PART A – MATHEMATICS (SET-D)

ALL THE GRAPHS GIVEN ARE SCHEMATIC AND NOT DRAWN TO SCALE

1. If S is the set of distinct values of 'b' for which the following system of linear equations

$$x + y + z = 1$$
$$x + ay + z = 1$$
$$ax + by + z = 0$$

has no solution, then S is:
(1) an empty set
(2) an infinite set
(3) a finite set containing two or more elements
(4) a singleton

Solution: (4)

$$\begin{vmatrix} 1 & 1 & 1 \\ 1 & a & 1 \\ a & b & 1 \end{vmatrix} = -(a-1)^2$$

By putting a =1 , we get

$$x + y + z = 1$$
$$x + y + z = 1$$
$$x + by + z = 0$$

Now, if b = 1, then there cannot be any solution of the system because x + y + z cannot be equal to both 0 and 1 simultaneously.

2. The following statement $(p \to q) \to [(\sim p \to q) \to q]$ is:

(1) a tautology
(2) equivalent to $\sim p \to q$
(3) equivalent to $p \to \sim q$
(4) a fallacy

Solution: (1)

p	q	$\sim p$	$p \to q$	$\sim p \to q$	$(\sim p \to q) \to q$	$p \to q \to [(\sim p \to q) \to q]$
0	0	1	1	0	1	1
0	1	1	1	1	1	1
1	0	0	0	1	0	1
1	1	0	1	1	1	1

3. If $5(\tan^2 x - \cos^2 x) = 2\cos 2x + 9$, then the value of $\cos 4x$ is:

(1) $-\frac{3}{5}$ (2) $\frac{1}{3}$ (3) $\frac{2}{9}$ (4) $-\frac{7}{9}$

Solution: (4)

$$\frac{5(1-\cos^2 x)}{\cos^2 x} - 5\cos^2 x = 4\cos^2 x + 7$$

$$9\cos^4 x + 12\cos^2 x - 5 = 0 \Rightarrow \cos^2 x = \frac{1}{3} \text{ or } -\frac{5}{3}$$

$$\cos 4x = 2\left[2\cos^2 x - 1\right]^2 - 1 = -\frac{7}{9}$$

4. For three events A, B and C, P (Exactly one of A or B occurs) = P(Exactly one of B or C occurs) =P(Exactly one of C or A occurs) = $\frac{1}{4}$ and P(All the three events occur simultaneously) = $\frac{1}{16}$. Then the probability at least one of the events occurs, is:

(1) $\frac{7}{32}$ (2) $\frac{7}{16}$ (3) $\frac{7}{64}$ (4) $\frac{3}{16}$

Solution: (2)

$2\left[P(A \cup B \cup C)\right]$ = P(Exactly one of A or B) + P(Exactly one of B or C) + P(Exactly one of C or A) + 2P (All of A, B & C)

$$2P(A \cup B \cup C) = 3 \times \frac{1}{4} + 2 \times \frac{1}{16}$$

$$P(A \cup B \cup C) = \frac{7}{16}$$

5. Let ω be a complex number such that $2\omega + 1 = z$ where $z = \sqrt{-3}$. If $\begin{vmatrix} 1 & 1 & 1 \\ 1 & -\omega^2 - 1 & \omega^2 \\ 1 & \omega^2 & \omega^7 \end{vmatrix} = 3k$, then k is equal to:

(1) –z (2) z (3) –1 (4)1

Solution: (1)

As $\omega = \dfrac{-1 + \sqrt{3}i}{2}$

$$\therefore \begin{vmatrix} 1 & 1 & 1 \\ 1 & \omega & \omega^2 \\ 1 & \omega^2 & \omega \end{vmatrix} = 3k$$

$$\Rightarrow 3(\omega^2 - \omega) = 3k = 3(-1 - 2\omega)$$

$$\Rightarrow k = -z$$

6. Let k be an integer such that the triangle with vertices (k, –3k), (5, k) and (–k, 2) has area 28 sq. units. Then the orthocentre of this triangle is at the point:

(1) $\left(2, -\frac{1}{2}\right)$ (2) $\left(1, \frac{3}{4}\right)$ (3) $\left(1, -\frac{3}{4}\right)$ (4) $\left(2, \frac{1}{2}\right)$

Solution: (4)

$$\frac{1}{2}\begin{vmatrix} k & -3k & 1 \\ 5 & k & 1 \\ -k & 2 & 1 \end{vmatrix} = 28 \quad \Rightarrow \quad 5k^2 + 13k - 46 = 0$$

$$\Rightarrow \quad k = 2 \ \text{or} \ k = -\frac{23}{5}$$

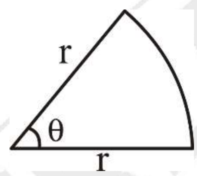
Points are (2, –6), (5, 2), (–2, 2), Let orthocentre be (x, y)

$$\frac{y+6}{x-2}\times\frac{2-2}{-2-5}=-1\Rightarrow x=2$$
$$\frac{y-2}{x-5}\times\frac{2+6}{-2-2}=-1\Rightarrow y=x-\frac{3}{2}=\frac{1}{2}$$

7. Twenty meters of wire is available for fencing off a flower-bed in the form of a circular sector. Then the maximum area (in sq. m) of the flower-bed, is:
(1) 12.5 (2) 10 (3) 25 (4) 30

Solution: (3)

$$2r+\frac{\theta}{2\pi}\times 2\pi r=20\Rightarrow\theta=\frac{2(10-r)}{r}$$



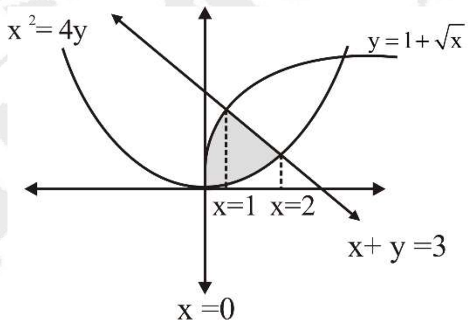
Area = $\frac{\theta}{2\pi}\times\pi r^2=r=(10-r)$

For maximum r = 10 – r $\Rightarrow$ r = 5

Area = 25

8. The area (in sq. units) of the region $\{(x, y): x \geq 0, x + y \leq 3, x^2 \leq 4y \text{ and } y \leq 1 + \sqrt{x}\}$ is:
(1) $\frac{59}{12}$ (2) $\frac{3}{2}$ (3) $\frac{7}{3}$ (4) $\frac{5}{2}$

Solution: (4)



Area = $\int_0^1\left(1+\sqrt{x}-\frac{x^2}{4}\right)dx+\int_1^2\left(3-x-\frac{x^2}{4}\right)dx=\frac{5}{2}$

9. If the image of the point P(1, –2, 3) in the plane, 2x + 3y – 4z + 22 = 0 measured parallel to the line, $\frac{x}{1}=\frac{y}{4}=\frac{z}{5}$ is Q, then PQ is equal to:
(1) $3\sqrt{5}$ (2) $2\sqrt{42}$ (3) $\sqrt{42}$ (4) $6\sqrt{5}$

Solution: (2)

Parametric equation of line PQ is $(1+\lambda,-2+4\lambda,3+5\lambda)$

Mid point of PQ lie on the given plane

$$\Rightarrow 2\left(\frac{2+\lambda}{2}\right)+3\left(\frac{-4+4\lambda}{2}\right)-4\left(\frac{6+5\lambda}{2}\right)+22=0$$

$\Rightarrow \lambda=2$

Now distance PQ = $\sqrt{(3-1)^2+(6+2)^2+(13-3)^2}=2\sqrt{42}$

10. If for $x \in \left(0, \frac{1}{4}\right)$, the derivative of $\tan^{-1}\left(\frac{6x\sqrt{x}}{1-9x^3}\right)$ is $\sqrt{x}$. g(x), then g(x) equals:

(1) $\frac{9}{1+9x^3}$ (2) $\frac{3x\sqrt{x}}{1-9x^3}$ (3) $\frac{3x}{1-9x^3}$ (4) $\frac{3}{1+9x^3}$

Solution: (1)

$$y = \tan^{-1}\left(\frac{6x\sqrt{x}}{1-9x^3}\right) = 2\tan^{-1}\left(3x^{\frac{3}{2}}\right)$$

$$\Rightarrow \frac{dy}{dx} = 2.\frac{1}{1+9x^3}.\frac{9}{2}\sqrt{2}$$

$$\Rightarrow g(x) = \frac{9}{1+9x^3}$$

11. If $(2+\sin x)\frac{dy}{dx} + (y+1)\cos x = 0$ and y(0) = 1, then $y\left(\frac{\pi}{2}\right)$ is equal to:

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

Solution: (1)

$$(2+\sin x)\frac{dy}{dx} + (y+1)\cos x = 0$$

$$\frac{d}{dx}\left[(2+\sin x)(y+1)\right] = 0$$

$$(2+\sin x)(y+1) = c \text{ ; } c = 4 \text{ as } y(0) = 1$$

$$y\left(\frac{\pi}{2}\right) = \frac{1}{3}$$

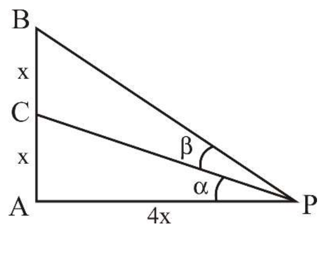
12. Let a vertical tower AB have its end A on the level ground. Let C be the mid-point of AB and P be a point on the ground such that AP = 2AB. If ∠ BPC = β, then tan β is equal to:

(1) $\frac{6}{7}$ (2) $\frac{1}{4}$ (3) $\frac{2}{9}$ (4) $\frac{4}{9}$

Solution: (3)

$$\tan(\alpha+\beta) = \frac{1}{2},\ \tan\alpha = \frac{1}{4}$$

$$\frac{\tan\alpha + \tan\beta}{1-\tan\alpha\tan\beta} = \frac{1}{2} \Rightarrow \tan\beta = \frac{2}{9}$$



13. If $A = \begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix}$, then adj $(3A^2 + 12A)$ is equal to:

(1) $\begin{bmatrix} 72 & -84 \\ -63 & 51 \end{bmatrix}$ (2) $\begin{bmatrix} 51 & 63 \\ 84 & 72 \end{bmatrix}$ (3) $\begin{bmatrix} 51 & 84 \\ 63 & 72 \end{bmatrix}$ (4) $\begin{bmatrix} 72 & -63 \\ -84 & 51 \end{bmatrix}$

Solution: (2)

$$3\begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix}\begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix} + 12\begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix} = \begin{bmatrix} 72 & -63 \\ -84 & 51 \end{bmatrix}$$

$$\text{Adj}(3A^2 + 12\,A) = \begin{bmatrix} 51 & 63 \\ 84 & 72 \end{bmatrix}$$

14. For any three positive real numbers a, b and c,

$$9\,(25a^2 + b^2) + 25(c^2 - 3ac) = 15b(3a + c).$$

Then:

(1) b, c and a are in G.P. (2) b, c and a are in A.P.
(3) a, b and c are in A.P. (4) a, b and c are in G.P.

Solution: (2)

$$9(25a^2 + b^2) + 25(c^2 - 3ac) = 15b(3a + c)$$

$$9(5a - b)^2 + (3b - 5c)^2 + 25(c - 3a)^2 = 0$$

$\Rightarrow$ 5a = b, 3b = 5c, c = 3a $\qquad \Rightarrow \dfrac{a}{1} = \dfrac{b}{5} = \dfrac{c}{3}$

$\Rightarrow$ b, c, a are in A.P.

15. The distance of the point (1, 3, –7) from the plane passing through the point (1, –1, –1), having normal perpendicular to both the lines $\dfrac{x-1}{1} = \dfrac{y+2}{-2} = \dfrac{z-4}{3}$ and $\dfrac{x-2}{2} = \dfrac{y+1}{-1} = \dfrac{z+7}{-1}$, is:

(1) $\dfrac{20}{\sqrt{74}}$ (2) $\dfrac{10}{\sqrt{83}}$ (3) $\dfrac{5}{\sqrt{83}}$ (4) $\dfrac{10}{\sqrt{74}}$

Solution: (2)

$$\text{Equation of plane} = \begin{vmatrix} x-1 & y+1 & z+1 \\ 1 & -2 & 3 \\ 2 & -1 & -1 \end{vmatrix} = 0$$

$\Rightarrow 5x + 7y + 3z + 5 = 0$

$$\text{Distance} = \left|\frac{5 + 21 - 21 + 5}{\sqrt{25 + 49 + 9}}\right| = \frac{10}{\sqrt{83}}$$

16. Let $I_n = \int \tan^n x\,dx, (n > 1)$. If $I_4 + I_6 = a\tan^5 x + bx^5 + C$, where C is a constant of integration, then the ordered pair (a, b) is equal to:

(1) $\left(-\dfrac{1}{5}, 1\right)$ (2) $\left(\dfrac{1}{5}, 0\right)$ (3) $\left(\dfrac{1}{5}, -1\right)$ (4) $\left(-\dfrac{1}{5}, 0\right)$

Solution: (2)

$$I_n = \int \tan^{n-2} x\left(\sec^2 x - 1\right)dx = -I_{n-2} + \frac{\tan^{n-1} x}{n-1} + C$$

Put n = 6

$$I_6 + I_4 = \frac{\tan^5 x}{5} + C$$

$$\Rightarrow\ a = \frac{1}{5},\ b = 0$$

17. The eccentricity of an ellipse whose centre is at the origin is $\frac{1}{2}$. If one of its directrices is $x = -4$, then the equation of the normal to it at $\left(1, \frac{3}{2}\right)$ is:

(1) $2y - x = 2$ (2) $4x - 2y = 1$ (3) $4x + 2y = 7$ (4) $x + 2y = 4$

Solution: (2)

$e = \frac{1}{2}$, $ae = 4$ $\Rightarrow a = 2$

$e^2 = 1 - \frac{b^2}{a^2}$ $\Rightarrow b^2 = 3 \Rightarrow \frac{x^2}{4} + \frac{y^2}{3} = 1$ is the ellipse

$\Rightarrow$ normal at $\left(1, \frac{3}{2}\right)$ is $4x - 2y = 1$

18. A hyperbola passes through the point $P\left(\sqrt{2}, \sqrt{3}\right)$ and has foci at $(\pm 2, 0)$. Then the tangent to this hyperbola at P also passes through the point:

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

Solution: (2)

$2ae = 4$, $2a = PS - PS' = 2$

$\frac{x^2}{1} - \frac{y^2}{4-1} = 1$

Now tangent at $\left(\sqrt{2}, \sqrt{3}\right)$ is $\sqrt{2}x - \frac{y}{\sqrt{3}} = 1$

It passes through $\left(2\sqrt{2}, 3\sqrt{3}\right)$

19. The function $f : \mathbf{R} \to \left[-\frac{1}{2}, \frac{1}{2}\right]$ defined as $f(x) = \frac{x}{1+x^2}$, is:

(1) invertible. (2) injective but not surjective.
(3) surjective but not injective. (4) neither injective nor surjective.

Solution: (3)

$f(x) = \frac{x}{1+x^2}$; $f'(x) = \frac{1-x^2}{(1+x^2)^2} \Rightarrow$ not injective

Range $= \left[-\frac{1}{2}, \frac{1}{2}\right]$ Hence, surjective

20. $\lim_{x \to \frac{\pi}{2}} \frac{\cot x - \cos x}{(\pi - 2x)^3}$ equals:

(1) $\frac{1}{24}$ (2) $\frac{1}{16}$ (3) $\frac{1}{8}$ (4) $\frac{1}{4}$

Solution: (2)

$$\lim_{x \to \frac{\pi}{2}} \frac{\cot x - \cos x}{(\pi - 2x)^3}$$

Let $x = \frac{\pi}{2} - h$

$$\Rightarrow \lim_{h \to 0} \frac{\tan h - \sin h}{8h^3} = \lim_{h \to} \frac{\tan h}{h}\left(\frac{1 - \cos h}{h^2}\right) \cdot \frac{1}{8} = \frac{1}{16}$$

21. Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. Let $\vec{c}$ be a vector such that $|\vec{c} - \vec{a}| = 3$, $|(\vec{a} \times \vec{b}) \times \vec{c}| = 3$ and the angle between $\vec{c}$ and $\vec{a} \times \vec{b}$ be 30°. Then $\vec{a} . \vec{c}$ is equal to:

(1) $\frac{25}{8}$ (2) 2 (3) 5 (4) $\frac{1}{8}$

Solution: (2)

$|(\vec{a} \times \vec{b}) \times \vec{c}| = 3$

$|\vec{a} \times \vec{b}|.|\vec{c}|.\sin 30^\circ = 3$ as $|\vec{a} \times \vec{b}| = 3 \times \sqrt{2} \times \frac{1}{\sqrt{2}}$

$\Rightarrow |\vec{c}| = 2$

$|\vec{c} - \vec{a}|^2 = |\vec{c}|^2 + |\vec{a}|^2 - 2\vec{a}.\vec{c} = 9$

$\vec{a} . \vec{c} = 2$

22. The normal to the curve y(x – 2)(x – 3) = x + 6 at the point where the curve intersects the y-axis passes through the point:

(1) $\left(-\frac{1}{2}, -\frac{1}{2}\right)$ (2) $\left(\frac{1}{2}, \frac{1}{2}\right)$ (3) $\left(\frac{1}{2}, -\frac{1}{3}\right)$ (4) $\left(\frac{1}{2}, \frac{1}{3}\right)$

Solution: (2)

$y = \frac{x+6}{(x-2)(x-3)}$ Point on y-axis is (0, 1)

$\left|\frac{dy}{dx}\right|_{x=0} = 1$

$\Rightarrow$ Normal is x + y = 1

It passes through $\left(\frac{1}{2}, \frac{1}{2}\right)$

23. If two different numbers are taken from the set {0, 1, 2, 3, …. 10}; then the probability that their sum as well as absolute difference are both multiple of 4, is:

(1) $\frac{6}{55}$ (2) $\frac{12}{55}$ (3) $\frac{14}{45}$ (4) $\frac{7}{55}$

Solution: (1)

a + b = 4m, |a – b| = 4n $\Rightarrow$ both should be even and are of same type either 4k or 4k + 2 type

$$\frac{{}^3C_2 + {}^3C_2}{{}^{11}C_2} = \frac{6}{55}$$

24. A man X has 7 friends, 4 of them are ladies and 3 are men. His wife Y also has 7 friends, 3 of them are ladies and 4 are men. Assume X and Y have no common friends. Then the total number of ways in which X and Y together can throw a party inviting 3 ladies and 3 men, so that 3 friends of each of X and Y are in this party, is:

(1) 485 (2) 468 (3) 469 (4) 484

Solution: (1)

$X \rightarrow$ 4 ladies, 3 men

$Y \rightarrow$ 3 ladies, 4 men

as 4 cases are possible therefore

$$\text{No. of ways} = \frac{{}^4C_1 \times {}^3C_2}{X} \times \frac{{}^3C_2 \times {}^4C_1}{Y} + \frac{{}^4C_2 \times {}^3C_1}{X} \times \frac{{}^3C_1 \times {}^4C_2}{Y} + \frac{{}^4C_3 \times {}^3C_o}{X} \times \frac{{}^3C_o \times {}^4C_3}{Y} + \frac{{}^4C_o \times {}^3C_3}{X} \times \frac{{}^3C_3 \times {}^4C_o}{Y} = 485$$

25. The value of $\left({}^{21}C_1 - {}^{10}C_1\right) + \left({}^{21}C_2 - {}^{10}C_2\right) + \left({}^{21}C_3 - {}^{10}C_3\right) + \left({}^{21}C_4 - {}^{10}C_4\right) + \ldots + \left({}^{21}C_{10} - {}^{10}C_{10}\right)$ is:

(1) $2^{21} - 2^{11}$ (2) $2^{21} - 2^{10}$ (3) $2^{20} - 2^{9}$ (4) $2^{20} - 2^{10}$

Solution: (4)

$$\left({}^{21}C_1 + {}^{10}C_1\right) + \left({}^{21}C_2 - {}^{10}C_2\right) + \ldots + \left({}^{21}C_{10} - {}^{10}C_{10}\right)$$

$$\Rightarrow \left({}^{21}C_1 + {}^{21}C_2 + \ldots + {}^{21}C_{10}\right) - \left({}^{10}C_1 + {}^{10}C_2 + \ldots + {}^{10}C_{10}\right)$$

$$\left(\frac{2^{21}}{2} - 1\right) - \left(2^{10} - 1\right) = 2^{20} - 2^{10}$$

26. A box contains 15 green and 10 yellow balls. If 10 balls are randomly drawn, one-by-one, with replacement, then the variance of the number of green balls drawn is:

(1) $\frac{12}{5}$ (2) 6 (3) 4 (4) $\frac{6}{25}$

Solution: (1)

Variance = n . p . q

Here n = 10, $p = \frac{15}{15+10}$, $q = \frac{10}{15+10}$

Variance = $\frac{12}{5}$

27. Let a, b, c $\in \mathbf{R}$. If f(x) = ax^2 + bx + c is such that a + b + c = 3 and f(x + y) = f(x) + f(y) + xy, $\forall$ x, y $\in \mathbf{R}$, then $\sum_{n=1}^{10} f(n)$ is equal to:

(1) 330 (2) 165 (3) 190 (4) 255

Solution: (1)

$$f(x+y) = f(x) + f(y) + xy \ \forall \ x, y \in R$$

$$\Rightarrow f(0+0) = 0 \Rightarrow c = 0$$

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} = x + \lim_{h \to 0} \frac{f(h)}{h}$$

$$f'(x) = x + f'(0) \Rightarrow 2ax + b = x + b$$

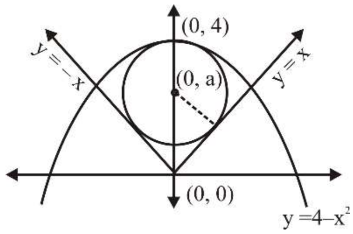
$a = \frac{1}{2}$, $b = \frac{5}{2}$, as a + b + c = 3

$$\sum_{n=1}^{10} f(n) = \sum_{n=1}^{10} \left(\frac{n^2}{2} + \frac{5n}{2}\right) = 330$$

28. The radius of a circle, having minimum area, which touches the curve $y = 4 - x^2$ and the lines, $y = |x|$ is:

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

Solution: (3)



Equating radii, $4 - a = \dfrac{a}{\sqrt{2}}$

$\Rightarrow$ Radius $= \dfrac{a}{\sqrt{2}} = 4\left(\sqrt{2}-1\right)$

29. If, for a positive integer n, the quadratic equation,

$$x(x+1)+(x+1)(x+2)+\ldots+\left(x+\overline{n-1}\right)(x+n)=10n$$

has two consecutive integral solutions, then n is equal to:

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

Solution: (4)

Let the solutions are m and m + 1,

$$\Rightarrow\ m+m+1=\frac{-(1+3+5+\ldots+2n-1)}{n}=-n$$

$$\Rightarrow\ m(m+1)=\frac{\sum_{k=1}^{n}k(k-1)-10n}{n}=\frac{n^2-31}{3}$$

Eliminating m from both the equations

n = 11

30. The integral $\displaystyle\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\frac{dx}{1+\cos x}$ is equal to;

(1) –2 (2) 2 (3) 4 (4) –1

Solution: (2)

$$I=\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\frac{dx}{1+\cos x} \qquad 2I=\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}\left(\frac{1}{1+\cos x}+\frac{1}{1-\cos x}\right)dx$$

$$I=\frac{1}{2}\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}}2\operatorname{cosec}^2 x\,dx=2$$

PART B – PHYSICS (SET-D)

ALL THE GRAPHS GIVEN ARE SCHEMATIC AND NOT DRAWN TO SCALE

31. A radioactive nucleus A with a half-life T, decays into a nucleus B. At t = 0 there is no nucleus B. At some time t, the ratio of the number of B to that of A is 0.3 Then, t is given by:

(1) $t = \dfrac{T}{\log(1.3)}$ (2) $t = \dfrac{T}{2}\dfrac{\log 2}{\log(1.3)}$ (3) $t = T\dfrac{\log 1.3}{\log 2}$ (4) $t = T\log(1.3)$

Solution: (3)

$$A \longrightarrow B$$

N_o 0 ---- t = 0

N $N_0 – N$ ---- t = t

$$\frac{N_o - N}{N} = 0.3 \quad \Rightarrow \quad N = \frac{N_o}{1.3}$$

$$N_o\left(\frac{1}{2}\right)^{t/T} = N_o\left(\frac{1}{1.3}\right)$$

$$t = \frac{T\log(1.3)}{\log(2)}$$

32. The following observations were taken for determining surface tension T of water by capillary method:

Diameter of capillary, $D = 1.25 \times 10^{-2}$ m rise of water, $h = 1.45 \times 10^{-2}$ m

Using $g = 9.80\ m/s^2$ and the simplified relation $T = \dfrac{rhg}{2} \times 10^3$ N/m, the possible error in surface tension is closest to

(1) 10% (2) 0.15% (3) 1.5% (4) 2.4%

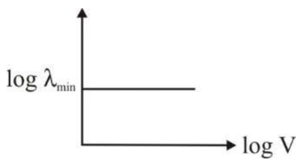
Solution: (3)

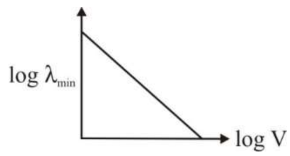
$$T = \frac{dhg}{4} \times 10^3$$

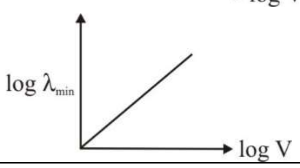
$$\frac{\Delta T}{T} = \frac{\Delta d}{d} + \frac{\Delta h}{h}$$

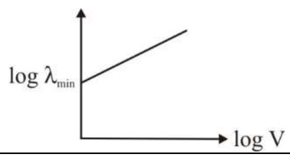
$$= \left[\frac{0.01}{1.25} + \frac{0.01}{1.45}\right] \times 100 = 1.5\ \%$$

33. An electron beam is accelerated by a potential difference V to hit a metallic target to produce X-rays. It produces continuous as well as characteristic X-rays. If λ_{min} is the smallest possible wavelength of X-ray in the spectrum, the variation of log λ_{min} with log V is correctly represented in

(1)


(2)


(3)


(4)


Solution: (2)

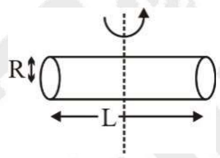
$$\lambda_{min} = \frac{hc}{e\nu}$$

$$\log(\lambda_{min}) = \log\left(\frac{hc}{e}\right) - \log V$$

34. The moment of inertia of a uniform cylinder of length l and radius R about its perpendicular bisector is I. What is the ratio l/R such that the moment of inertia is minimum?

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

Solution: (2)



$$I = \frac{MR^2}{4} + \frac{ML^2}{12}$$

Volume = $\pi R^2 L$

Hence, $R^2 = \frac{V}{\pi L}$

So, $I = \frac{M}{4}\left[\frac{V}{\pi L}\right] + \frac{ML^2}{12}$

$$\frac{dI}{dL} = \frac{MV}{4\pi}\left[-\frac{1}{L^2}\right] + \frac{2ML}{12} = 0$$

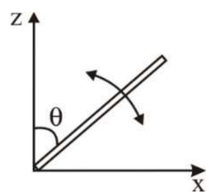
$$\Rightarrow \quad \frac{L}{6} = \frac{V}{4\pi L^2} = \frac{\pi R^2 L}{4\pi L^2}$$

$$\frac{R^2}{L^2} = \frac{2}{3}$$

$$\Rightarrow \quad \frac{R}{L} = \sqrt{\frac{2}{3}}$$

$$\Rightarrow \quad \frac{L}{R} = \sqrt{\frac{3}{2}}$$

35. A slender uniform rod of mass M and length l is pivoted at one end so that it can rotate in a vertical plane (see figure). There is negligible friction at the pivot. The free end is held vertically above the pivot and then released. The angular acceleration of the rod when it makes an angle θ with the vertical is:



(1) $\frac{2g}{3\ell}\cos\theta$ (2) $\frac{3g}{2\ell}\sin\theta$

(3) $\frac{2g}{3\ell}\sin\theta$ (4) $\frac{3g}{2\ell}\cos\theta$

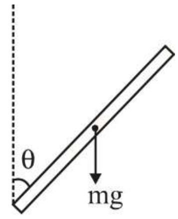
Solution: (2)

$$\tau = Mg\left(\frac{L}{2}\sin\theta\right)$$

$$\alpha = \frac{\tau}{I}$$

$$= \frac{\frac{MgL\sin\theta}{2}}{\frac{ML^2}{3}}$$

$$= \frac{3g\sin\theta}{2L}$$



36. C_p and C_v are specific heats at constant pressure and constant volume respectively. It is observed that

$C_p - C_v = a$ for hydrogen gas

$C_p - C_v = b$ for nitrogen gas

The correct relation between a and b is:

(1) a = 28 b (2) $a = \frac{1}{14}b$ (3) a = b (4) a = 14 b

Solution: (4)

$$C_p - C_v = \frac{R}{M_{H_2}} = a$$

$$C_p - C_v = \frac{R}{M_{N_2}} = b$$

Hence a = 14 b

37. A copper ball of mass 100 gm is at a temperature T. It is dropped in a copper calorimeter of mass 100 gm, filled with 170 gm of water at room temperature. Subsequently, the temperature of the system is found to be 75°C. T is given by:

(Given: room temperature = 30°C, specific heat of copper = 0.1 cal/gm°C)

(1) 825°C (2) 800°C (3) 885°C (4) 1250°C

Solution: (3)

$$(100\text{gm})(0.1)(T-75) = 100\times 0.1(75-30) + 170\times 1\times(75-30)$$

T = 88.5°C

38. In amplitude modulation, sinusoidal carrier frequency used is denoted by ω_c and the signal frequency is denoted by ω_m. The bandwidth ($\Delta\omega_m$) of the signal is such that $\Delta\omega_m << \omega_c$. Which of the following frequencies is not contained in the modulated wave?

(1) $\omega_c - \omega_m$ (2) ω_m (3) ω_c (4) $\omega_m - \omega_c$

Solution: (2)

Signal contains

$$(\omega_c + \omega_m), \omega_c, (\omega_c - \omega_m)$$

39. The temperature of an open room of volume 30 m^3 increases from 17°C to 27°C due to the sunshine. The atmospheric pressure in the room remains 1×10^5. Pa. If n_i and n_f are the number of molecules in the room before and after heating, then $n_f - n_i$ will be:

(1) -2.5×10^{25} (2) -1.61×10^{23} (3) 1.38×10^{23} (4) 2.5×10^{25}

Solution: (1)

$$n_f - n_i = \frac{PV}{R}\left[\frac{1}{T_f} - \frac{1}{T_i}\right]$$

$$= \frac{10^5 \times 30}{8.31}\left[\frac{1}{300} - \frac{1}{290}\right] \times 6.023 \times 10^{23}$$

$$= -2.5 \times 10^{25}$$

40. In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is:

(1) 15.6 mm (2) 1.56 mm (3) 7.8 mm (4) 9.75 mm

Solution: (3)

$$n(650) = m(520)$$

$$\frac{n}{m} = \frac{4}{5}$$

$$y = \frac{4 \times 650 \times 10^{-9} \times 1.5}{0.5 \times 10^{-3}}$$

$$= 7.8\text{mm}$$

41. A particle A of mass m and initial velocity v collies with a particle B of mass m/2 which is at rest. The collision is head on and elastic. The ratio of the de-Broglie wavelengths λ_A to λ_B after the collision is:

(1) $\frac{\lambda_A}{\lambda_B} = \frac{1}{2}$ (2) $\frac{\lambda_A}{\lambda_B} = \frac{1}{3}$ (3) $\frac{\lambda_A}{\lambda_B} = 2$ (4) $\frac{\lambda_A}{\lambda_B} = \frac{2}{3}$

Solution: (3)

$$mv = mv_A + \frac{m}{2}v_B$$

$$v = v_A + \frac{v_B}{2} \qquad \text{….(i)}$$

$$v_B - v_A = v \qquad \text{….(ii)}$$

$$v_A = \frac{v}{3}, v_B = \frac{4v}{3}$$

$$\frac{\lambda_A}{\lambda_B} = \frac{m_B v_B}{m_A v_A} = \frac{\frac{m}{2}.\frac{4v}{3}}{m.\frac{v}{3}} = \frac{2}{1}$$

42. A magnetic needle of magnetic moment 6.7×10^{-2} Am^2 and moment of inertia 7.5×10^{-6} kg m^2 is performing simple harmonic oscillation in a magnetic field of 0.01 T. Time taken for 10 complete oscillation is:

(1) 8.76 s (2) 6.65 s (3) 8.89 s (4) 6.98s

Solution: (2)

$$T = 2\pi\sqrt{\frac{I}{\mu B}} = 0.664\,\text{sec}$$

$$t = 10T = 6.65\,\text{sec}$$

43. An electric dipole has a fixed dipole moment $\vec{p}$, which makes angle θ with respect to x-axis. When subjected to an electric $\vec{E}_1 = E\hat{i}$, it experiences a torque $\vec{T}_1 = \tau\hat{k}$. When subjected to another electric field $\vec{E}_2 = \sqrt{3}E_1\hat{j}$ it experiences a torque $\vec{T}_2 = -\vec{T}_1$. The angle θ is :

(1) 90° (2) 30° (3) 45° (4) 60°

Solution: (4)

$$\vec{\tau}_1 = -\vec{\tau}_2$$

$$\vec{\tau}_1 = \left(p\cos\theta\hat{i} + p\sin\theta\hat{j}\right) \times E\hat{i}$$

$$= -PE\sin\theta\hat{k}$$

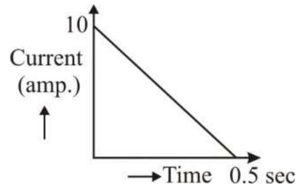
$$\vec{\tau}_2 = \left(p\cos\theta\hat{i} + p\sin\theta\hat{j}\right) \times \sqrt{3}\,E\hat{j}$$

$$= \sqrt{3}PE\cos\theta\hat{k}$$

$$PE\sin\theta = \sqrt{3}PE\cos\theta$$

$$\tan\theta = \sqrt{3} \Rightarrow \theta = 60^{\circ}$$

44. In a coil of resistance 100 Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is:



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

Solution: (4)

$$\frac{\Delta\phi}{R} = \Delta q = \text{Area under the curve}$$

$$\Delta\phi = 100 \times \frac{1}{2} \times 0.5 \times 10 = 250\,\text{Wb}$$

45. A times dependent force F = 6t acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1sec will be :

(1) 18 J (2) 4.5 J (3) 22 J (4) 9 J

Solution: (2)

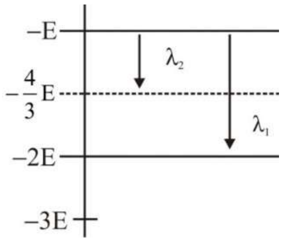
$$a = \frac{F}{m} = 6t$$

$$\int dv = \int 6t\ dt$$

$$v = \frac{6t^2}{2} = 3t^2 = 3\text{m/sec}$$

$$W = \Delta KE = \frac{1}{2}(1)(3)^2 \quad = 4.5\text{ J.}$$

46. Some energy levels of a molecule are shown in the figure. The ratio of the wavelengths $r = \lambda_1/\lambda_2$, is given by



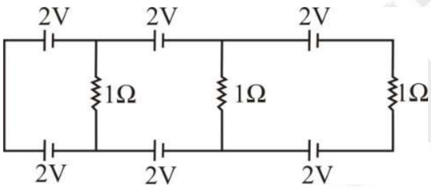
(1) r = 1/3 (2) r = 4/3 (3) r = 2/3 (4) r = 3/4

Solution: (1)

$$\frac{hc}{\lambda_1} = E$$

$$\frac{hc}{\lambda_2} = \frac{E}{3}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{1}{3}$$

47. 

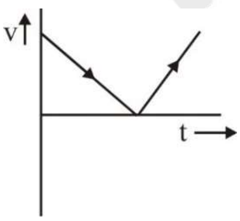
In the above circuit the current in each resistance is:

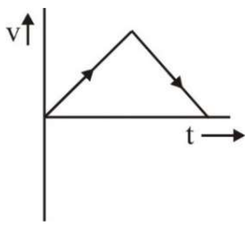
(1) 0 A (2) 1 A (3) 0.25 A (4) 0.5 A

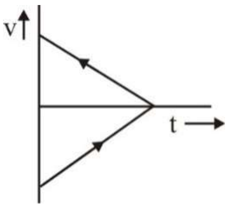
Solution: (1)

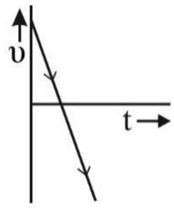
Each resistance has zero potential difference across it.

48. A body is through vertically upwards. Which one of the following graphs correctly represent the velocity vs time

(1) 

(2) 

(3) 

(4) 

Solution: (4)

$$V = (V_0 - gt)$$

49. A capacitance of 2 μF is required in an electrical circuit across a potential difference of 1.0 kV. A large number of 1 μF capacitors are available which can withstand a potential difference of not more than 300 V. The minimum number of capacitors required to achieve this is:

(1) 32 (2) 2 (3) 16 (4) 24

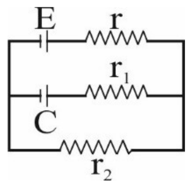
Solution: (1)

$V = 1000V$

$C = 2\mu F$

4 capacitors in series then 8 such branches in parallel

50. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be



(1) $CE\frac{r_1}{(r_1 + r)}$ (2) CE

(3) $CE\frac{r_1}{(r_2 + r)}$ (4) $CE\frac{r_2}{(r + r_2)}$

Solution: (4)

In steady state.

$$I = \frac{E}{r + r_2}$$

$$V_A - V_B = Ir_2 = \frac{Er_2}{r + r_2}$$

$$Q = C(V_A - V_B).$$

51. In a common emitter amplifier circuit using an n-p-n transistor, the phase difference between the input and the output voltage will be:

(1) 180° (2) 45° (3) 90° (4) 135°

Solution: (1)

Input and output voltages have a phase difference of π.

52. Which of the following statements is false?

(1) Kirchhoff's second law represents energy conservation.

(2) Wheatstone bridge is the most sensitive when all the four resistance s are of the same order of magnitude

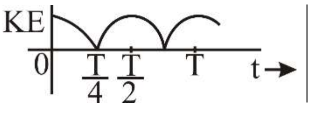
(3) In a balanced Wheatstone bridge is the cell and the galvanometer are exchanged, the null point is disturbed.

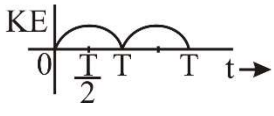
(4) A rheostat can be used as a potential divider.

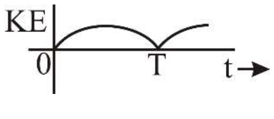
Solution: (3)

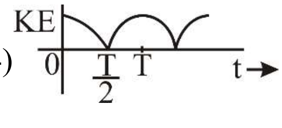
The circuit remains unchanged if we interchange battery and galvanometer.

53. A particle is executing simple harmonic motion with a time period T. At time t = 0 it is at its position of equilibrium. The kinetic energy time graph of the particle will look like:

(1) 

(2) 

(3) 

(4) 

Solution: (1)

KE oscillates with a period of T/2.

54. An observer is moving with half the speed of light towards a stationary microwave source emitting waves at frequency 10 GHz. What is the frequency of the microwave measured by the observer? (Speed of light = 3×10^8 m/s)

(1) 15.3 GHz (2) 10. GHz (3) 12.1 GHz (4) 17.3.GHz

Solution: (4)

$$\nu_{app} = \frac{\nu_{act}\left(1+\frac{v}{c}\right)}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$= \frac{10\left(1+\frac{1}{2}\right)}{\sqrt{1-\frac{1}{4}}} = 10\sqrt{3} = 17.3 \text{ GHz}$$

55. A man grown into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of

(1) 1/81 (2) 9 (3) 1/9 (4) 81

Solution: (2)

$$\text{Stress} = \frac{\text{weight}}{\text{Area}} = \frac{Mg}{A} \propto \frac{(9)^3}{(9)^2} = 9\,\text{times.}$$

56. When a current of 5 mA is passed through a galvanometer having a coil of resistance 15 Ω, it shows full scale deflection. The value of the resistance to be put in series with the galvanometer to convert it into a voltmeter of range 0 – 10 V is

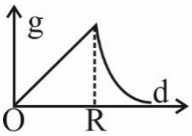
(1) 4.005×10^3 Ω (2) 1.985×10^3 Ω (3) 2.045×10^3 Ω (4) 2.535×10^3 Ω

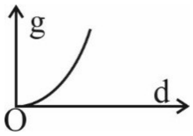
Solution: (2)

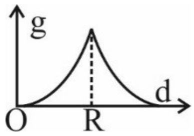
$$R = \frac{V}{i_g} - G = \frac{10}{5 \times 10^{-3}} - 15$$

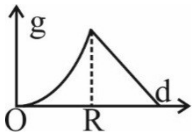
$$= 1.985 \times 10^3\,\Omega$$

57. The variation of acceleration due to gravity g with distance d form centre of the earth is best represented by (R = Earth's radius) :

(1) 

(2) 

(3) 

(4) 

Solution: (1)

$$g = \frac{GM_e r}{R_e}, r < R_e$$

$$g = \frac{GMe}{r^2}, r > R_e$$

58. An external pressure P is applied on a cube at 0ºC so that it is equally compressed from all sides. K is the bulk modules of the material of the cube and α is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by:

(1) $3PK\alpha$ (2) $\frac{P}{3\alpha K}$ (3) $\frac{P}{\alpha K}$ (4) $\frac{3\alpha}{PK}$

Solution: (2)

$$K = -\frac{dp}{(dv/v)}$$

$$K = \frac{p}{(3\alpha)T}$$

$$T = \frac{p}{3\alpha K}$$

59. A diverging lens with magnitude of focal length 25 cm is placed at a distance of 15 cm form a converging lens of magnitude of focal length 20 cm. A beam of parallel light falls on the diverging lens. The final image formed is:

(1) real and at a distance of 6 cm from the convergent lens.

(2) real and at a distance of 40 cm from convergent lens.

(3) virtual and at a distance of 40 cm from convergent lens.

(4) real and at a distance of 40 cm form the divergent lens.

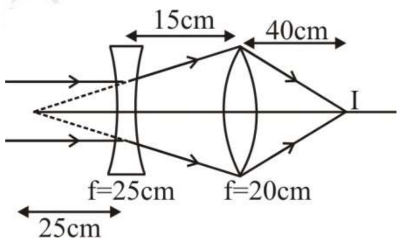
Solution: (2)

For convex lens

$u = -40\,cm$

$f = +20\,cm$

$$\frac{1}{V} = \frac{1}{20} - \frac{1}{40} \Rightarrow V = 40 \text{ cm}$$



60. A body of mass m = 10^{-2} kg moving in medium and experiences a fractional force $F = -kv^2$. Its initial speed is $v_0 = 10\ ms^{-1}$. If, after 10 s, its energy is 1/8 mv_0^2, the value of k will be:

(1) 10^{-1} kg m^{-1} s^{-1} (2) 10^{-3} kg m^{-1} (3) 10^{-3} kg s^{-1} (4) 10^{-4} kg m^{-1}

Solution: (4)

$$F = -kv^2$$

$$a = -\frac{kv^2}{(10^{-2})} = \frac{dv}{dt}$$

$$\int_{v_0}^{v_0/2} \frac{dv}{-v^2} = \frac{k}{10^{-2}} \int_0^{10} dt$$

$$\frac{2}{v_0} - \frac{1}{v_0} = k(10^3)$$

$$k = 10^{-4}$$

PART C – CHEMISTRY (SET-D)

61. 1 gram of a 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 mol^{-1} is :
(1) 84.3 (2) 118.6 (3) 11.86 (4) 1186

Solution:(1)

$$M_2CO_3 + 2HCl \longrightarrow 2MCl + H_2O + CO_2$$

1gm 0.01186 mole

So $\frac{1}{M} = 0.01186 \Rightarrow M = 84.3$

62. Given $C_{(graphite)} + O_2(g) \rightarrow CO_2(g)$; $\Delta_rH° = -393.5$ kJ mol^{-1} $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$;
$\Delta_rH° = -285.8$ kJ mol^{-1} $CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$; $\Delta_rH° = +890.3$ kJ mol^{-1}
Based on the above thermochemical equations, the value of $\Delta_rH°$ at 298 K for the reaction.
$C_{(graphite)} + 2H_2(g) \rightarrow CH_4(g)$ will be :
(1) + 144.0 kJ mol^{-1} (2) –74.8 kJ mol^{-1}
(3) –144.0 kJ mol^{-1} (4) + 74.8 kJ mol^{-1}

Solution:(2)

$$\Delta H_{f_{CH_4}} - \Delta H_{f_{CO_2}} - \Delta H_f H_2O = 2 + 890.3$$

$$\Delta H_{f_{CH_4}} = 890.3 + (-393.5) + (-285.8 \times 2)$$

$$\Delta H^{\circ}_{fCH_4} = -74.8 \text{ kJ / mole}$$

63. The freezing point of benzene decreases by 0.45°C when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be :
(K_f for benzene = 5.12 K kg mol^{-1})
(1) 80.4% (2) 74.6% (3) 94.6% (4) 64.6%

Solution:(3)

$\Delta T_f = iK_f\,m$

$0.45 = (1 - \alpha/2)\ 5.12 \times \frac{0.2 \times 1000}{60 \times 20}$

$\alpha = 94.6\%$

64. The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%); Carbon (22.9%), Hydrogen (10.0%) ; and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is :
(1) 37.5 kg (2) 7.5 kg (3) 10 kg (4) 15 kg

Solution:(2)

Amount of H = 75× 0.1 = 7.5 kg
Increase in mass = 7.5 kg

65. ΔU is equal to :
(1) Isobaric work (2) Adiabatic work
(3) Isothermal work (4) Isochoric work

Solution:(2)

$\Delta U = q + w$

if $q = 0$ then $\Delta U = w$

hence adiabatic work.

NCERT XI Vol.-1- [Page no.-60]

66. The formation of which of the following polymers involves hydrolysis reaction?
(1) Bakelite (2) Nylon 6, 6 (3) Terylene (4) Nylon 6

Solution:(4)

Nylon 6 is obtained by heating caprolactum with water at a high temperature.

NCERT XII Vol.-2 [Page – 431]

67. Given :

$E^{\circ}_{Cl_2/Cl^-} = 1.36\,V, E^{\circ}_{Cr^{3+}/Cr} = -0.74V$

$E^{\circ}_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\,V, E^{\circ}_{MnO_4^-/Mn^{2+}} = 1.51\,V.$

Among the following, the strongest reducing agent is :
(1) Mn^{2+} (2) Cr^{3+} (3) Cl^- (4) Cr

Solution:(4)

The one having most –ve standard reduction potential is strongest reducing agent.

68. The Tyndall effect is observed only when following conditions are satisfied :
(1) The diameter of the dispersed particles is much smaller than the wavelength of the light used.
(2) The diameter of the dispersed particle is not much smaller than the wavelength of the light used.
(3) The refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude.
(4) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.
(1) (b) and (d) (2) (a) and (c) (3) (b) and (c) (4) (a) and (d)

Solution:(1)

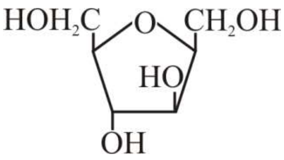
NCERT XII Vol.-1- [5.4.6 (ii) Page no.-139]

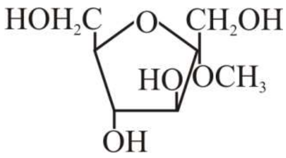
69. In the following reactions, ZnO is respectively acting as a/an :
(a) $ZnO + Na_2O \rightarrow Na_2ZnO_2$
(b) $ZnO + CO_2 \rightarrow ZnCO_3$
(1) base and base (2) acid and acid (3) acid and base (4) base and acid

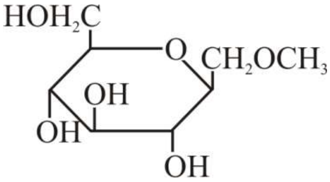
Solution:(3)

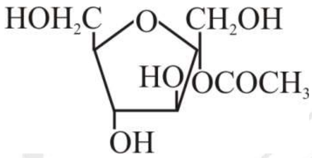
ZnO is Amphoteric oxide when reacts with base it act as acid & vice verse.

70. Which of the following compounds will behave as a reducing sugar in an aqueous KOH solution?

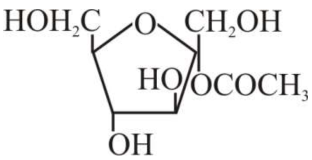
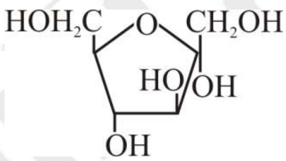
(1) 

(2) 

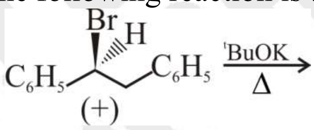
(3) 

(4) 

Solution:(4)

 on alkaline hydrolysis produces 

71. The major product obtained in the following reaction is :



(1) $C_6H_5CH= CHC_6H_5$ (2) $(+)C_6H_5CH(O^tBu)CH_2C_6H_5$
(3) $(–) C_6H_5CH(O^tBu)CH_2C_6H_5$ (4) $(\pm)C_6H_5CH(O^tBu)CH_2C_6H_5$

Solution:(1)

It will undergo elimination

72. Which of the following species is not paramagnetic?
(1) CO (2) O_2 (3) B_2 (4) NO

Solution:(1)

CO is 14 e^- $\sigma 1s^2\ \sigma^*\ 1s^2\ \sigma^2 s^2\ \ \sigma^*\ 2s^2\ \pi^2 px^2\ \pi 2py^2\ \sigma^*\ \ 2p_2^2$

So no unpaired e^-

NCERT XI Vol.-1- [Page no.-126]

73. On treatment of 100 mL of 0.1 M solution of $CoCl_3.6H_2O$ with excess $AgNO_3$; 1.2×10^{22} ions are precipitated. The complex is :
(1) $[Co(H_2O)_3Cl_3].3H_2O$ (2) $[Co(H_2O)_6]Cl_3$
(2) $[Co(H_2O)_5Cl]Cl_2.H_2O$ (4) $[Co(H_2O)_4Cl_2]Cl.2H_2O$

Solution:(3)

Number of moles of precipitate = $\dfrac{1.2\times10^{22}}{6.02\times10^{23}} = 2\times10^{-2}$

moles of complex = $100 \times 0.1 \times 10^{-3} = 10^{-2}$

So from 1 mole complex two moles of AgCl is precipited.

74. pK_a of a weak acid (HA) and pK_b of a weak base (BOH) are 3.2 and 3.4, respectively. The pH of their salt (AB) solution is :
(1) 6.9 (2) 7.0 (3) 1.0 (4) 7.2

Solution:(1)

$$pH = 7 + \frac{1}{2}pK_a - \frac{1}{2}pK_b$$
$$= 7 + \frac{3.2}{2} - \frac{3.4}{2} = 6.9$$

75. The increasing order of the reactivity of the following halides for the S_N1 reaction is :

$CH_3CH(Cl)CH_2CH_3$ (I) $CH_3CH_2CH_2Cl$ (II) $p-H_3CO-C_6H_4-CH_2Cl$ (III)

(1) (II) < (I) < (III) (2) (I) < (III) < (II)
(3) (II) < (III) < (I) (4) (III) < (II) < (I)

Solution:(1)

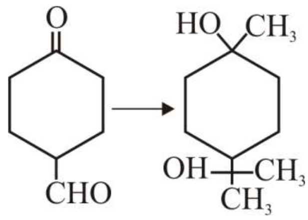
Rate of SN^1 reaction depends on stability of carbocation.
So III > I > II

76. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is :
(1) both form soluble bicarbonates
(2) both form nitrides
(3) nitrates of both Li and Mg yield NO_2 and O_2 on heating
(4) both form basic carbonates

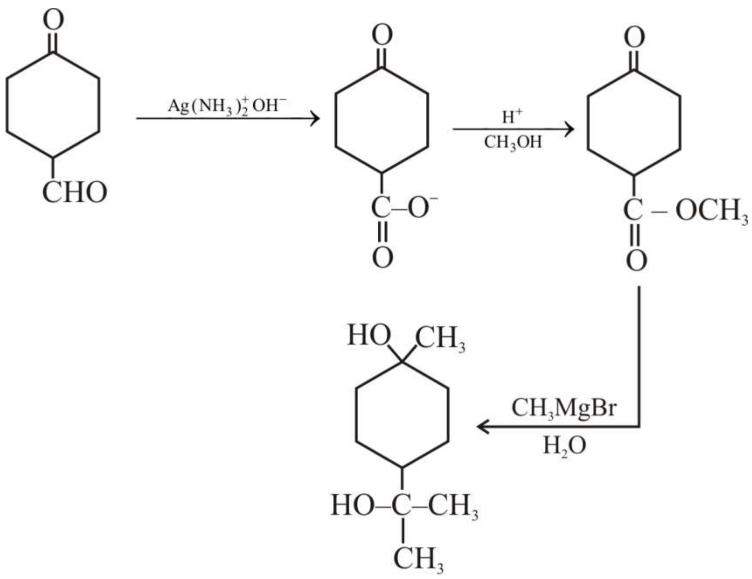
Solution:(1)

NCERT XI vol. II. [10.3.1 (iv) Page no.296]

77. The correct sequence of reagents for the following conversion will be :
(1) CH_3MgBr, H^+/CH_3OH, $[Ag(NH_3)_2]^+OH^-$
(2) CH_3MgBr, $[Ag(NH_3)_2]^+OH^-$, H^+/CH_3OH
(3) $[Ag(NH_3)_2]^+OH^-$, CH_3MgBr, H^+/CH_3OH
(4) $[Ag(NH_3)_2]^+OH^-$, H^+/CH_3OH, CH_3MgBr



Solution:(4)



78. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are :

(1) ClO_2^- and ClO_3^- (2) Cl^- and ClO^-

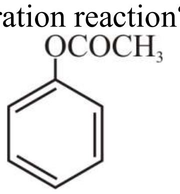
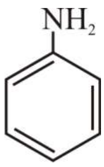
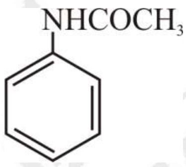
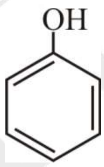
(3) Cl^- and ClO_2^- (4) ClO^- and ClO_3^-

Solution:(2)

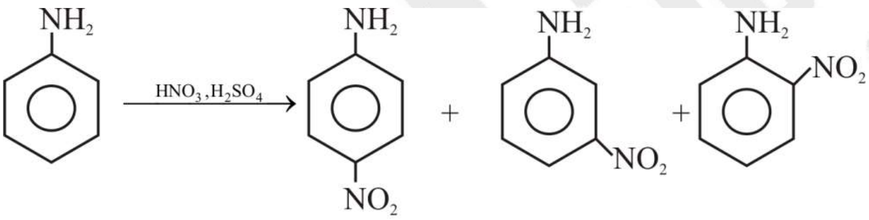
$$\underset{\text{(cold dil)}}{Cl_2 + NaOH} \longrightarrow NaCl + NaClO$$

NCERT XII Vol.-1, [7.19 Page no. 197]

79. Which of the following compounds will form significant amount of meta product during mono-nitration reaction?

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

Solution:(2)



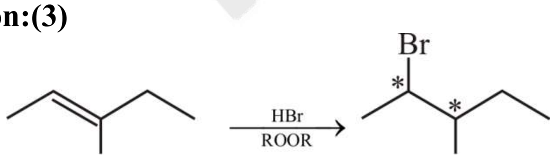
(51%) (47%) (2%)

NCERT XII Vol;.-2 [Page no. 305]

80. 3-Methyl-pent-2-ene on reaction with HBr in presence of peroxide forms an addition product. The number of possible stereoisomers for the product is :

(1) Zero (2) Two (3) Four (4) Six

Solution:(3)



no. of stereo isomers = 4

81. Two reactions R_1 and R_2 have identical pre-exponential factors. Activation energy of R_1 exceeds that of R_2 by 10 kJ mol^{-1}. If k_1 and k_2 are rate constants for reactions R_1 and R_2 respectively at 300 K, then $\ln(k_2/k_1)$ is equal to :

($R = 8.314$ J mol^{-1} K^{-1})

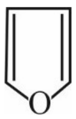
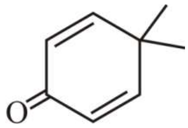
(1) 12 (2) 6 (3) 4 (4) 8

Solution:(3)

$$\ln K = \ln A - \frac{E_a}{RT}$$

$$\ln \frac{K_2}{K_1} = -\frac{(E_{a_2} - E_{a_1})}{RT} = \frac{10 \times 10^3}{8.31 \times 300} = 4$$

82. Which one the following molecules is least resonance stabilized?

(1)  (2)  (3)  (D) 

Solution:(3)

1, 2, 4 are aromatic

83. The group having isoelectronic species is

(1) O^{-}, F^{-}, Na, Mg^{+} (2) O^{2-}, F^{-}, Na, Mg^{2+} (3) O^{-}, F^{-}, Na^{+}, Mg^{2+} (4) O^{2-}, F^{-}, Na^{+}, Mg^{2+}

Solution:(4)

O^{2-}, F^{-}, Na^{+} & Mg^{2+} all have $10e^{-}$.

NCERT XI Vol.-1- [Page no.-84]

84. The radius of the second Bohr orbit for hydrogen atom is

(Plank's Const. $h = 6.6262 \times 10^{-34}$Js; mass of electron $= 9.1091 \times 10^{-31}$kg; charge of electron $e = 1.60210 \times 10^{-19}$C; permittivity of vacuum, $\varepsilon_0 = 8.854185 \times 10^{-12}\ kg^{-1}\ m^{-3}\ A^2$)

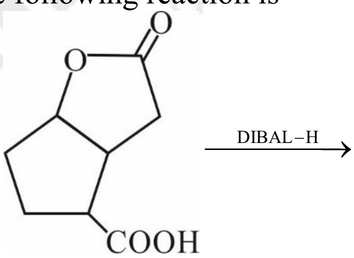
(1) 4.76 Å (2) 0.529 Å (3) 2.12 Å (4) 1.65 Å

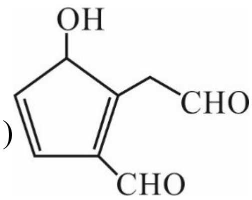
Solution:(3)

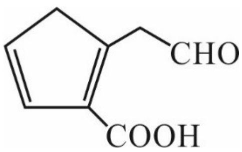
$$r = 0.529\ \frac{H^2}{Z}\text{Å} = 0.529 \times \frac{2^2}{1} = 2.12\,\text{Å}$$

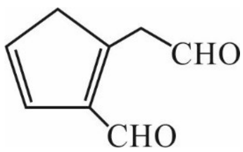
NCERT XI Vol.-1- [Page no.-44]

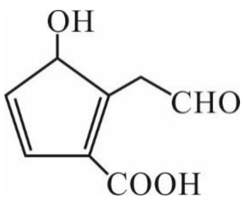
85. The major product obtained in the following reaction is



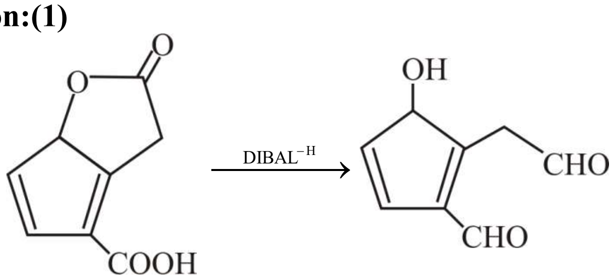
(1) 

(2) 

(3) 

(4) 

Solution:(1)



NCERT XII Vol.-2 [Page no. -354]

86. Which of the following reactions is an example of a redox reaction?

(1) $XeF_2 + PF_5 \rightarrow [XeF]^+ PF_6^-$ (2) $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$

(3) $XeF_6 + H_2O \rightarrow XeO_2F_2 + 4HF$ (4) $XeF_4 + O_2F_5 \rightarrow XeF_6 + O_2$

Solution:(4)

$$\overset{+4}{Xe}F_4 + \overset{+1}{O_2}F_2 \longrightarrow \overset{+6}{Xe}F_6 + \overset{0}{O_2}$$

87. A metal crystallises in a face centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be

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

Solution:(3)

Closest approach between two atoms in FCC = $\frac{a\sqrt{2}}{2} = \frac{a}{\sqrt{2}}$

NCERT XII Vol.-1- [Page no.-18]

88. Sodium salt of an organic acid 'X' produces effervescence with conc. H_2SO_4. 'X' reacts with the acidified aqueous $CaCl_2$ solution to give a white precipitate which decolourises acidic solution of $KMNO_4$. 'X' is

(1) HCOONa (2) CH_3COONa (3) $Na_2C_2O_4$ (4) C_6H_5COONa

Solution:(3)

$Na_2C_2O_4 + H_2SO_4 \longrightarrow CO + CO_2 \uparrow$

$Na_2C_2O_4 + CaCl_2 \longrightarrow \underset{\text{(White ppt)}}{CaC_2O_4}$

89. A water sample has ppm level concentration of following anions

$F^- = 10;\ SO_4^{2-} = 100;\ NO_3^- = 50$

The anion/anions that make/makes the water sample unsuitable for drinking is/are :

(1) Both SO_4^{2-} and NO_3^- (2) Only F^-

(3) Only SO_4^{2-} (4) Only NO_3^-

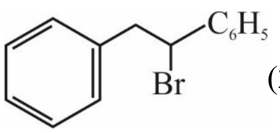
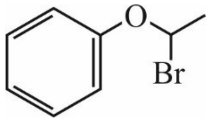
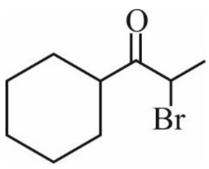
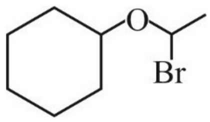
Solution:(2)

$F^- > 2\text{ppm}$ $SO_4^{2-} > 500\,\text{pm}$ $NO_3^- > 50\text{ ppm}$

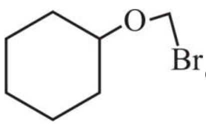
is not suitable for drinking.

NCERT XI Vol.-2 [Page- 407, 408]

90. Which of the following, upon treatment with tert-BuONa followed by addition of bromine water, fails to decolourize the colour of bromine?

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

Solution:(4)

 does not give alkene on reaction with test BuONa