 67 - 36\sqrt{3}\ \therefore\ \gamma = 67, \delta = -36$ and $\gamma + \delta = 31$

24. If $\int \operatorname{cosec}^5 x\,dx = \alpha \cot x \operatorname{cosec} x\left(\operatorname{coesc}^2 x + \frac{3}{2}\right) + \beta \log_e\left|\tan\frac{x}{2}\right| + c$ Where $\alpha, \beta, \in R$ and C is the constant of integration, then the value of $8(\alpha+\beta)$ equals_____

Reso. **(1)**

NTA **(1)**

Sol. $I_n = \int \operatorname{cosec}^n x\,dx$

Reduction formula $I_n = -\frac{\operatorname{cosec}^{n-2} x \cot x}{n-1} + \frac{n-2}{n-1} I_{n-2}$

$I_5 = \frac{\operatorname{cosec}^3 x \cot x}{4} + \frac{3}{4}\left(\frac{-\operatorname{cosec} x \cot x}{2} + \frac{1}{2}\int \operatorname{cosec} x\right) + c$

$I_5 = -\frac{1}{4}\operatorname{cosec} x \cot x\left(\operatorname{cosec}^2 x + \frac{3}{2}\right) + \frac{3}{8}\ell n\left|\tan\frac{x}{2}\right| + C$

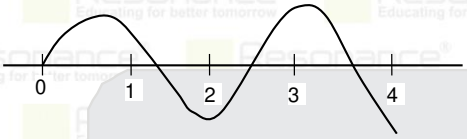
$\alpha = -\frac{1}{4}, \beta = \frac{3}{8}$ and $8(\alpha + \beta) = 1$

25. Let $f:R\to R$ be a thrice differentiable function such that $f(0)=0, f(1)=1, f(2)=-1, f(3)=2$ and $f(4)=-2$, Then, the minimum number of zeros of $(3f'f''+ff''')(x)$ is_____

Reso. **(5)**

NTA **(5)**

Sol.



min. roots of f(x) = 0 are 4

min. roots of f '(x) = 0 are 3

min. roots of f(x). f'(x) = 0 are 7

min. roots of (f(x). f'(x))' = 0 are 6

min. roots of (f(x). f'(x))" = 0 are 5

(f(x) f '(x))" = ((ff ')')' = ((f')^2 + ff ")'

= 2f'f " + f' f " + ff "'

= 3f'f " + f' f '"

26. Let A be a 2 × 2 symmetric such that $A\begin{bmatrix}1\\1\end{bmatrix}=\begin{bmatrix}3\\7\end{bmatrix}$ and the determinant of A be 1, If $A^{-1}=\alpha A+\beta I$, where I is an identity matrix of order 2 × 2, then $\alpha+\beta$ equals _____

Reso. **(5)**

NTA **(5)**

Sol. $A\begin{bmatrix}1\\1\end{bmatrix}=\begin{bmatrix}3\\7\end{bmatrix}\Rightarrow\begin{bmatrix}a&c\\c&b\end{bmatrix}\begin{bmatrix}1\\1\end{bmatrix}=\begin{bmatrix}3\\7\end{bmatrix}$

$a+c=3$, $b+c=7$ .....(1)

also $|A|=1\Rightarrow ab-c^2=1$ .....(2)

(1) and (2) $a=1, b=5, c=2$

$A=\begin{bmatrix}1&2\\2&5\end{bmatrix}$

also $\alpha A^2+\beta A-I=0$

$\therefore\quad -\frac{\beta}{\alpha}=6$ and $-\frac{1}{\alpha}=1\Rightarrow\alpha=-1, \beta=6$

$\alpha+\beta=5$

27. Consider the function $f:R\to R$ defined by $f(x)=\frac{2x}{\sqrt{1+9x^2}}$. If the composition of $f.\frac{(f\circ f\circ f\circ....\circ f)(x)}{10\,times}=\frac{2^{10}x}{\sqrt{1+9ax^2}}$, then the value of $\sqrt{3a+1}$ is equal to _____

Reso. **(1024)**

NTA **(1024)**

Sol. $f(x) = \dfrac{2x}{\sqrt{1+9x^2}}$

$fof(x) = \dfrac{2f(x)}{\sqrt{1+9(f(x)^2}} = \dfrac{2(2x)}{\sqrt{1+45x^2}} = \dfrac{2^2k}{\sqrt{1+9(5)x^2}}$

$fofof(x) = \dfrac{2^3x}{\sqrt{1+9(21)x^2}}$

$fofofo\ldots\ldots f_{ntimes} = \dfrac{2^nx}{\sqrt{1+9\left(\dfrac{4^n-1}{3}\right)x^2}}$ (General term of sequence 1, 5, 21..... is $t_n = \dfrac{4^n-1}{3}$)

$\therefore\ \alpha = \dfrac{4^n-1}{3} \Rightarrow 3\alpha + 1 = 4^n$

for $n = 10 \rightarrow 3\alpha + 1 = 4^{10} \Rightarrow \sqrt{3\alpha+1} = 2^{10} = 1024$

28. Consider a line L passing through the points P(1,2,1) and Q(2,1,-1). If the mirror image of the point A(2,2,2) in the line L is (α,β,γ), then $\alpha + \beta + 6\gamma$ is

Reso. **(6)**

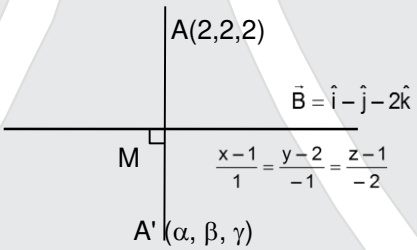
NTA **(6)**

Sol. $M(\lambda+1,-\lambda+2,-2\lambda+1)$

$\overrightarrow{PM}.\vec{B} = 0$

$1(\lambda-1)-1(-\lambda)-2(-2\lambda-1) = 0$

$\lambda = -\dfrac{1}{6}$



$M\left(\dfrac{5}{6},\dfrac{13}{6},\dfrac{4}{3}\right), \left(\dfrac{\alpha+2}{2},\dfrac{\beta+2}{2},\dfrac{\gamma+2}{2}\right)$

$\alpha = -\dfrac{1}{3}, \beta = \dfrac{7}{3}, \gamma = \dfrac{2}{3} \Rightarrow \alpha + \beta + 6\gamma = 6$

29. In a tournament, a team plays 10 matches with probabilities of winning and losing each match $\frac{1}{3}$ and $\frac{2}{3}$ respectively. Let x be the number of matches that the team wins, and y be the number of matches that team loses, If the probability $P(|x-y| \le 2)$ is p, then 3^9p equals _____.

Reso. **(8288)**

NTA **(8288)**

Sol. $|x-y| \le 2$ and $0 \le x \le 10$, $0 \le y \le 10$

P = P(x = 4, y = 6) + P(x = 5, y = 5) + P(x = 6, y = 4)

$P = \left(\dfrac{1}{3}\right)^4\left(\dfrac{2}{3}\right)^6.\dfrac{10!}{4!6!} + \left(\dfrac{1}{3}\right)^5\left(\dfrac{2}{3}\right)^5\dfrac{10!}{5!5!} + \left(\dfrac{1}{3}\right)^6\left(\dfrac{2}{3}\right)^4\dfrac{10!}{6!4!}$

$P = \dfrac{2^5}{3^{10}}(420+3(84)+105)$

$3^9P = 8288$

30. Let $S=\left\{\sin^2 2\theta:\left(\sin^4\theta+\cos^4\theta\right)x^2+\left(\sin 2\theta\right)x+\left(\sin^6\theta+\cos^6\theta\right)=0 has real root\right\}$ If α and β the smallest and largest elements of the set S, respectively, then $3((\alpha-2)^2+(\beta-1)^2)$ equals_____

Reso. **(4)**

NTA **(4)**

Sol. $D \geq 0 \Rightarrow \sin^2 2\theta - 4(\sin^4\theta + \cos^4\theta)(\sin^6\theta + \cos^6\theta) \geq 0$

$\Rightarrow t - 4\left(1-\frac{t}{2}\right)\left(1-\frac{3t}{4}\right) \geq 0$ (Let $\sin^2 2\theta = t$)

$\Rightarrow 3t^2 - 12t + 8 \leq 0$

$\Rightarrow t \in \left[2-\frac{2}{\sqrt{3}}, 2+\frac{2}{\sqrt{3}}\right]$ .....(1)

But $t = \sin^2 2\theta \in [0,1]$ .....(2)

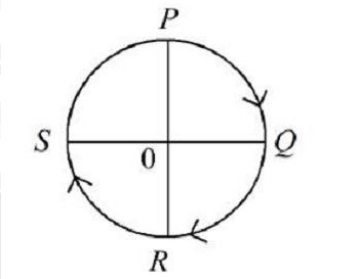
(1) $\cap$ (2) $t \in \left[2-\frac{2}{\sqrt{3}}, 1\right]$

$\alpha = 2-\frac{2}{\sqrt{3}}$, $\beta = 1$

$3((\alpha-2)^2 + (\beta-1)^2) = 4$

PART : PHYSICS

31. A cyclist starts from the point P of a circular ground of radius 2km and travels along its circumference to the point S. The displacement of a cyclist is :



(1) 8 km (2) 4 km (3) 6 km (4) $\sqrt{8}$ km

Ans. **(4)**

Sol. PS = $\sqrt{r^2+r^2}$

$\sqrt{(2)^2+(2)^2}$ $\sqrt{8}$

32. Given below are two statements :
Statement I The contact mangle between a solid and a liquid is a property of the material of the solid and liquid as well.
Statement II : the rise of a liquid in a capillary tube does not depend on the inner radius of the tube.
In the light of the above statements choose the correct answer from the options given below
(1) Both Statement I and Statement II are true.
(2) Statement I is false but Statement II is true
(3) Statement I is true but Statement II is false.
(4) Both Statement I and Statement II are false.

Ans. **(3)**

Sol. (1) informative

(2) $h = \frac{2s\cos\theta}{\rho g r}$

33. A sample of gas at temperature T is adiabatically expanded to double is volume, Adiabatic constant for the gas is $\gamma = 3/2$. The work done by the gas in the process is ($\mu = 1$ mole)

(1) RT $[2-\sqrt{2}]$ (2) RT $[\sqrt{2}-2]$ (3) RT [1 – 2 $\sqrt{2}$] (4) RT [2 $\sqrt{2}$ – 1]

Ans. **(1)**

Sol. $w = \frac{nR(T_1-T_2)}{\gamma-1}$

$= 2k\,(T-T_2)$

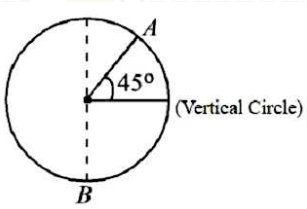
$= 2Rt\,(1-\frac{1}{\sqrt{2}})$

$= \frac{2RT}{\sqrt{2}}\,(\sqrt{2}-1)$

$= \sqrt{2}$ RT $(\sqrt{2}-1)$

$= RT\,(2-\sqrt{2})$

34. A body of m kg slides form rest along the curve of vertical circle from point A to B in friction less path. The velocity of the body at B is



(given , R = 14 m, g = 10 m/s^2 and $\sqrt{2}$ = 1.4)

(1) 16.7 m/s (2) 21.9 m/s (3) 10.6 m/s (4) 19.8 m/s

Ans. **(2)**

Sol. $v = \sqrt{2gh}$

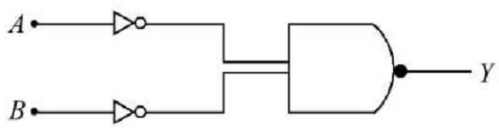
$h = r + \left(\frac{r}{\sqrt{2}}\right) = r\left(1+\frac{1}{\sqrt{2}}\right) = 14\left(1+\frac{1}{1.4}\right)$

$= \frac{14}{1.4}(2.4) = 24$

$v = \sqrt{2\times10\times24}$

$\sqrt{480} = 21.9$

35. Identify the logic gate given in the circuit.



(1) NOR gate (2) AND gate (3) NAND gate (4) OR gate

Ans. **(4)**

Sol. $\overline{\overline{A}\times\overline{B}} = A + B = OR$

36. Applying the principle of homogeneity of dimensions. determine which one is correct, where T is time period , G is gravitational constant. M is mass, r is radius of orbit

(1) $T^2 = \frac{4\pi^2r^3}{GM}$ (2) $T^2 = 4\pi^2r^3$ (3) $T^2 = \frac{4\pi^2r^3}{GM}$ (4) $T^2 = \frac{4\pi^2r^3}{GM^2}$

Ans. **(1)**

Sol. $T = \frac{2\pi r^{312}}{\sqrt{Gm}}$

$T^2 = \frac{4\pi^2\times r^3}{Gm}$

37. The magnetic moment of a bar magnet is 0.5 Am^2 . It is suspended in a uniform magnetic field of 8 × 10^{-2} T. The work done in rotating it from its most stable to most unstable position is :

(1) Zero (2) 4 × 10^{-2} J (3) 16 × 10^{-2}J (4) 8 × 10^{-2}J

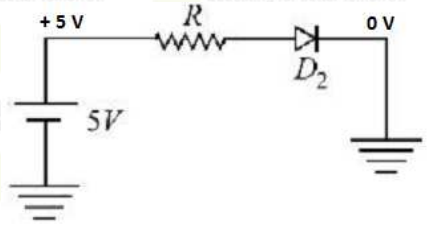
Ans. **(4)**

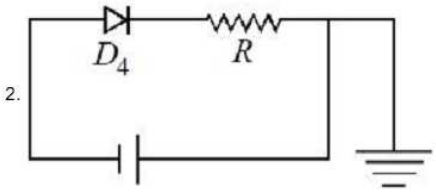
Sol. W = 2 MB

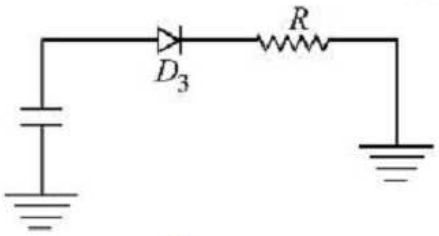
= 2 × 0.5 × 8 × 10^{-2}

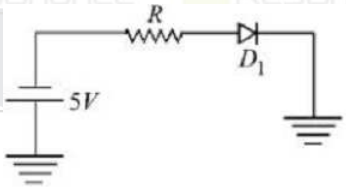
= 8 × 10^{-2}J

38. Which of the diode circuit shows correct biasing used for the measurement of dynamic resistance of p-n junction diode :

(1) 

(2) 

(3) 

(4) 

Ans. **(1)**

Sol. $D_2 \Rightarrow$ Forward

$D_1, D_3, D_4 \Rightarrow$ Revered

39. The width of one of the two slits in a Young's double slit experiment is 4 times that of the other slit. the ratio of the maximum of the minimum intensity in the interference pattern is :

(1) 9 : 1 (2) 4 : 1 (3) 16 : 1 (4) 1 : 1

Ans. **(1)**

Sol. $I_1 = I_0 = I_{min}$

$I_2 = 4I_0$

$$I_{max} = \left[\sqrt{I_0} + \sqrt{4I_0}\right]^2$$

$I_{max} = 9I_0$

$$\frac{I_{max}}{I_{max}} = \frac{9I_0}{I_0} = \frac{9}{1}$$

40. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Number of photons increases with increase in frequency of light.

Reason R : Maximum kinetic energy or emitted electrons increases with the frequency of incident radiation.

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) A is correct but R is not correct

(2) A is not correct but R is correct

(2) Both A and R are correct and R is NOT the correct explanation of A

(4) Both A and R are correct R is the correct explanation of A.

Ans. **(2)**

Sol. $I \propto N \times \upsilon$

$A \Rightarrow$ wrong

$R \Rightarrow KE_{max} = h\upsilon - \phi$

41. Arrange the following in the ascending order of wavelength

(A) Gamma rays (λ_1) (B) x -rays (λ_2)

(C) Infrared waves (λ_3) (D) Microwaves (λ_4)

Choose the most appropriate answer from the options given below

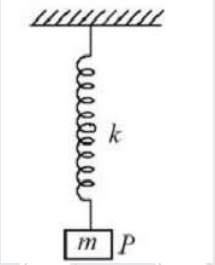
(1) $\lambda_1 < \lambda_2 < \lambda_3 < \lambda_4$ (2) $\lambda_2 < \lambda_1 < \lambda_4 < \lambda_3$

(3) $\lambda_4 < \lambda_3 < \lambda_1 < \lambda_2$ (4) $\lambda_4 < \lambda_3 < \lambda_2 < \lambda_1$

Ans. **(1)**

Sol. Gamma ray > UV ray > Infrared ray > micro wave

42. In simple harmonic motion, the total mechanical energy of given system is E. If mass of oscillating particle P is doubled then the new energy of the system for same amplitude is :



(1)2E (2) E (3) $\frac{E}{\sqrt{2}}$ (4) E $\sqrt{2}$

Ans. **(2)**

Sol. $E = \frac{1}{2}KA^2$

K and A constant

E = constant

43. A 90 kg body placed at 2R distance from surface of earth experiences gravitational pull of :

(R = Radius of earth, g = 10 m s^{-2})

(1) 225 N (2) 100 N (3) 300 N (4) 120 N

Ans. **(2)**

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

h = 2R

$g' = \frac{g}{9}$

F = mg'

$= 90 \times \frac{10}{9} = 100$ N

44. The translational degrees of freedom (f_t) and rotational degrees of freedom (f_r) of CH_4 molecule are :

(1) $f_t = 2$ and $f_r = 2$ (2) $f_t = 2$ and $f_r = 3$ (3) $f_t = 3$ and $f_r = 3$ (4) $f_t = 3$ and $f_r = 2$

Ans. **(3)**

Sol. CH_4 translational degrees of freedom (f_t) = 3

CH_4 rotational degrees of freedom (f_r) = 3

45. An electric bulb rated 50 W- 200 V is connected across a 100 V supply. The power dissipation of the bulb is :

(1) 25 W (2) 50 W (3) 12.5 W (4) 100 W

Ans. **(3)**

Sol. $R = \frac{V_r^2}{P_r} = \frac{200 \times 200}{50} = 800\ \Omega$

$P = \frac{V^2}{R} = \frac{100 \times 100}{800} = 12.5\ W$

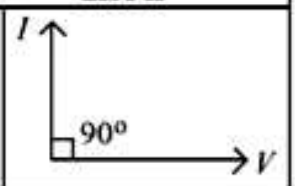
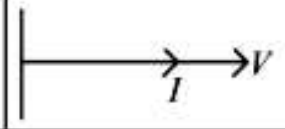
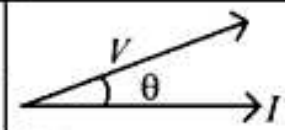
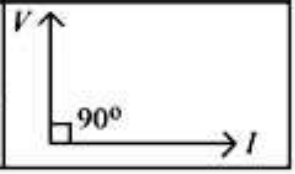
46. According to Bohr's theory, the moment of momentum of an electron revolving in 4^{th} orbit of hydrogen atom is :

(1) $2\frac{h}{\pi}$ (2) $\frac{h}{2\pi}$ (3) $\frac{h}{\pi}$ (4) $8\frac{h}{\pi}$

Ans. **(1)**

Sol. $\frac{nh}{2\pi} = \frac{4h}{2\pi} = \frac{2h}{\pi}$

47. Match List-I with List-II

LIST I		LIST II	
A.	Purely capacitive circuit	I.	
B.	Purely inductive circuit	II.	
C.	LCR series at resonance	III.	
D.	LCR series circuit	IV.	

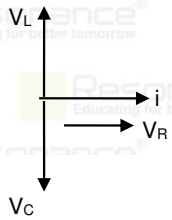
Choose the correct answer from the opotions given below :

(1) A-I. B-IV, C-II, D-III (2) A-IV. B-I, C-III, D-II

(3) A-I. B-IV, C-III, D-II (4) A-IV. B-I, C-II, D-III

Ans. **(1)**

Sol.



48. A charge q is placed at the centre of one of the surface of a cube. The flux linked with the cube is :

(1) $\frac{q}{4\epsilon_0}$ (2) zero (3) $\frac{q}{2\epsilon_0}$ (4) $\frac{q}{8\epsilon_0}$

Ans. **(3)**

Sol. $\Sigma q_{in} = \frac{q}{2}$

$f = \frac{\Sigma q_{in}}{\epsilon_0} = \frac{q}{2\epsilon_0}$

49. Correct formula for height of a satellite from earths surface is :

(1) $\left(\frac{T^2R^2g}{4\pi^2}\right)^{1/3} - R$ (2) $\left(\frac{T^2R^2}{4\pi^2 g}\right)^{1/3} - R$ (3) $\left(\frac{T^2R^2g}{4\pi^2}\right)^{-1/3} + R$ (4) $\left(\frac{T^2R^2g}{4\pi}\right)^{1/2} - R$

Ans. **(1)**

Sol. $T^2 = \frac{4\pi^2 r^3}{Gm}$

$GM = gR^2$

$R + h = \left(\frac{T^2 \times gR^2}{4\pi^2}\right)^{\frac{1}{3}}$

50. A 2 kg brick begins to slide over a surface which is inclined at an angle of 45º with respect to horizontal axis. The co-efficient of static friction between their surfaces is :

(1) 1 (2) $\frac{1}{\sqrt{3}}$ (3) 0.5 (4) 1.7

Ans. **(1)**

Sol. $\alpha = 45°$

$\tan\alpha = \mu$

$\mu = 1$

51. A parallel plate capacitor of capacitance 12.5 pF is charged by a battery connected between its plates to potential difference of 12.0 V. The battery is now disconnected and a dielectric slab ($\epsilon_r = 6$) is inserted between the plates. the change in its potential energy after inserting the dielectric slab is _____ $\times 10^{-12}$ J.

Ans. **750**

Sol. $V_1 = \frac{1}{2} CV^2$

$V_2 = \frac{q^2}{2C \times 6}$

$= \frac{C^2V^2}{2C \times 6} = \frac{1}{12} CV^2$

$AU = CV^2 \left(\frac{1}{12} - \frac{1}{2}\right)$

$= CV^2 \times \frac{-5}{12}$

$= -\frac{5}{12} \times 12.5 \times 10^{-12} \times 12$

750×10^{-12}

52. The disintegration energy Q for the nuclear fission of $^{235}U \rightarrow {}^{140}Ce + {}^{94}Zr + n$ is _____ MeV.
Given atomic masses of ^{235}U : 235.0439u: ^{140}Ce : 139.9054 u,
^{94}Zr : 93.9063u ; n : 1.0086u,
Value of c^2 = 931 MeV/u.

Ans. **208**

Sol. $\Delta m = M_U - (M_{Ce} + M_{Zr} + M_n)$
$\Delta m = 0.2236$
Q = 208 .1716 MeV

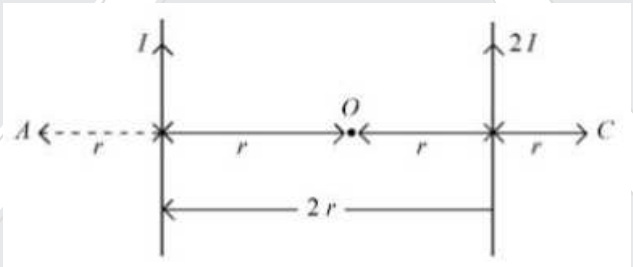
53. Mercury is filled in a tube of radius 2 cm up to a height of 30 cm. the force exerted by mercury on the bottom of the tube is _____ N.

(Given, atmospheric pressure = 10^5 Nm^{-2}, density of mercury = 1.36×10^4 kg m^{-3}, g = 10 ms^{-2}, $\pi = \frac{22}{7}$)

Ans. **177**

Sol. $F = (P_0 + \rho gh) \times A$
$A = \pi r^2$
$F = 10^5 + 1.36 \times 10^4 \times 10 \times 3 \times 10^{-1}$
$= 10^5 (1 + 0.408) \times \frac{22}{7} \times 4 \times 10^{-4}$
$F = 10^5 \times 1.408 \times \frac{22}{7} \times 4 \times 10^{-4}$
$= \frac{10 \times 1.408 \times 22 \times 4}{7} = 177.005$
= 177 Ans.

54. Two parallel long current carrying wire separated by a distance 2r are shown in the figure. The ratio of magnetic field at A to the magnetic field produced at C is $\frac{x}{7}$. The value of x is _____.



Ans. **5**

Sol. $B_A = \frac{\mu_0 i}{\pi r}\left[\frac{1}{1} + \frac{2}{3}\right]$

$B_{CZ} = \frac{\mu_0 i}{\pi r}\left[\frac{2}{1} + \frac{1}{3}\right]$

$\frac{B_A}{B_C} = \frac{1 + \frac{2}{3}}{2 + \frac{1}{3}} = \frac{5}{7} = \frac{x}{7}$

x = 5 Ans.

55. A light ray is incident on a glass slab of thickness $4\sqrt{3}$ cm and refractive index $\sqrt{2}$. The angle of incidence is equal to the critical angle for the glass slab with air. The lateral displacement of ray after passing through glass slab is _____ cm.
(Given $\sin 15^\circ = 0.25$)

Ans. **2**

Sol. $t = 4\sqrt{3}$ cm

$\mu = \sqrt{2}$

$i = C = 45^\circ$

$\Delta x = ?$

$1 \times \sin 45^\circ = \sqrt{2} \sin r$

$r = 30^\circ$

$$\Delta x = \frac{t\sin(i-r)}{\cos r}$$

$$4\sqrt{3}\ \frac{\sin(45-30)\times 2}{\sqrt{3}}$$

$$= 8 \times \frac{1}{4} = 2 \text{ Ans}$$

56. The displacement of a particle executing SHM is given by $x = 10 \sin\left(\omega t + \frac{\pi}{3}\right)$m. The time period of motion is 3.14 s. The velocity of the particle at t = 0 is _____ m/s.

Ans. **10**

Sol. $V = ?$

$T = 3.14$, $A = 10$ $w = \frac{2\pi}{\pi} = 2$

$$\mathbf{x = 10\times}\left(\frac{2\pi}{3.14}\times 0 + \frac{\pi}{3}\right)$$

$$= 10 \times \frac{\sqrt{3}}{2}$$

$$V = \omega\sqrt{A^2 - \pi^2}$$

$$= 2\sqrt{10^2 - 10^2 \times \frac{3}{4}}$$

$$= 2 \times \sqrt{100-75}$$

$2 \times 5 = 10$

57. In a system two particles of masses $m_1 = 3$ kg and $m_2 = 2$ kg are placed at certain distance from each other. The particle of mass m_1 is moved towards the center of mass of the system through a distance 2 cm. In order to keep the center of mass of the system at the original position, the particle of mass m_2 should move towards the center of mas by the distance _____ cm.

Ans. **3**

Sol. $m_1x_1 = m_2x_2$

$3\times 2 = 2 \times x_2$

$x_2 = 3$

58. A bus moving along a straight highway with speed of 72 km/h is brought to halt within 4s after applying the brakes. The distance travelled by the bus during this time (Assume the retardation is uniform) is _____ m.

Ans. **40**

Sol. $c = 0$

$t = 4$

$x = ?$

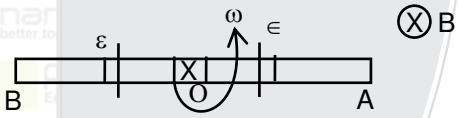
$x = \frac{4+v}{2}\ t$

$= \frac{20+0}{2} \times 4 = 40$ Ans

59. A rod of length 60 cm rotates with a uniform angular velocity 20 rad s^{-1} about its perpendicular bisector, in a uniform magnetic field 0.5 T. The direction of magnetic field is parallel to the axis of rotation. The potential difference between the two ends of the rod is _____ V.

Ans. **0**

Sol.



$V_0 - V_A = \in = \frac{1}{2}B\omega\ell^2$

$V_0 - V_B = \in$

$V_A - V_B = 0$

60. Two wires A and B are made up of the same material and have the same mass. Wire A has radius of 2.0 mm and wire B has radius of 4.0 mm. The resistance of wire B is 2Ω. The resistance of wire A is _____ Ω.

Ans. **8**

Sol. $R = \rho\frac{\ell}{A} = \Rightarrow R \propto \frac{\ell}{A}$

$R \propto \frac{1}{A^2}$; $R \propto \frac{1}{r^4}$

$\frac{R_1}{R}\left(\frac{r_2}{r_1}\right)^4$; $\frac{R_A}{R_B} = \frac{(4)^4}{(2)^4}$

$RA = 32$

PART : CHEMISTRY

61. When MnO_2 and H_2SO_4 is added to a salt (A), the greenish yellow gas liberated as salt (A) is :

(1) NH_4Cl (2) NaBr (3) CaI_2 (4) KNO_3

Ans. **NTA (1)**

Sol. $Cl^- + MnO_2 + H^+ \longrightarrow Cl_2(g)$

Greenish yellow

So salt is NH_4Cl.

62. $CH_3–CH_2–CH_2–Br + NaOH \xrightarrow{C_2H_5OH}$ Product 'A'

Product (A) $\xrightarrow[H^+]{H_2O}$ Product "B"

Product (A) $\xrightarrow[H_2O/O_2H_2/\bar{O}H]{\text{Diborane}}$ Product "C"

Consider the above reactions, identify product B and product C.

(1) B = C = 1-Propanol (2) B = C = 2-Propanol

(3) B = 2-Propanol C = 1-Propanol (4) B = 1-Propanol C = 2-Propanol

Ans. **NTA (3)**

Sol.

$$CH_3–\underset{\underset{Br}{|}}{CH}–CH_2 \xrightarrow[C_2H_5OH]{NaOH} CH_3–CH=CH_2 \xrightarrow[H_2O_2/OH^-]{B_2H_6} CH_3–CH_2–\underset{\underset{OH}{|}}{CH_2}$$

(A)

$$CH_3–CH=CH_2 \xrightarrow[H_2O]{\overset{\oplus}{H}} CH_3–\underset{\underset{OH}{|}}{CH}–CH_3$$

63. Fuel cell, using hydrogen and oxygen as fuels.

A. has been used in spaceship

B. has as efficiency of 40% to produce electricity

C. uses aluminum as catalyst

D. is eco-friendly

E. is actually a type of Galvanic cell only

(1) A, D, E only (2) A, B, D only (3) A, B, D, E only (4) A, B, C only

Ans. **NTA (1)**

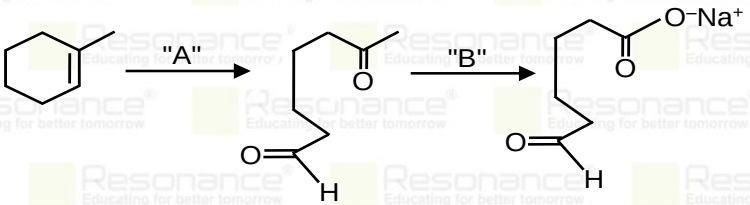
Sol. Fuel cell

(i) used in spaceship

(ii) eco friendly

(iii) is a type of Galvanic cell

64.



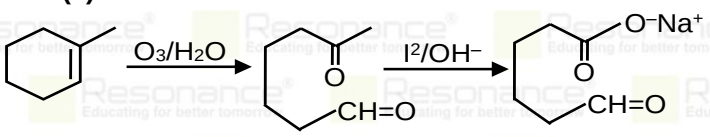
In the above chemical reaction sequence "A" and "B" respectively are

(1) H_2O, H^+ and $KMnO_4$ (2) H_2O, H^+ and $NaOH_{(alc)}/I_2$

(3) O_3, Zn/H_2O and $NaOH_{(alc)}/I_2$ (4) O_3, Zn/H_2O and $KMnO_4$

Ans. **NTA (3)**

Sol.

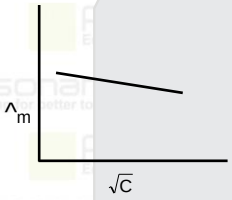


65. For a strong electrolyte, a plot of molar conductivity against (concentration)$^{1/2}$ is a straight line, with a negative slope, the correct unit for the slope is

(1) S cm^2 mol$^{-3/2}$ L (2) S cm^2 mol$^{-3/2}$ L$^{-1/2}$ (3) S cm^2 mol$^{-3/2}$ L$^{1/2}$ (4) S cm^2 mol^{-1} L$^{1/2}$

Ans. **NTA (3)**

Sol. graph λ_m vs $\sqrt{C}$ is



for strong electrolyte $\lambda_M^C = \lambda_M^0 - b\sqrt{C}$

slope = –b unit of b = S cm^2 mole$^{-3/2}$ L$^{1/2}$

66. Choose the **Incorrect** Statement about Dalton's Atomic Theory

(1) Matter consists of indivisible atoms.

(2) Compounds are formed when atoms of different elements combine in any ratio.

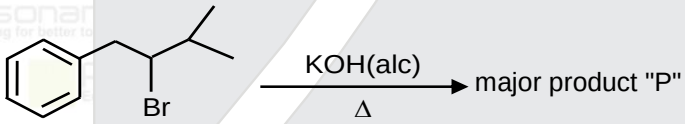
(3) All the atoms of a given element have identical properties including identical mass.

(4) Chemical reactions involve reorganization of atoms

Ans. **NTA (2)**

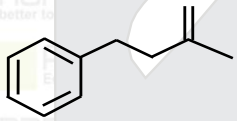
Sol. According to Dalton atomic theory compounds are only formed when atoms of different element combine in fixed ratio.

67.

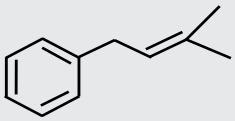


Product P is

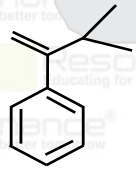
(1)



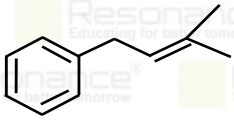
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(3)

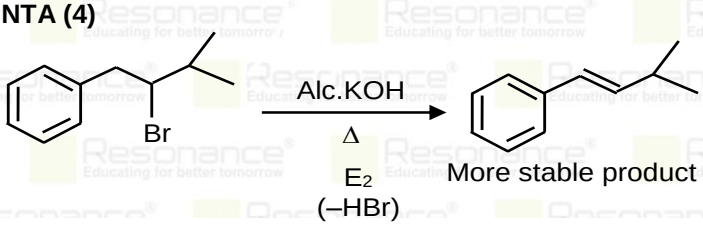


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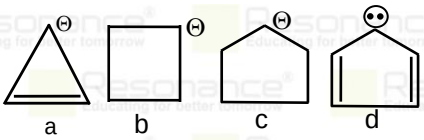


Ans. **NTA (4)**

Sol.



68. Correct order of stability of carbanion is -



(1) d > a > c > b (2) a > b > c > d (3) d > c > b > a (4) c > b > d > a

Ans. **NTA (3)**

Sol.



Being aromatic it is most stable among the given anions

Order $\rightarrow$ d > c > b > a

69. The number of species from the following that have pyramidal geometry around the central atoms is _____

$S_2O_3^{2-}$, SO_4^{2-}, SO_3^{2-}, $S_2O_7^{2-}$

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

Ans. **NTA (2)**

Sol.

	Species	Hybridisation	Geometry
(i)	$S_2O_3^{2-}$	sp^3	Tetrahedral
(ii)	SO_4^{2-}	sp^3	Tetrahedral
(iii)	SO_3^{2-}	sp^3	Pyramidal
(iv)	$S_2O_7^{2-}$	sp^3	Tetrahedral

70. If an iron (III) complex with the formula $[Fe(NH_3)_x(CN)_y]^-$ has no electron in its e_g orbital, then the value of x + y is :

(1) 4 (2) 5 (3) 3 (4) 6

Ans. **NTA (4)**

Sol. $2_6^{Fe^{3+}} = 3d^5 4s^0 \Rightarrow t_{2g}^{2,2,1}, e_g^{0,0}$

$\Rightarrow$ $[Fe(NH_3)_x(CN)_y]^-$

3 + 0 – y = 1

y = 2

So x = 4 & y = 2

complex is $\Rightarrow [Fe(NH_3)_4(CN)_2]^-$

So x + y = 6

correct option = (4)

71. The correct order of the first ionization enthalpy is

(1) Al > Ga > Tl (2) Tl > Ga > Al (3) Ga > Al > B (4) B > Al > Ga

Ans. **NTA (2)**

Sol.

13^{th} group element	B	Al	Ga	In	Tl
1^{st} IE (kJ/mole)	801	577	579	558	589

So correct order = B > Tl > Ga > Al > In

72. A first row transition metal in its +2 oxidation state has a spin-only magnetic moment value of 3.86 BM. The atomic number of the metal is

(1) 23 (2) 22 (3) 25 (4) 26

Ans. **NTA (1)**

Sol. As magnetic moment (spin only) = 3.86 BM
so unpaired electron = 3
Oxidation state = +2
so element is $\Rightarrow {}_{3}^{V}2$

${}_{3}^{V^{2+}}2 = 3d^3 4s^0$

73. Given below are two statements:
Statement I: The correct order of first ionization enthalpy values of Li, Na, F and Cl is Na Li < Cl < F.
Statement II: The correct order of negative electron gain enthalpy values of Li, Na. F and Cl is Na < Li < F < Cl.
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is true but Statement II is false (2) Both Statement I and Statement II are false
(3) Both Statement I and Statement II are true (4) Statement I is false but Statement II is true

Ans. **NTA (3)**

Sol. Correct order of 1st IE = Na < Li < Cl < F
Correct order of (negative) electron gain enthalpy $\Rightarrow$ Na < Li < F < Cl

74. The adsorbent used in adsorption chromatography is/are -
A. silica gel
B. alumina
C. quick lime
D. magnesia
Choose the most appropriate answer from the options given below:
(1) C and D only (2) B only (3) A and B only (4) A only

Ans. **NTA (3)**

Sol. SiO_2 (silica gel) & Al_2O_3 (Alumina) can be used in adsorption chromatography as a adsorbent.

75. The number of unpaired d-electrons in $[Co(H_2O)_6]^{3+}$ is _____ .
(1) 1 (2) 2 (3) 4 (4) 0

Ans. **NTA (4)**

Sol. $[CoCH_2O)_6]^{3+}$

$\downarrow$

$Co^{3+} = 3d^6 = t_{2g}^{2,2,2}, e_g^{0,0}$

so number of unpaired electrons are = 0

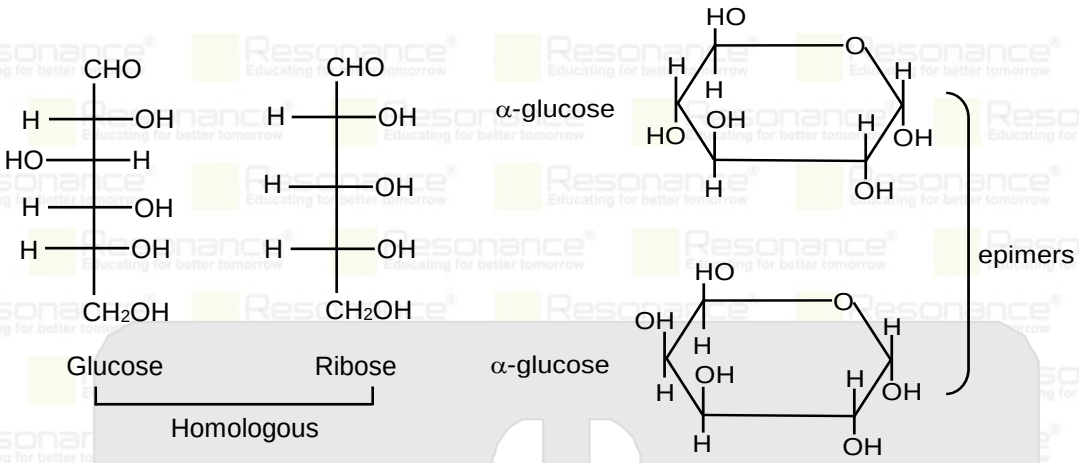
76. Match List I with List II

	List I		List II
A.	α-Glucose and α-Galactose	I.	Functional isomers
B.	α-Glucose and β-Glucose	II.	Homologous
C.	α-Glucose and α-Fructose	III.	Anomers
D	α-Glucose and α-Ribose	IV.	Epimers

Choose the correct answer from the options given below:
(1) A-III, B-IV, C-I, D-II (2) A-III, B-IV, C-II, D-I (3) A-IV, B-III, C-I, D-II (4) A-IV, B-III, C-II, D-I

Ans. **NTA (3)**

Sol.

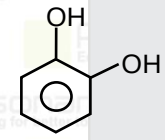


77. Common name of Benzene 1, 2-diol is - -

(1) resorcinol (2) quinol (3) catechol (4) o-cresol

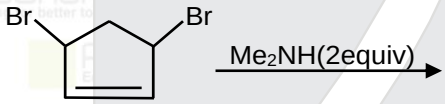
Ans. **NTA (3)**

Sol.

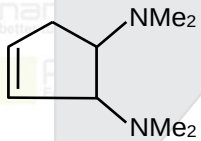


Catechol

78. Find out the major product formed from the following reaction. [Me: $-CH_3$]



(1)



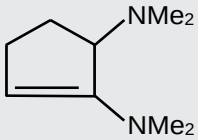
(2)



(3)

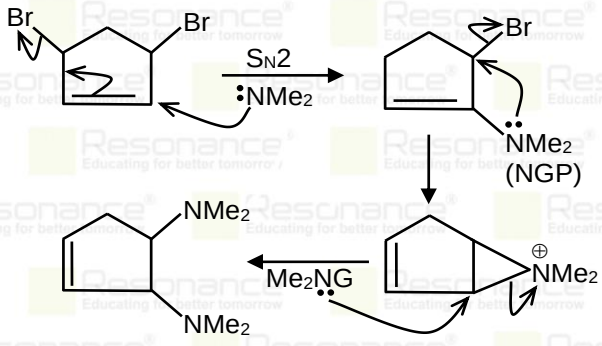


(4)



Ans. **NTA (1)**

Sol.



79. The correct statement/s about Hydrogen bonding is/are
A. Hydrogen bonding exists when H is covalently bonded to the highly electro negative atom.
B. Intermolecular H bonding is present in o-nitro phenol.
C. Intramolecular H bonding is present in HF.
D. The magnitude of H bonding depends on the physical state of the compound.
E. H-bonding has powerful effect on the structure and properties of compounds.
Choose the correct answer from the options given below:
(1) A, D, E only (2) A only (3) A, B, C only (4) A, B, D only

Ans. **NTA (1)**

Sol. (i) In o-nitrophenol intramolecular H-bonding is present.
(ii) In HF intermolecular H-bonding is present.

80. The equilibrium constant for the reaction

$SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$

is $K = 4.9 \times 10^{-2}$. The value of Ke for the reaction given below is

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is:

(1) 416 (2) 41.6 (3) 4.9 (4) 49

Ans. **NTA (1)**

Sol. $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$ $\quad K_C = 4.9 \times 10^{-2}$

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ $\quad K_C^1 = ?$

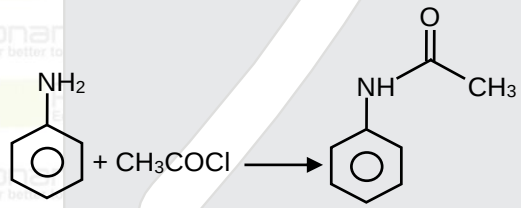
$$K_C^1 = \frac{1}{(K_C)^2} = \frac{1}{(4.9\times10^{-2})^2} = \frac{10^4}{4.9\times4.9}$$

$= 416.49$

81. From 6.55 g of aniline, the maximum amount of acetanilide that can be prepared will be _____ $\times 10^{-1}$ g.

Ans. **NTA (95)**

Sol.



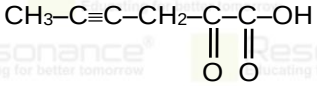
Molar = 0.07 Molar = 0.07

Weight of Acetanilide = $0.07 \times 135 = 95 \times 10^{-1}$

82. The total number of 'sigma' and 'Pi' bonds in 2-oxohex-4-ynoic acid is _____ .

Ans. **NTA (18)**

Sol.



$\underset{(14)}{\Pi} + \underset{(14)}{\Pi} = 18$

83. Number of compounds/species from the following with non-zero dipole moment is _____
$BeCl_2$, BCl_3, NF_3, XeF_4, CCl_4, H_2O, H_2S, HBr, CO_2, H_2, HCl

Ans. **NTA (5)**

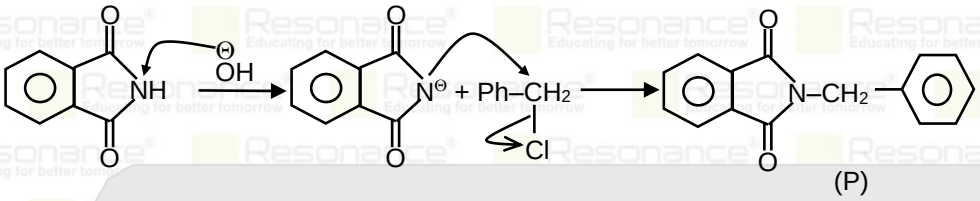
Sol. Total species with dipole moment zero = $BeCl_2$, BCl_3, XeF_4, CCl_4, CO_2, H_2
Non zero dipole moment species = NF_3, H_2O, H_2S, HBr, HCl

84. Phthalimide is made to undergo following sequence of reactions.

$$\text{Phthalimide} \xrightarrow[\text{(ii) Benzylchlo ride}]{\text{(i) KOH}} \text{'P'}$$

Total number of a bonds present in product 'P' is/are _____ .

Ans. **NTA (8)**



(P)

8 π bonds

85. The maximum number of orbitals which can be identified with n = 4 and $m_\ell = 0$ is _____ .

Ans. **NTA (4)**

Sol. n = 4 possible value of ℓ = 0, 1, 2, 3 possible orbital

	4s	4p	4d	4f
n	4	4	4	4
ℓ	0	1	2	3
m_ℓ	0	□ □ □ –1 0 +1	□ □ □ □ □ –2 –1 0 +1 +2	□ □ □ □ □ □ □ –3 –2 –1 0 +1 +2 +3

Total orbital with Mℓ = 0 are = 4

86. 2.7 kg of each of water and acetic acid are mixed. The freezing point of the solution will be –x°C. Consider the acetic acid does not dimerise in water, nor dissociates in water. x = _____ (nearest integer)
[Given: Molar mass of water = 18 g mol^{-1}, acetic acid = 60 g mol^{-1}
$K_{f\,H_2O}$: 1.86 K kg mol^{-1}
K_f acetic acid: 3.90 K kg mol^{-1}
freezing point: H_2O = 273 K, acetic acid = 290 K]

Ans. **NTA (31)**

Sol. $\Delta_F^T = iK_F \times M$

as per question i = 1

$$n_{H_2O} = \frac{2.7\times10^3}{18} = 150 \text{ mole}$$

$$n_{CH_3COOH} = \frac{2.7\times10^3}{60} = 45 \text{ mole}$$

so here solute in CH_3COOH & solvent is water

$\Delta T_F = K_F \times M$

$$= 1.86\left\{\frac{45}{2700}\times1000\right\}$$

$$= 1.86 \times \frac{45}{2.7}$$

= 31

$\Delta T_F = T_F - T_F^1$

$T_F^1 = 0 - 31$

= –31°C

87. Consider the following reaction, the rate expression of which is given below

$A + B \rightarrow C$

rate = $k [A]^{1/2} [B]^{1/2}$

The reaction is initiated by taking 1 M concentration of A and B each. If the rate constant (k) is 4.6×10^{-2} s^{-1}, then the time taken for A to become 0.1 M is _____ sec. (nearest integer)

Ans. **NTA (50)**

Sol.

	A	+	B	$\longrightarrow$ C	rate = $k [A]^{1/2} [B]^{1/2}$
Intial conc.	1M		1M		
After t time	0.1 M		0.1 M		

As reaction is 1st order

so $k = \frac{2.3}{t} \log\left(\frac{1}{0.1}\right)$

$4.6 \times 10^{-2} = \frac{2.3}{t}$

t = 50 sec

88. A first row transition metal with highest enthalpy of atomisation, upon reaction with oxygen at high temperature forms oxides of formula M_2O_n (where n = 3, 4, 5). The 'spin-only' magnetic moment value of the amphoteric oxide from the above oxides is _____ BM (near integer)

(Given atomic number: Sc: 21, Ti: 22, V: 23, Cr: 24, Mn: 25, Fe: 26, Co: 27, Ni: 28, Cu: 29, Zn: 30)

Ans. **NTA (0)**

Sol. Element is V on oxide V_2O_5.

Unpaired electron 0.

89. Three moles of an ideal gas are compressed isothermal from 60 L to 20 L using constant pressure of 5 atm. Heat exchange Q for the compression is – _____ Lit. atm.

Ans. **NTA (200)**

Sol. For isother process

$Q = -20 = -[-P^{ext}(V_2 - V_1)]$

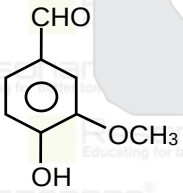
$= 5[20 - 60]$

$= -200$ Lit atm.

90. Vanillin compound obtained from vanilla beans, has total sum of oxygen atoms and π-electrons is _____

Ans. **NTA (11)**

Sol.



Vanillin

Sum of 'O' atoms = 3 + 8 = 11 & π electrons