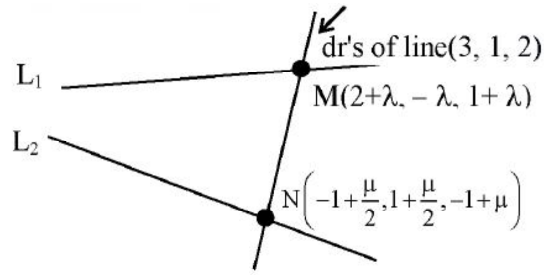
MATHEMATICS

1. B

Sol.



$$L_1 : \frac{x-2}{1} = \frac{y}{-1} = \frac{z-1}{1} = \lambda$$

$$L_2 : \frac{x+1}{\frac{1}{2}} = \frac{y-1}{\frac{1}{2}} = \frac{z+1}{1} = \mu$$

dr of line MN will be

$< 3+\lambda-\frac{\mu}{2},\ -1-\lambda-\frac{\mu}{2} >$ & it will be proportional to $< 3, 1, 2 >$

$$\therefore \frac{3+\lambda-\frac{\mu}{2}}{3} = \frac{-1-\lambda-\frac{\mu}{2}}{1} = \frac{2+\lambda-\mu}{2}$$

$4\lambda + \mu = -6$ $\quad$ $4 + 3\lambda = 0$

$$\Rightarrow \lambda = -\frac{4}{3} \ \& \ \mu = -\frac{2}{3}$$

$\therefore$ Coordinate of M will be $< \left(\frac{2}{3}, \frac{4}{3}, -\frac{1}{3}\right)$

and equation of required line will be.

$$\frac{x-\frac{2}{3}}{3} = \frac{y-\frac{4}{3}}{1} = \frac{z+\frac{1}{3}}{2} = k$$

So any point on this line will be

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

$$\because \frac{2}{3}+3k = -\frac{1}{3} \Rightarrow k = -\frac{1}{3}$$

$\therefore$ Point lie on the line for

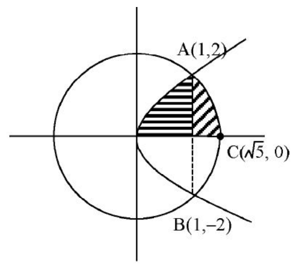
$k = -\frac{1}{3}$ is $\left(-\frac{1}{3},\ 1,\ -1\right)$

2. A

Sol. $y^2 = 4x$

$x^2 + y^2 = 5$

$\therefore$ Area of shaded region as shown in the figure will be



$$A_1 = \int_0^1 \sqrt{4x}\,dx + \int_1^{\sqrt{5}} \sqrt{5-x^2}\,dx$$

$$= \frac{4}{3}\cdot\left[x^{\frac{3}{2}}\right]_0^1 + \left[\frac{x}{2}\sqrt{5-x^2} + \frac{5}{2}\sin^{-1}\frac{x}{\sqrt{5}}\right]_1^{\sqrt{5}}$$

$$= \frac{1}{3} + \frac{5\pi}{4} - \frac{5}{2}\sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$$

$\therefore$ Required Area $= 2A_1$

$$= \frac{2}{3} + \frac{5\pi}{2} - 5\sin^{-1}\left(\frac{1}{\sqrt{5}}\right)$$

$$= \frac{2}{3} + 5\left(\frac{\pi}{2} - \sin^{-1}\frac{1}{\sqrt{5}}\right)$$

$$= \frac{2}{3} + 5\cos^{-1}\frac{1}{\sqrt{5}}$$

$$=\frac{2}{3}+5\sin^{-1}\left(\frac{2}{\sqrt{5}}\right)$$

3. A

Sol. $(2y-5)\frac{dy}{dx}=-3$

$(2y-5)dy=-3\ dx$

$2\cdot\frac{y^2}{2}-5y=-3x+\lambda$

$\because$ Curve passes through (0, 1)

$\Rightarrow \lambda=-4$

$\because$ Curve will be

$$\left(y-\frac{5}{2}\right)^2=-3\left(x-\frac{3}{4}\right)$$

$\therefore$ Vertex of parabola will be $\left(\frac{3}{4},\ \frac{5}{2}\right)$

$\therefore 2x+3y=9$

4. D

Sol.

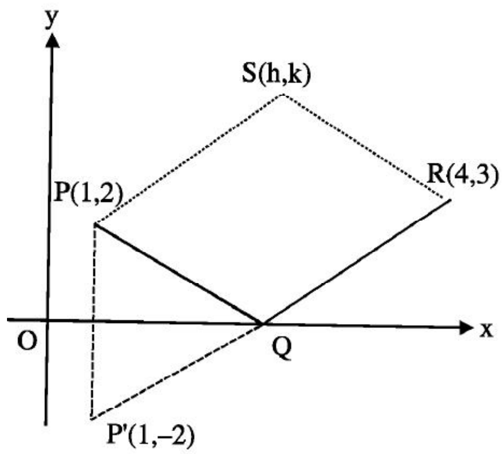


Image of P wrt x-axis will be P'(1, –2) equation of line joining P'R will be

$$y-3=\frac{5}{3}(x-4)$$

Above line will meet x-axis at Q where

$$y=0\Rightarrow x=\frac{11}{5}$$

$$\therefore Q\left(\frac{11}{5},\ 0\right)$$

$\because$ PQRS is parallelogram so their diagonals will bisects each other

$$\Rightarrow \frac{4+1}{2}=\frac{\frac{11}{5}+h}{2}\ \&\ \frac{2+3}{2}=\frac{k+0}{2}$$

$$\Rightarrow h=\frac{14}{5}\ \&\ k=5$$

$$\therefore hk^2=\frac{14}{5}\times5^2=70$$

5. A

Sol. $3x+5y+\lambda z=3$

$7x+11y-9z=2$

$97x+155y-189z=\mu$

$93x+155y+31\lambda z=93$

$97x+155y-189z=\mu$

$\underline{-\quad\ -\quad\ +\quad\ -}$

$-4x+(31+189)z=93-\mu$

$1085x+1705y-1395z=310$

$1067x+1705y-2079z=11\mu$

$\underline{-\quad\ -\quad\ +\quad\ -}$

$18x+684z=310-11\mu$

$-36x+9(31\lambda+189)z=9(93-\mu)$

$36x+1368z=2(310-11\mu)$

$(279\lambda+3069)z=1457-31\mu$

for infinite solutions

$$\lambda=\frac{-3069}{279}=\frac{-341}{31}$$

$$\mu=\frac{1457}{31}$$

$$\mu+2\lambda=\frac{1457-682}{31}=\frac{775}{31}=25$$

6. D

Sol. $x^2(1+x)^{98}+x^3(1+x^{97})+x^4(1+x)^{96}+\ldots\ldots\ x^{54}(1+x)^{46}$

Coeff. of x^{70} : ${}^{98}C_{68}+{}^{97}C_{67}+{}^{96}C_{66}+\ldots\ldots\ {}^{47}C_{17}+{}^{46}C_{16}$

$=({}^{46}C_{31}+{}^{46}C_{30})+{}^{47}C_{30}+\ldots\ldots\ {}^{98}C_{30}-{}^{46}C_{31}\ \ldots\ldots$

$= {}^{99}C_{31} - {}^{46}C_{31} = {}^{99}C_p - {}^{46}C_q$

Possible values of (p + q) are 62, 83, 99, 46

$\Rightarrow p + q = 83$

7. C

Sol. $\int \frac{2-\tan x}{3+\tan x}dx = \int \frac{2\cos x - \sin x}{3\cos x + \sin x}dx$

2 cos x – sin x = A(3 cos x + sin x) + B(cos x – 3 sin x)

$3A + B = 2$

$A - 3B = -1$

$\Rightarrow A = \frac{1}{2},\ B = \frac{1}{2}$

$\therefore \int \frac{2\cos x - \sin x}{3\cos x + \sin x}dx$

$= \frac{x}{2} + \frac{1}{2}\ln|3\cos x + \sin x| + C$

$= \frac{1}{2}(x + \ln|3\cos x + \sin x|) + C$

$= \frac{1}{2}(\alpha x + \ln|\beta \sin x + \gamma \cos x|) + C$

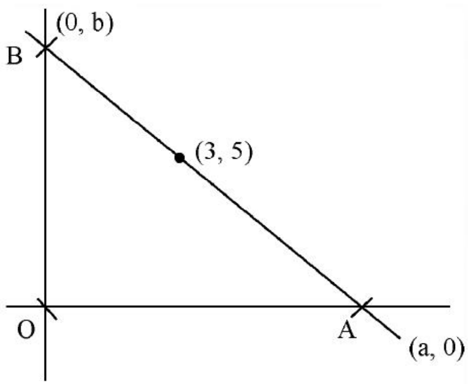
$\alpha = 1,\ \beta = 1,\ \gamma = 3$

$\therefore \alpha + \frac{\gamma}{\beta} = 1 + \frac{3}{1} = 4$

8. A

Sol. $\frac{x}{a} + \frac{y}{b} = 1$

$\frac{3}{a} + \frac{5}{b} = 1 \Rightarrow b = \frac{5a}{a-3},\ a > 3$



$A = \frac{1}{2}ab = \frac{1}{2}a\frac{5a}{(a-3)} = \frac{5}{2}\cdot\frac{a^2}{a-3}$

$= \frac{5}{2}\left(\frac{a^2 - 9 + 9}{a-3}\right)$

$= \frac{5}{2}\left(a + 3 + \frac{9}{a-3}\right)$

$= \frac{5}{2}\left(a - 3 + \frac{9}{a-3} + 6\right) \geq 30$

9. C

Sol. We know that

$(\cos\theta)(\cos(60^\circ - \theta))(\cos(60^\circ + \theta)) = \frac{1}{4}\cos 3\theta$

So equation reduces to $\left|\frac{1}{4}\cos 3\theta\right| \leq \frac{1}{8}$

$\Rightarrow |\cos 3\theta| \leq \frac{1}{2}$

$\Rightarrow -\frac{1}{2} \leq \cos 3\theta \leq \frac{1}{2}$

$\Rightarrow$ maximum value of $\cos 3\theta = \frac{1}{2}$, here

$\Rightarrow 3\theta = 2n\pi \pm \frac{\pi}{3}$

$\theta = \frac{2n\pi}{3} \pm \frac{\pi}{9}$

As $\theta \in [0,\ 2\pi]$ possible values are

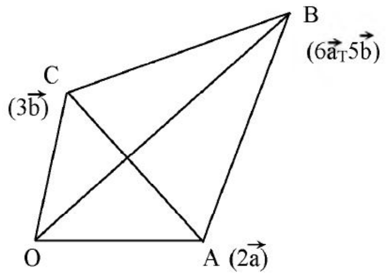
$\theta = \left\{\frac{\pi}{9}, \frac{5\pi}{9}, \frac{7\pi}{9}, \frac{11\pi}{9}, \frac{13\pi}{9}, \frac{17\pi}{9}\right\}$

Whose sum is

$\frac{\pi}{9} + \frac{5\pi}{9} + \frac{7\pi}{9} + \frac{11\pi}{9} + \frac{13\pi}{9} + \frac{17\pi}{9} = \frac{54\pi}{9} = 6\pi$

10. D

Sol.



Area of parallelogram having sides

$\overline{OA}$ & $\overline{OC} = |\overline{OA} \times \overline{OC}| = |2\vec{a} \times 3\vec{b}| = 15$

$6|\vec{a} \times \vec{b}| = \frac{5}{2}$ .....(1)

Area of quadrilateral

$OABC = \frac{1}{2}|\vec{d}_1 \times \vec{d}_2|$

$= \frac{1}{2}|\overline{AC} \times \overline{OB}| = \frac{1}{2}|(3\vec{b} - 2\vec{a}) \times (6\vec{a} + 5\vec{b})|$

$= \frac{1}{2}|18\vec{b} \times \vec{a} - 10\vec{a} \times \vec{b}| = 14|\vec{a} \times \vec{b}|$

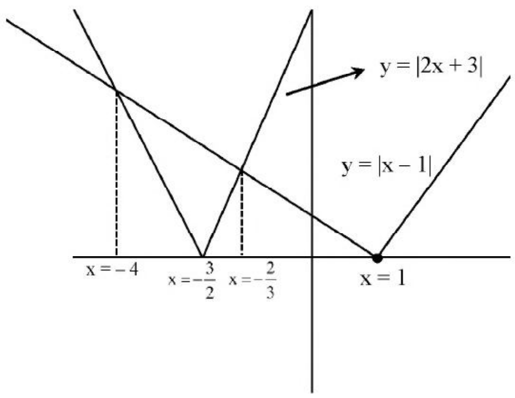
$= 14 \times \frac{5}{2} = 35$

11. D

Sol. Domain of $f(x) = \sin^{-1}\left(\frac{x-1}{2x+3}\right)$ is

$2x + 3 \neq 0$ & $x \neq \frac{-3}{2}$ and $\left|\frac{(x-1)}{2x+3}\right| \leq 1$

$|x - 1| \leq |2x + 3|$



For $|2x + 3| \geq |x - 1|$

$x \in (-\infty, -4] \cup \left(-\frac{2}{3}, \infty\right)$

$\alpha = -4$ & $\beta = -\frac{2}{3} : 12\alpha\beta = 32$

12. B

Sol. $\frac{1}{1\cdot(1+d)} + \frac{1}{(1+d)(1+2d)} + ...$

$\frac{1}{(1+9d)(1+10d)} = 5$

$\frac{1}{d}\left[\frac{(1+d)-1}{1\cdot(1+d)} + \frac{(1+2d)-(1-d)}{(1+d)(1+2d)}\right] + ...$

$\frac{(1+10d)-(1+9d)}{(1+9d)(1+10d)} = 5$

$\frac{1}{d}\left[\left(1 - \frac{1}{1+d}\right) + \left(\frac{1}{1+d} - \frac{1}{1+2d}\right) + ...\right.$

$\left.\left(\frac{1}{1+9d} - \frac{1}{1+10d}\right)\right] = 5$

$\frac{1}{d}\left[1 - \frac{1}{(1+10d)}\right] = 5$

$\frac{10d}{1+10d} = 5d$

$50d = 5$

13. D

Sol. $f(x) = ax^3 + bx^2 + cx + 41$

$f'(x) = 3ax^2 + 2bx + cx$

$\Rightarrow f'(1) = 3a + 2b + c = 2$ ....(1)

$f''(n) = 6ax + 2b$

$\Rightarrow f''(1) = 6a + 2b = 4$

$3a + b = 2$........(2)

(1) – (2)

$b + c = 0$........(3)

$f(1) = 40$

$a + b + c + 41 = 40$

use (3)

$a + 41 = 40$

by (2)

$-3 + b = 2 \Rightarrow b = 5$ & $c = -5$

$a^2 + b^2 + c^2 = 1 + 25 + 25 = 51$

14. A

Sol. $(2+c)x + 5c^2\left(\frac{1-3x}{5}\right) = 1$

$$x = \frac{1-c^2}{2+c-3c^2},\ y = \frac{1-3x}{5} = \frac{c-1}{5(2+c-3c^2)}$$

$$h = \lim_{c\to 1}\frac{(1-c)(1+c)}{(1-c)(2+3c)} = \frac{2}{5}$$

$$K = \lim_{c\to 1}\frac{c-1}{-5(c-1)(3c+2)} = -\frac{1}{25}$$

Centre $\left(\frac{2}{25},\ -\frac{1}{25}\right)$,

$$r = \sqrt{\left(2-\frac{2}{5}\right)^2 + \left(0-\frac{1}{25}\right)^2} = \sqrt{\frac{64}{25}+\frac{1}{625}}$$

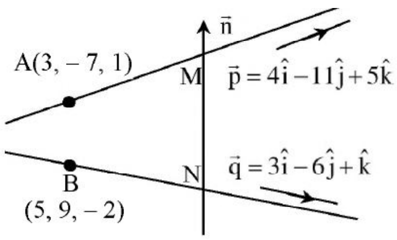
$$r = \frac{\sqrt{161}}{25}$$

$$\left(x-\frac{2}{5}\right)^2 + \left(y+\frac{1}{25}\right)^2 = \frac{161}{125}$$

$$\Rightarrow 25x^2 + 25y^2 - 20x + 2y - 60 = 0$$

15. A

Sol.



$\vec{n} = \vec{p} \times \vec{q}$

$$\vec{n} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 4 & -11 & 5 \\ 3 & -6 & 1 \end{vmatrix} = 19\hat{i} + 11\hat{j} + 9\hat{k}$$

S.d. = projection of $\overrightarrow{AB}$ on $\vec{n}$

$$= \left|\frac{\overrightarrow{AB}\cdot\vec{n}}{|\vec{n}|}\right| = \left|\frac{(2\hat{i}+16\hat{j}-3\hat{k})\cdot(19\hat{i}+11\hat{j}+9\hat{k})}{\sqrt{361+121+81}}\right|$$

$$= \frac{38+176-27}{\sqrt{563}}$$

$$\text{S.d.} = \frac{187}{\sqrt{563}}$$

163. B

Sol. $x + y = 10$ .....(1)

Median = 18 = M

$$\text{M.D.} = \frac{\Sigma f_i\,|x_i - M|}{\Sigma f_i}$$

$$1.25 = \frac{36 + x + 2y}{40}$$

$x + 2y = 14$ ......(2)

by (1) & (2)

$x = 6,\ y = 4$

$\Rightarrow 4x + 5y = 24 + 20 = 44$

Age(x_i)	f	$\lvert x_i - M\rvert$	$f_i\lvert x_i - M\rvert$
15	5	3	15
16	8	2	16
17	5	1	5
18	12	0	0
19	x	1	x
20	y	2	2y

17. A

Sol. $(x^2 + y^2)dx = 5xydy$

$$\Rightarrow \frac{dy}{dx} = \frac{x^2+y^2}{5xy}$$

Put $y = Vx$

$$\Rightarrow V + x\frac{dv}{dx} = \frac{1+V^2}{5V}$$

$$\Rightarrow \frac{xdv}{dx} = \frac{1-4V^2}{5V}$$

$$\Rightarrow \int \frac{V}{1-4V^2}dV = \int \frac{dx}{5x}$$

Let $1 - 4V^2 = t$

$\Rightarrow -8V\,dV = dt$

$$\Rightarrow \int \frac{dt}{(-8)(t)} = \int \frac{dx}{5x}$$

$\Rightarrow \frac{-1}{8}\ln|t| = \frac{1}{5};n|x| + \ln C$

$\Rightarrow$ –5 ln |x| = 8 ln |x| + ln K

$\Rightarrow$ ln x^8 + ln $|t^5|$ + ln K = 0

$\Rightarrow$ x^8 $|t^5|$ = C

$\Rightarrow$ x^8 $|1 - 4V^2|^5$ = C

$$\Rightarrow x^8 \left|\frac{x^2 - 4y^2}{x^2}\right|^5 = C$$

$\Rightarrow$ $|x^2 - 4y|^5 = Cx^2$

given y(1) = 0

$\Rightarrow$ $|1|^5$ = C $\Rightarrow$ C = 1

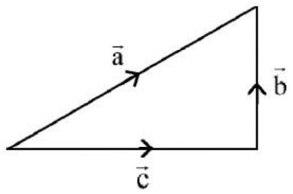
$\Rightarrow$ $|x^2 - 4y^2|^5 = x^2$

18. B

Sol. $\vec{c} = \vec{a} - \vec{b}$

$\Rightarrow (x, y, z) = (\alpha - 5, 1, -2)$

$\Rightarrow x = \alpha - 5,\ y = 1,\ z = -2$ .....(1)



Area of $\Delta = 5\sqrt{6}$ (given)

$$\frac{1}{2}|\vec{a} \times \vec{c}| = 5\sqrt{6}$$

$$\left\|\begin{matrix} \hat{i} & \hat{j} & \hat{k} \\ \alpha & 4 & 2 \\ x & 1 & -2 \end{matrix}\right\| = 10\sqrt{6}$$

$\Rightarrow |-10\hat{i} - \hat{j}(-2\alpha - 2x) + \hat{k}(\alpha - 4x)| = 10\sqrt{6}$

$\Rightarrow (2\alpha + 2\alpha - 10)^2 + (\alpha - 4\alpha + 20)^2 = 500$

$\Rightarrow (4\alpha - 10)^2 + (20 - 3\alpha)^2 = 500$

$\Rightarrow 25\alpha^2 - 80\alpha - 120\alpha = 0$

$\Rightarrow \alpha(25\alpha - 200) = 0$

$\Rightarrow \alpha = 8$ (given α is +ve number)

$\Rightarrow x = \alpha - 5 = 3$

$|\vec{c}|^2 = x^2 + y^2 + z^2$

= 9 + 1 + 4

= 14

19. C

Sol. $x^2 + 2\sqrt{2}x - 1 = 0$

$\alpha + \beta = -2\sqrt{2}$

$\alpha\beta = -1$

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

$= ((\alpha + \beta)^2 - 2\alpha\beta)^2 - 2(\alpha\beta)^2$

$= (8 + 2)^2 - 2(-1)^2$

= 100 – 2 = 98

$\alpha^6 + \beta^6 = (\alpha^2 + \beta^3)^2 - 2\alpha^3\beta^3$

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

$= (-2\sqrt{2} + (8 + 3))^2 + 2$

= (8) (121) + 2 = 970

$\frac{1}{10}(\alpha^6 + \beta^6) = 97$

$x^2 - (98 + 97)x + (98)(97) = 0$

$\Rightarrow$ $x^2 - 195x + 9506 = 0$

20. B

Sol. $f(x) = x^2 + 9\ g(x) = \frac{x}{x - 9}$

$a = f(g(10)) = f\left(\frac{10}{10 - 9}\right)$

= f(10) = 109

b = g(f(3)) = g(9 + 9)

$= g(18) = \frac{18}{9} = 2$

$E: \frac{x^2}{109} + \frac{y^2}{2} = 1$

$e^2 = 1 - \frac{2}{109} = \frac{107}{109}$

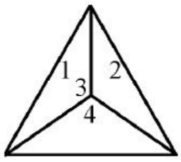
$\ell = \frac{2(2)}{\sqrt{109}} = \frac{4}{\sqrt{109}}$

$8e^2 + \ell^2 = \frac{8(107)}{109} + \frac{16}{109}$

= 8

21. 19

Sol. $a, b, c \in \{1, 2, 3, 4\}$



Tetrahedral dice

$ax^2 + bx + c = 0$

has all real roots

$\Rightarrow D \geq 0$

$\Rightarrow b^2 - 4ac \geq 0$

Let $b = 1 \Rightarrow 1 - 4ac \geq 0$ (Nor feasible)

$b = 2 \Rightarrow 4 - 4ac \geq 0$

$1 \geq ac \Rightarrow a = 1, \ c = 1,$

$b = 3 \Rightarrow 9 - 4ac \geq 0$

$\frac{9}{4} \geq ac$

$\Rightarrow a = 1, c = 1$

$\Rightarrow a = 1, c = 2$

$\Rightarrow a = 2, c = 1$

$b = 4 \Rightarrow 16 - 4ac \geq 0$

$4 \geq ac$

$\Rightarrow a = 1, c = 1$

$\Rightarrow a = 1, c = 2$ $\quad \Rightarrow a = 2, c = 1$

$\Rightarrow a = 1, c = 3$ $\quad \Rightarrow a = 3, c = 1$

$\Rightarrow a = 1, c = 4$ $\quad \Rightarrow a = 4, c = 1$

$\Rightarrow a = 2, c = 2$

Probability $= \frac{12}{(4)(4)(4)} = \frac{3}{16} = \frac{m}{n}$

$m + n = 19$

22. 9

Sol. $|z - 1| \leq 1$

$\Rightarrow |(x-1) + iy| \leq 1$

$\Rightarrow \sqrt{(x-1)^2 + y^2} \leq 1$

$\Rightarrow (x-1)^2 + y^2 \leq 1$ .....(1)

Also $|z - 5| \leq |z - 5i|$

$(x-5)^2 + y^2 \leq x^2 + (y-5)^2$

$-10x \leq -10y$

$\Rightarrow x \geq y$ .....(2)

Solving (1) and (2)

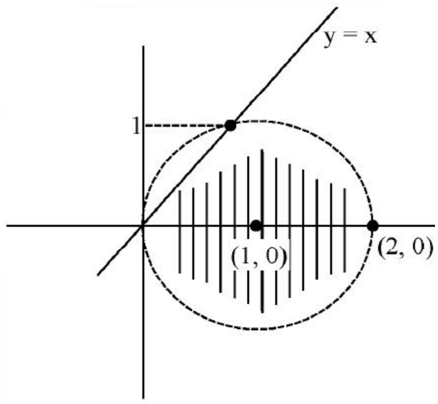
$\Rightarrow (x - 1)^2 + x^2 = 1$

$\Rightarrow 2x^2 - 2x = 0$

$\Rightarrow x(x - 1) = 0$

$\Rightarrow x = 0$ or $x = 1$

$y = 0$ or $y = 1$



Given $x, y \in I$

Points (0, 0), (1, 0), (2, 0), (1, 1), (1, –1) to find

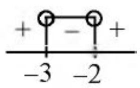
$|z_1|^2 + |z_2|^2 + |z_3|^2 + |z_4|^2 + |z_5|^2$

$= 0 + 1 + 4 + 1 + 1 + 1 + 1 = 9$

23. 39

Sol. $\frac{x^2 + x + 2}{x^2 + 5x + 6} < 0$

$\Rightarrow \frac{1}{(x+2)(x+3)} < 0$



$x \in (-3, \ -2)$ ......(1)

$f(x) = 1 + (\lambda^2 - x^2)$

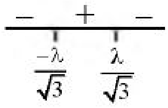
Finding local minima

$f'(x) = (\lambda^2 - x^2) + (-2x) \cdot x$

Put $f'(x) = 0$

$\Rightarrow \lambda^2 = 3x^2$

$$\Rightarrow x = \pm\frac{\lambda}{\sqrt{3}}$$



Local min Local mas

We want local min

$$\Rightarrow x = \frac{-\lambda}{\sqrt{3}}$$

from (1)

$$x \in (-3,\ -2)$$

$$-3 < \frac{-\lambda}{\sqrt{3}} < -2$$

$$3\sqrt{3} > \lambda > 2\sqrt{3}$$

$$\alpha = 2\sqrt{3},\ \beta = 3\sqrt{3}$$

$$\alpha^2 + \beta^2 = 12 + 27 = 39$$

24. 32

Sol. $\sum_{r=1}^{\infty} \frac{n}{\sqrt{n^4+r^4}} - \frac{2nr^2}{(n^2+r^2)\sqrt{n^4+r^4}}$

$$\sum_{r=1}^{\infty} \frac{\frac{1}{n}}{\sqrt{1+\left(\frac{r}{n}\right)^4}} - \frac{2\left(\frac{1}{n}\right)\left(\frac{r}{n}\right)^2}{\left(1+\left(\frac{r}{n}\right)^2\right)\sqrt{1+\left(\frac{r}{n}\right)^4}}$$

$$\Rightarrow \int_0^1 \frac{dx}{\sqrt{1+x^4}} - \frac{2x^2dx}{(1+x^2)\sqrt{1+x^4}}$$

$$\Rightarrow \int_0^1 \frac{1-x^2}{(1+x^2)\sqrt{1+x^4}}dx$$

$$\Rightarrow \int_0^1 \frac{\frac{1}{x^2}-1}{\left(x+\frac{1}{x}\right)\sqrt{x^2+\frac{1}{x^2}}}dx$$

$$\Rightarrow -\int_0^1 \frac{1-\frac{1}{x^2}}{\left(x+\frac{1}{x}\right)\sqrt{\left(x+\frac{1}{x}\right)^2-2}}dx$$

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

$$\Rightarrow -\int_{\infty}^{2} \frac{dt}{t\sqrt{t^2-2}}$$

$$\Rightarrow -\int_{\infty}^{2} \frac{tdt}{t^2\sqrt{t^2-2}}$$

take $t^2 - 2 = \alpha^2$

$t\,dt = \alpha\,d\alpha$

$$\Rightarrow -\int_{\infty}^{\sqrt{2}} \frac{\alpha d\alpha}{(\alpha^2+2)\alpha}$$

$$\Rightarrow -\int_{\infty}^{\sqrt{2}} \frac{d\alpha}{\alpha^2+2}$$

$$\Rightarrow \frac{-1}{\sqrt{2}}\tan^{-1}\frac{\alpha}{\sqrt{2}}\Big]_{\infty}^{\sqrt{2}}$$

$$\Rightarrow \frac{-1}{\sqrt{2}}\{\tan^{-1}1\} + \frac{1}{\sqrt{2}}\tan^{-1}\infty$$

$$\Rightarrow \frac{1}{\sqrt{2}}\left\{\frac{\pi}{2} - \frac{\pi}{4}\right\}$$

$$\Rightarrow \frac{\pi}{4\sqrt{2}} = \frac{\pi}{K}$$

So $K = 4\sqrt{2}$

$K^2 = 32$

25. 1

Sol. $(428)^{2024} = (420 + 8)^{2024}$

$= (21 \times 20 + 8)^{2024}$

$= 21m + 8^{2024}$

Now $8^{2024} = (8^2)^{1012}$

$= (64)^{1012}$

$= (63 + 1)^{1012}$

$= (21 \times 3 + 1)^{1012}$

$= 21n + 1$

$\Rightarrow$ Remainder is 1.

26. 81

Sol. LHL at $x = \frac{\pi}{2}$

$$\lim_{x\to\frac{\pi}{2}}\left(\frac{8}{7}\right)^{\frac{\tan 8x}{\tan 7x}} = \left(\frac{8}{7}\right)^{0} = 1$$

RHL at $x = \frac{\pi}{2}$

$$\lim_{x\to\frac{\pi}{2}}(1+|\cot x|)^{\frac{b}{a}|\tan x|}$$

$$= e^{\lim_{x\to\frac{\pi}{2}}|\cot x|\frac{b}{a}|\tan x|} = e^{\frac{b}{a}}$$

$$\Rightarrow 1 = a - 8 = e^{\frac{b}{a}}$$

$\Rightarrow$ a = 9, b = 0

$\Rightarrow$ $a^2 + b^2 = 81$

27. 14

Sol. $|3\ \text{adj}(2\text{adj}\ (|A|A))| = |3\text{adj}\ (2|A|^2\ \text{adj}(A)|$

$= |3.2^2|A|^4\ \text{adj}(\text{adj}\ (A)| = 2^6 3^3\ |A|^{12}\ |A|^4$

$= 2^6\ 3^3\ |A|^{16} = 2^{-10}\qquad 3^{-13}$

$\Rightarrow\ |A|^{16} = 2^{-16}\ 3^{-16} \Rightarrow |A| = 2^{-1}\ 3^{-1}$

Now $|3\text{adj}\ (2A)| = |3.2^2\ \text{adj}(A)|$

$= 2^6\ 3^3\ |A|^2 = 2^{-m}\ 3^{-n}$

$\Rightarrow\ 2^6\ 3^3\ 2^{-2}\ 3^{-2} = 2^{-m}\ 3^{-n}$

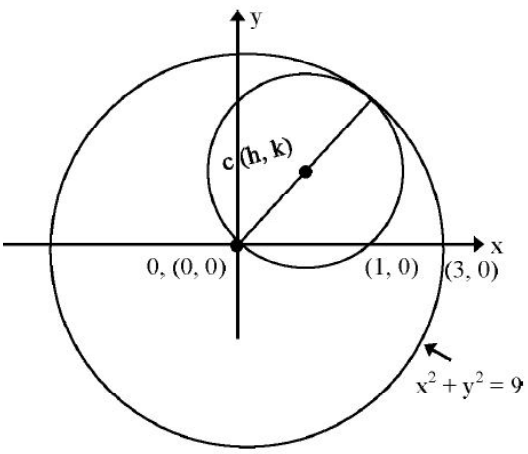
$\Rightarrow\ 2^{-m}\ 3^{-n} = 2^4\ 3^1$

$\Rightarrow$ m = –4, n = –1

$\Rightarrow$ |3m + 2n| = |–12 – 2| = 14

28. 9

Sol.



$(x - h)^2 + (y - k)^2 = h^2 + k^2$

$x^2 + y^2 - 2hx - 2ky = 0$

$\because$ passes through (1, 0)

$\Rightarrow$ 1 + 0 – 2h = 0

$\Rightarrow$ h = 1/2

$$\because OC = \frac{OP}{2}$$

$$\sqrt{\left(\frac{1}{2}\right)^2 + k^2} = \frac{3}{2}$$

$$\frac{1}{4} + k^2 = \frac{9}{4}$$

$k^2 = 2$

$k = \pm\sqrt{2}$

$\therefore$ Possible coordinate of

$$c(h,\ k)\left(\frac{1}{2},\ \sqrt{2}\right)\left(\frac{1}{2},\ -\sqrt{2}\right)$$

$$4(h^2 + k^2) = 4\left(\frac{1}{4} + 2\right) = 4\left(\frac{9}{4}\right) = 9$$

29. 1010

Sol. f(m + n) = f(m) + f(n)

$\Rightarrow$ f(x) = kx

$\Rightarrow$ f(1) = 1

$\Rightarrow$ k = 1

f(x) = x

Now

$$\sum_{k=1}^{2022} f(\lambda + k) \le (2022)^2$$

$$\Rightarrow \sum_{k=1}^{2022} (\lambda + k) \le (2022)^2$$

$$\Rightarrow 2022\lambda + \frac{2022 \times 2023}{2} \le (2022)^2$$

$$\Rightarrow \lambda \le 2022 - \frac{2023}{2}$$

$$\Rightarrow \lambda \le 1010.5$$

$\therefore$ largest natural no. λ is 1010.

30.25

A = {2, 3, 6, 7}

B = { 2, 5, 6, 8}

$(a_1,\ b_1)\ R(a_2,\ b_2)$

$a_1 + a_2 = b_1 + b_2$

$$\left.\begin{array}{ll} 1.\ (2,4)R(6,4) & 2.\ (2,4)R(7,5) \\ 3.\ (2,5)R(7,4) & 4.\ (3,4)R(6,5) \\ 5.\ (3,5)R(6,4) & 6.\ (3,5)R(7,5) \\ 7.\ (3,6)R(7,4) & 8.\ (3,4)R(7,6) \\ 9.\ (6,5)R(7,8) & 10.\ (6,8)R(7,5) \\ 11.\ (7,8)R(7,6) & 12.\ (6,8)R(6,4) \\ 13.\ (6,6)R(6,6) & \end{array}\right] \times 2$$

Total 24 + 1 = 25

PHYSICS

Section - A (Single Correct Answer)

31. B

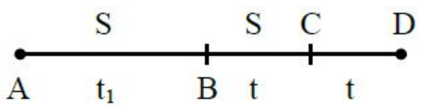
Sol. $\lambda_{DB} = \frac{h}{p} = \frac{h}{\sqrt{2mk}}$

$\Rightarrow \lambda_{DB} \alpha \frac{1}{\sqrt{m}}$

$\Rightarrow \lambda_a < \lambda_p < \lambda_e$

32. D

Sol.



BD $\Rightarrow$ S = 9t + 15t = 24t

AB $\Rightarrow$ S = 6t1 = 24t $\Rightarrow$ t1 = 4t

$< \text{speed} > = \frac{\text{dist.}}{\text{time}} = \frac{48t}{2t + t_1}$

$= \frac{48t}{2t + 4t} \Rightarrow \frac{48t}{6t} \Rightarrow 8 \text{ m/s}$

33. B

Sol. $E = BC \Rightarrow 60 = B \times 3 \times 10^8$

$\Rightarrow \quad B = 2 \times 10^{-7}$

Also $C = f\lambda$

$\Rightarrow \quad 3 \times 10^8 = f \times 4 \times 10^{-3}$

$\Rightarrow \quad f = \frac{3}{4} \times 10^{11}$

$\Rightarrow \quad \omega = 2\pi f = \frac{3}{4} \times 2\pi \times 10^{11}$

$\Rightarrow \quad \omega = \frac{\pi}{2} \times 10^3 C$

$\Rightarrow$ Electric field $\Rightarrow$ y direction

Propagation $\Rightarrow$ x direction

Magnetic field $\Rightarrow$ z-direction

34. A OR B

Sol. $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$\frac{1}{v} - \frac{1}{-2f} = \frac{1}{-f}$

$\Rightarrow \frac{1}{v} - \frac{-1}{2f} \Rightarrow v = -2f$

$\frac{1}{v} = \frac{1}{u} + \frac{1}{f} \Rightarrow$ Virtual image of Real object.

In statement II, it is not mentioned that object is real or virtual hence **Statement II** is false.

35. C

Sol. $\lambda = \frac{1240}{1.42} = 875 \text{ nm (Approx)}$

36. A

Sol. weight (w) $= \frac{4}{3}\pi\left(\frac{D^3 - d^3}{8}\right)\sigma g$

Buoyant force $(F_b) = 1 \times \frac{4}{3}\pi\left(\frac{D^3}{8}\right) \cdot g$

For Just Float $\Rightarrow w = F_b$

$\Rightarrow (D^3 - d^3)\sigma = D^3$

$\Rightarrow 1 - \frac{d^3}{D^3} = \frac{1}{\sigma}$

$\Rightarrow 1 - \frac{1}{\sigma} = \left(\frac{d}{D}\right)^3$

$\Rightarrow \left(\frac{\sigma}{\sigma - 1}\right)^{\frac{1}{3}} = \left(\frac{D}{d}\right)$

37. A

Sol. All capacitor are in parallel combination.

Also effective area is common area only

$\Rightarrow \quad C_{eq} = C_1 + C_2 + C_3$

$\Rightarrow \quad C_{eq} = \frac{A\varepsilon_0}{3d} + \frac{A\varepsilon_0}{3(2d)} + \frac{A\varepsilon_0}{3(3d)}$

$\Rightarrow \quad C_{eq} = \frac{A\varepsilon_0}{3}\left(\frac{11}{6d}\right)$

$\Rightarrow \quad C_{eq} = \frac{11A\varepsilon_0}{18d}$

38. A

Sol. $a_{sys} = \left(\frac{m_2 - m_1}{m_1 + m_2}\right)g = \frac{g}{8} \Rightarrow \frac{m_2}{m_1} = \frac{9}{7}$

39. C

Sol. Latent heat is specific heat

$$\Rightarrow \frac{ML^2T^{-2}}{M} = M^0L^2T^{-2}$$

40. C

Sol. For Adiabatic process

$$P_iV_i = P_fV_f^{\gamma}$$

$$P_i(5)^{1.5} = P_f(4)^{1.5}$$

$$\frac{P_i}{P_f} = \left(\frac{4}{5}\right)^{\frac{3}{2}} = \frac{4}{5}\cdot\left(\frac{4}{5}\right)^{\frac{1}{2}} \Rightarrow \frac{8}{5\sqrt{5}}$$

41. D

Sol. $E = mC^2$

$\Rightarrow \quad E = (1 \times 10^{-3}) \times (3 \times 10^8)^2$ J

$\Rightarrow \quad E = (10^{-3})(9 \times 10^{16})(6.241 \times 10^{18})$ eV

$E = 56.169 \times 10^{31}$ eV

$E \approx 5.6 \times 10^{26}$ MeV

42. A

Sol. $h = 318.5 \approx \left(\frac{R_e}{20}\right)$

$$T.E_i = \frac{-GM_em}{R_e}$$

$$T.E_f = \frac{-GM_em}{2(R_e + h)} = \frac{-GM_em}{2\left(R_e + \frac{R_e}{20}\right)}$$

$$\Rightarrow T.E_f = \frac{-10GM_em}{21R_e}$$

Change in total mechanical energy

$= TE_f - TE_i$

$$= \frac{GM_em}{Re}\left[1 - \frac{10}{21}\right] = \frac{11GM_em}{21Re}$$

43. B

Sol. Conceptual.

44. C

Sol. $v = \alpha\sqrt{x}$

at $x = 0 : v = 0$

& at $x = d$; $v = \alpha\sqrt{d}$

$W.D = K_f - K_i$

$$W.D. = \frac{1}{2}m\left(\alpha\sqrt{d}\right)^2 - \frac{1}{2}m(0)^2$$

$$\Rightarrow W.D. = \frac{m\alpha^2 d}{2}$$

45. B

Sol. $G = 200\ \Omega$

$i_g = 20\ \mu A$

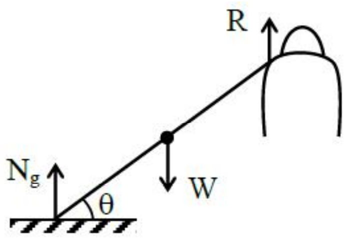
$$i = i_g\left(\frac{G}{S} + 1\right)$$

$$\Rightarrow 20 \times 10^{-3} = 20 \times 10^{-6}\left(\frac{200}{S} + 1\right)$$

$$\Rightarrow \frac{200}{S} = 999 \Rightarrow S \approx 0.2\ \Omega$$

46. A

Sol.



R = net reaction force by shoulder

Balancing torque about pt of contact on ground:

$$W\left(\frac{L}{2}\cos\theta\right) = R(L\cos\theta)$$

$$\Rightarrow R = \frac{W}{2}$$

47. B

Sol. n MSD = (n + 1) VSD

$$\Rightarrow \quad 1\ VSD = \frac{n}{n+1}MSD$$

$$L.C = 1MSD - 1VSD$$

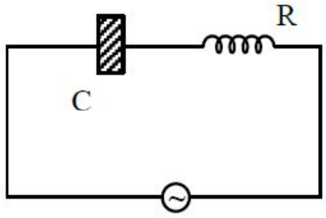
$$L.C = m - m\left(\frac{n}{n+1}\right)$$

$$L.C = m\left(\frac{n+1-n}{n+1}\right)$$

$$\Rightarrow L.C = \left(\frac{m}{n+1}\right)$$

48. A

Sol.



$$Z=\sqrt{R^2+X_C^2} \quad \& \quad X_C=\frac{1}{WC}$$

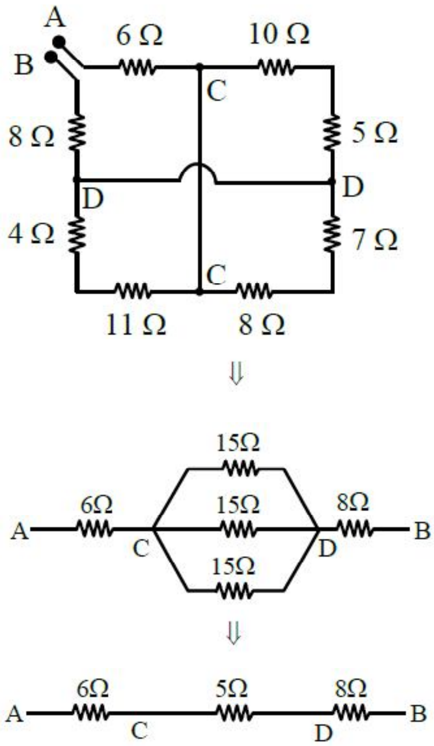
due to dielectric

$$C\uparrow \Rightarrow X_C\downarrow \Rightarrow Z\downarrow$$

So, current increases & thus bulb will glow more brighter.

49. D

Sol.



$\Rightarrow$ Req = 6Ω + 5Ω + 8Ω = 19Ωfn

50. A

Sol. $TV^{\gamma-1}$ = constant

$$\Rightarrow T(V)^{\frac{3}{2}-1}=T_f(2V)^{\frac{3}{2}-1}$$

$$\Rightarrow TV^{\frac{1}{2}}=T_f(2)^{\frac{1}{2}}(V)^{\frac{1}{2}}$$

$$\Rightarrow T_f=\left(\frac{T}{\sqrt{2}}\right)$$

Now, $$\text{W.D.}=\frac{nR\Delta T}{1-\gamma}=\frac{1\cdot R\left[\frac{T}{\sqrt{2}}-T\right]}{1-\frac{3}{2}}$$

$$\Rightarrow \text{W.D.}=2RT\left[1-\frac{1}{\sqrt{2}}\right]$$

$$\Rightarrow \text{W.D.}=RT\left[2-\sqrt{2}\right]$$

51. 3

Sol.

$$\cos\theta=\frac{5}{9}$$

$$\frac{\vec{a}\cdot\vec{b}}{ab}=\frac{5}{9} \qquad .....(1)$$

$$\left|\vec{a}+\vec{b}\right|=\sqrt{2}\left|\vec{a}-\vec{b}\right|$$

$$a^2+b^2+2\vec{a}\cdot\vec{b}=2a^2+2b^2-4\vec{a}\cdot\vec{b}$$

$$6\vec{a}\cdot\vec{b}=a^2+b^2$$

$$6\times\frac{5}{9}ab=a^2+b^2$$

$$\frac{10}{3}ab=a^2+b^2 \quad \& \quad a=nb$$

$$\frac{10}{3}nb^2=n^2b^2+b^2$$

$$3n^2-10n+3=0$$

$$n=\frac{1}{3} \text{ and } n=3$$

integer value n = 3

52. 36

Sol. Potential at centre of half ring

$$V=\frac{KQ}{R}$$

$$V=\frac{K\lambda\pi R}{R}$$

$V = K\lambda\pi$

$\Rightarrow V = 9\times10^{9}\times4\times10^{-9}\pi$

$V = 36\pi$

53. 5 OR 15

Sol. $^4He + {}^4He + {}^4He \rightarrow {}^{12}C + Q$

power generated $=\frac{N}{t}Q$

where, N $\rightarrow$ No. of reaction/sec.

$Q = (3m_{He} - m_C)C^2$

Q = (3 × 4.0026 – 12) (3 × $10^8)^2$

Q = 7.266 MeV

$\frac{N}{t} = \frac{Power}{Q} = \frac{5.808 \times 10^{30}}{7.266 \times 10^6 \times 1.6 \times 10^{-19}}$

$\frac{N}{t} = 5 \times 10^{42}$

rate of conversion of ^{4}He into ^{12}C = 15 × 10^{42}

Hence, n = 15

54. 200

Sol. $I = I_0 \cos^2\left(\frac{\Delta\phi}{2}\right)$

$\frac{I_0}{4} = \cos^2\left(\frac{\Delta\phi}{2}\right)$

$\Delta\phi = \frac{2\pi}{3}$

$\frac{2\pi}{\lambda}\left(\frac{yd}{D}\right) = \frac{2\pi}{3}$

$y = \frac{\lambda D}{3d} = \frac{600 \times 10^{-9} \times 1}{3 \times 10^{-3}} = 2 \times 10^4 m$

55. 100

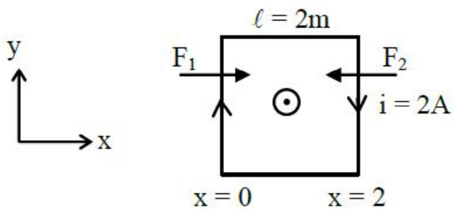
Sol. τ = FR = Iα ⇒ 40 × 0.1 = 0.4α

α = 10 rad/s^2

W_f = 10 × 10 = 100 rad/s

56. 160

Sol.



B(x = 0) = B_0, B(x = 2) = 9B_0

Also, F = i*l*B

⇒ $F_1 = ilB_0$ & $F_2 = 9ilB_0$

$F = F_2 - F_1 = 8ilB_0$ = 8 × 2 × 2 × 5

F = 160 N

57. 20

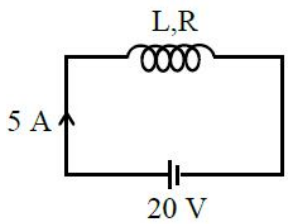
Sol.

$\frac{F}{A} = Y\frac{\Delta l}{l} \Rightarrow \Delta l = \frac{Fl}{AY}$

$\Delta l = \frac{200 \times 2}{2 \times 10^{-4} \times 10^{11}} = 2 \times 10^{-5} = 20\mu m$

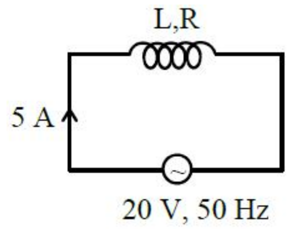
58. 10

Sol. **Case-I:**



$i = \frac{20}{R} \Rightarrow R = 4\Omega$

Case-II:



$i = \frac{20}{Z}$

$4 = \frac{20}{\sqrt{R^2 + X_L^2}} \Rightarrow \sqrt{R^2 + X_L^2} = 5$

$R^2 + X_L^2 = 25 \Rightarrow X_L = 3\Omega$

$L = \frac{3}{2\pi f} = \frac{1}{2 \times 50} = \frac{1000}{100} mH$

L = 10 mH

59. 17

Sol. x = 4 m, V = 2 m/s, a = 16 m/s^2

|a| = ω^2 x

⇒ 16 = ω^2(D)

ω = 2 rad/s

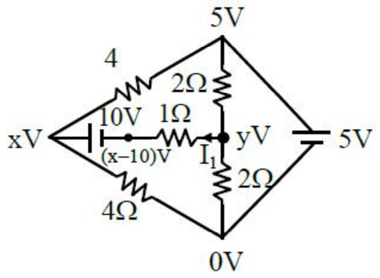
$v = \omega\sqrt{A^2 - x^2}$

$A = \sqrt{\frac{v^2}{\omega^2} + x^2} \Rightarrow A = \sqrt{\frac{4}{4} + 16}$

$A = \sqrt{17} m$

60. 25

Sol.



$$\frac{y-5}{2}+\frac{y-0}{2}+\frac{y-x+10}{1}=0$$

$y - 5 + y + 2y - 2x + 20 = 0$

$4y - 2x + 15 = 0$

$$\frac{x-5}{4}+\frac{x-0}{4}+\frac{x-10-y}{1}=0$$

$x - 5 + x + 4x - 40 - 4y = 0$

$6x - 4y - 45 = 0 \quad ......(i)$

$-2x + 4y + 15 = 0 \quad ......(ii)$

$4x - 30 = 0$

$$x=\frac{15}{2} \;\&\; 4y-15+15=0$$

$y = 0$

$$i=\frac{y-x+10}{1}$$

$$i=\frac{0-7.5+10}{1}$$

$$i=2.5A=\frac{n}{10}A$$

$n = 25$

CHEMISTRY

Section - A (Single Correct Answer)

61. (C)

Sol.: A $\rightarrow$ Weak electrolyte

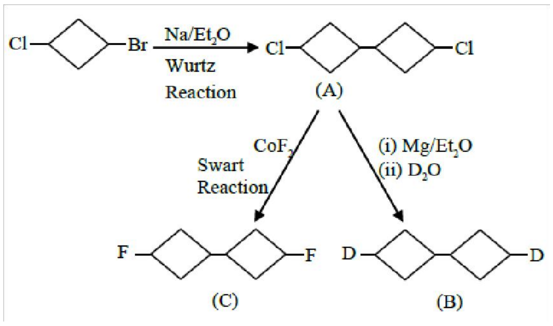
B $\rightarrow$ Strong electrolyte

62. (C)

Sol.: Organic compounds are purified based on their nature and impruity present in it.

63. (A)

Sol.:



64. (A)

Sol.: Order of basic strength is

N(sp^3, localized lone pair) > N(sp^2, localized lone pair) > N(sp^2, delocalized lone pair, aromatic)

$\therefore$ Piperidine > Pyridine > Pyrrole

65. (A)

$BF_3 \rightarrow sp^2$

$NO_2^- \rightarrow sp^2$

$H_2O \rightarrow sp^3$

$NO_2 \rightarrow sp^2$

$NO_2^- \rightarrow sp^3$

66. (A)

Sol.: Fluoroapatite $\Rightarrow$ $[3Ca_3(PO_4)_2.CaF_2]$

67. (B)

Sol.: (1) Neutral structures are more stable than charged ones. Therefore I is more stable than II and III.

(2) +ve charge on less electronegative atom is more stable i.e., $C^{\oplus}$ is more stable than $O^{\oplus}$

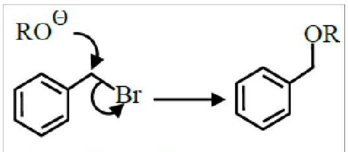
$\therefore$ Order is I > II > III

68. (D)

Sol.: Oxidation state of an element in a particular compound is defined by the charge acquired by its atom on the basis of electronegativity consideration from other atoms in molecule.

69. (C)

Sol.: The benzyl group acts in much the same way using the π-system of the benzene ring for conjugation with the p-orbital in the transition state



benzyl bromide

70. (D)

Sol.: Acidic strength order :-

B > D > C > A > E

Correct pKa Order :

B < D < C < A < E

All options are incorrect.

71. (C)

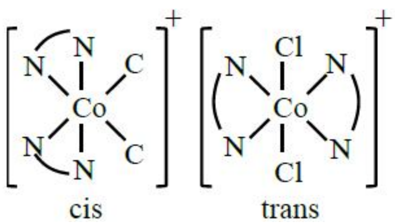
Sol.: Oxygen can form $2p\pi$-$2p\pi$ multiple bond with it self due to its small size while sulphur cannot form multiple bond with it self as $3p\pi$-$3p\pi$ bond will be unstable due to large size of sulphur, but sulphur can form multiple bond with small size atom like C and N.

eg. S=C=S

$S=C=N^{-}V \leftrightarrow S^{\ominus}-C\equiv N$

72. (C)

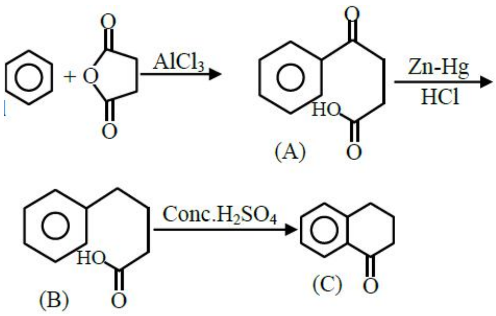
Sol.: $[Co(en)_2Cl_2]^{+}$ has octahedral geometry with two geometrical isomers.



73. (C)

Sol.: Cu(II) is more stable than Cu(I) because hydration energy of Cu^{+2} ion compensate IE_2 of Cu.

74. (A)

Sol.: 

75. (D)

Sol.: Energy level can be determined by comparing $(n+\ell)$ values

(A) $n=4,\ \ell=1 \Rightarrow (n+\ell)=5$

(B) $n=4,\ \ell=2 \Rightarrow (n+\ell)=6$

(C) $n=3,\ \ell=1 \Rightarrow (n+\ell)=4$

(D) $n=3,\ \ell=2 \Rightarrow (n+\ell)=5$

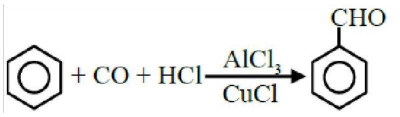
(E) $n=4,\ \ell=0 \Rightarrow (n+\ell)=4$

For same value of $(n+\ell)$, orbital having higher value of n, will have more energy.

(B) > (A) > (D) > (E) > (C)

76. (C)

Sol.: This is Gattermann-Koch reaction



77. (C)

(1) Hydration Reaction:

$$CH_3-CH=CH_2+H^{+}\rightarrow CH_3-\underset{\text{(More Stable)}}{\overset{+}{C}H}-CH_3$$

$$CH_3-\overset{+}{C}H-CH_3+H_2O\rightarrow (CH_3-\underset{\underset{(A)}{OH}}{CH}-CH_3)+H^{+}$$

(2) Hydroboration Oxidation Reaction:

$$3CH_3-CH=CH_2+B_2H_6\xrightarrow{THF}$$

$2(CH_3CH_2CH_2)_3B$

$$(CH_3CH_2CH_2)_3B+3H_2O_2\xrightarrow{OH^{-}}$$

$$\underset{(B)}{3CH_3CH_2CH_2OH+H_3BO_3}$$

78. (D)

Sol.: $PbS + HNO_3 \rightarrow Pb(NO_3)_2 + NO + S + H_2O$

Nitrous oxide (N_2O) is not formed during the reaction.

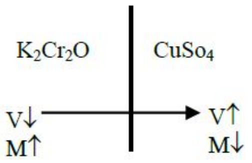
79. (D)

Sol.: $KMnO_4$ & NaOH $\rightarrow$ Secondary standard.

Primary standard should not be Hygroscopic.

80. (D)

Sol.: Only solvent Molecules are allowed to pass through the SPM.



Section - B (Numerical Value Type)

81. (82)

Sol.:
(1) $CuSO_4(s) + 5H_2O \xrightarrow{x} CuSO_4.5H_2O$
(2) $CuSO_4.5H_2O + H_2O \xrightarrow{12} CuSO_4(aq)$

$CuSO_4 + H_2O \xrightarrow{-70} CuSO_4(aq)$

from (1) and (2)

$-70 = x + 12$

$x = -82$

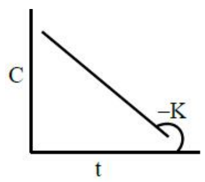
82. (8)

Sol.: $r = K[A]^2|B|$

if conc. are doubled

$r' = K[2A]^2[2B]^1$

$r' = 8r \Rightarrow x = 8$

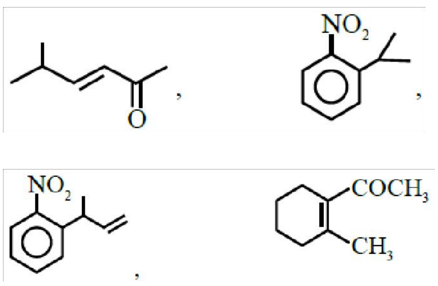


$\Rightarrow$ Zero order, $y = 0$

$x + y = 8$

83. (4)

Sol.:



84. (3)

Sol.: Fe, Ni, Ag will be oxidized due to lower S.R.P.

85. (2)

Sol.: $H^+ + OH^- \rightarrow H_2O \Rightarrow x$

$2H^+ + 2OH^- \rightarrow 2H_2O \Rightarrow 2x = y$

$y/x = 2$

86. (164)

Sol.: $M_{sol^n} = v_{sol^n} \times d_{sol^n}$

$= 500 \times 1.25 = 625$ g

Mass of solute (x) $= 0.2 \times 0.5 \times 159.5$

$= 15.95$

$n_{solute} = 0.1$,

Mass of solvent = Mass of solution – Mass of solute

$= 625 - 15.95$

$= 609.05$

$$m = \frac{0.1}{\frac{609.05}{1000}}$$

$m = 0.164 = 164 \times 10^{-3}$

87. (4)

Sol.: One unpaired e^- is present in :

$C_2^-; O_2^-; H_2^+; He_2^+$

88. (3)

Sol.: Ligands which have two different donor sites but at a time connects with only one donor site to central metal are ambidentate ligands.

Ambidentate ligands are

$NO_2^-; SCN^-; CN^-$

89. (4)

Sol.: Essential Amino acids are

Arginine, Phenylalanine, Histidine, Valine

90. (2)

La^{+3} – $[Xe]4f^0$

Nd^{+3} – $[Xe]4f^3$

Sm^{+3} – $[Xe]4f^5$

Eu^{+3} – $[Xe]4f^6$

Lu^{+3} – $[Xe]4f^{14}$

La^{+3} and Lu^{+3} do not show any colour because no unpaired electron is present.