Sri Chaitanya IIT Academy.,India.

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A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

SEC: Sr.Super60_STERLING BT JEE-MAIN Date: 07-06-2025

Time: 09:00AM to 12:00PM QMT-11 Max. Marks: 300

KEY SHEET

MATHEMATICS

1)	**1**	2)	**3**	3)	**2**	4)	**3**	5)	**3**
6)	**1**	7)	**1**	8)	**3**	9)	**2**	10)	**3**
11)	**2**	12)	**1**	13)	**2**	14)	**1**	15)	**2**
16)	**1**	17)	**1**	18)	**2**	19)	**2**	20)	**4**
21)	**3**	22)	**1**	23)	**1**	24)	**2**	25)	**1**

PHYSICS

26)	**3**	27)	**2**	28)	**4**	29)	**3**	30)	**3**
31)	**4**	32)	**4**	33)	**2**	34)	**1**	35)	**1**
36)	**1**	37)	**3**	38)	**2**	39)	**1**	40)	**2**
41)	**1**	42)	**2**	43)	**4**	44)	**3**	45)	**3**
46)	**20**	47)	**20**	48)	**13**	49)	**200**	50)	**2**

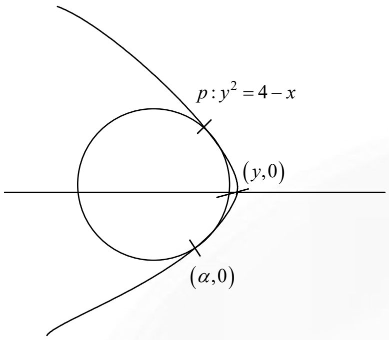
CHEMISTRY

51)	**2**	52)	**2**	53)	**2**	54)	**1**	55)	**2**
56)	**2**	57)	**3**	58)	**4**	59)	**4**	60)	**2**
61)	**3**	62)	**3**	63)	**4**	64)	**3**	65)	**1**
66)	**2**	67)	**3**	68)	**3**	69)	**3**	70)	**2**
71)	**24**	72)	**8**	73)	**1**	74)	**136**	75)	**6**

SOLUTIONS

MATHEMATICS

1. 1



Circle: $(x-\lambda)^2 + (y-0)^2 = \lambda^2$

$x^2 + y^2 - 2\lambda x = 0$

Intersect: $x^2 + (4-x) - 2\lambda x = 0$

$D = 0$

$\lambda = \frac{3}{2}, -\frac{5}{2} \quad \Rightarrow \lambda = \frac{3}{2}$

$p: y^2 = 4 - x$

$c: x^2 + y^2 - 3x = 0$

$r = \frac{3}{2}, c \equiv \left(\frac{3}{2}, 0\right)$

$x^2 + y - x - 3x = 0$

$x = 2$

$\alpha = 2$

2. 3

$AM \ge GM$

$$\frac{16^{x^2+y} + 16^{y^2+x}}{2} \ge \left(16^{x^2+y} 16^{y^2+x}\right)^{\frac{1}{2}}$$

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

$\frac{1}{2} \ge 2$

$1 \ge 2^{\frac{(2x+1)^2 + (2y+1)^2}{2}}$

$RHS \ge 1$

$\therefore \; 2x+1 = 0, \; 2y+1 = 0$

$x = -\frac{1}{2}, \; y = -\frac{1}{2}$

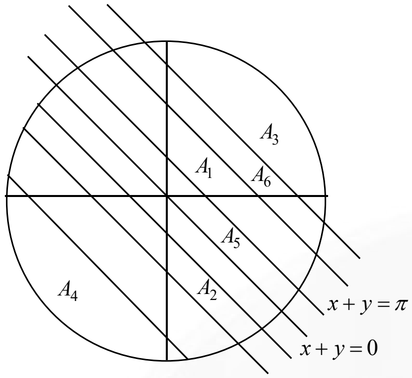
$\therefore 32\left(x^4 + y^4\right) = \frac{32}{2}\left(\frac{1}{16} + \frac{1}{16}\right) = 4$

3. 2

$\sin(x+y) \ge 0$

$\Rightarrow x + y \in [0, \pi] \cup [2\pi, 3\pi] \cup [4\pi, 5\pi] \cup$

$[-2\pi,-\pi]\cup[-4\pi,-3\pi]\cup.....$



By observation

$A_3 = A_4,\ A_1 = A_2$

Required area $= A_2 + A_4 + A_5 + A_6$

$= A_5 + A_1 + A_6 + A_3$

$= \frac{1}{2}(Area\ of\ circle)$

$= 50\pi$

4. 3

$$f(n) = \frac{4n + \sqrt{(2n+1)(2n-1)}}{\sqrt{2n+1} + \sqrt{2n-1}}$$

Rationalize

$$f(n) = \frac{1}{2}\left[(2n+1)^{3/2} - (2n-1)^{3/2}\right]$$

$$\sum f(n) = \frac{1}{2}\left(81^{\frac{3}{2}} - 1\right) = 364$$

5. 3

by observation

$\sqrt{2+\sqrt{2}} < \sqrt{3+\sqrt{3}} < \sqrt{4+\sqrt{4}} < .....$

and

$\sqrt{3+\sqrt{3}} < \sqrt{3+\sqrt{3+\sqrt{3}}},\ < \sqrt{3+\sqrt{3+\sqrt{3+\sqrt{3}}}} < ....$

$< ...... < \sqrt{3+\sqrt{3+.....\infty}}$

$\therefore\ solve$

$\sqrt{x+\sqrt{x+\sqrt{x+....\infty}}} = 8$

$\sqrt{x+8} = 8 \ \Rightarrow\ x = 56$

$x = 56$ will be included as this converges to 8 & will be less than 8.

$x = 0,1,2,.....\ 56$

No. of integers = 57

6. 1

$$x_{n+1}=\frac{x_n+\frac{1}{\sqrt{3}}}{1-\frac{1}{\sqrt{3}}x_n},\quad x_1=1$$

put $x_n=\tan\theta_n$

$$x_{n+1}=\tan\left(\theta_x+\frac{\pi}{6}\right)$$

$\theta_1=45$	$x_1=1$
$\theta_2=75$	$x_2=2+\sqrt{3}$
$\theta_3=105$	$x_3=-2-\sqrt{3}$
$\theta_4=135$	$x_4=-1$
$\theta_5=165$	$x_5=-2+\sqrt{3}$
$\theta_6=195$	$x_6=2-\sqrt{3}$
$\theta_7=225=180+45$	$x_7=x_1$
$\theta_8=225=180+75$	$x_8=x_2$
| | |	| | |

$\therefore x_1+x_2+\ldots x_6=x_7+\ldots .x_{12}=$

$x_{13}+\ldots .x_{18}=x_{19}+\ldots ..x_{24}=0$

$$\sum_{R=1}^{2008}x_R=0+0+0+\ldots+0+\left(x_1+x_2+x_3+x_4\right)$$

$=0$

7. 1

$i^k+i^{k+1}+i^{k+2}+i^{k+3}=0$

Sum of 4 consecutive powers

of $i=0$

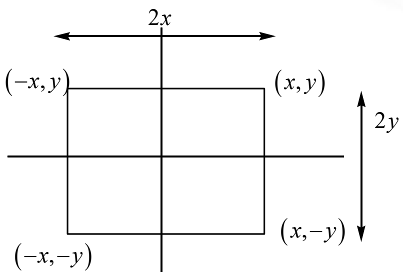
8. 3

Let $z=x+iy$

$\bar{z}=x-iy$

$\bar{z}-2\operatorname{Re}(\bar{z})=-x-iy$

$z-2\operatorname{Re}(z)=-x+iy$



$2x = 2y = 4(it\ is\ a\ square)$

9. 2

$z = -2e^{i\left(-\frac{\pi}{3}\right)}$

$= 2(-1)e^{i\left(-\frac{\pi}{3}\right)}$

$= 2e^{i\pi}e^{i\left(-\frac{\pi}{3}\right)}$

$= 2e^{i\frac{2\pi}{3}}$

$|z| = 2, \quad \arg(z) = \frac{2\pi}{3}$

10. 3

$z = x + iy$

$z^2 = \left(x^2 - y^2\right) + i(2xy)$

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

ATQ

$x^2 - y^2 + \sqrt{x^2 + y^2} = 0$

$2xy = 0 \qquad ----(1)$

using equation (1)

case I $\rightarrow x = 0 \Rightarrow y = \pm 1,\ 0$

case II $\rightarrow y = 0 \Rightarrow x = 0$

$\therefore \quad (0,0)(0,1)(0,-1)$

$z = 0, i, -1$

Number of solution = 3

11. 2

$z_1 = x_1 + iy_1$

$z_2 = x_2 + iy_2$

ATQ

$x_1 = |(x_1 - 1) + iy_1|$

$y_1^2 = 2x_1 - 1 \quad (1) \quad \& \quad y_2^2 = 2x_2 - 1 \quad (2)$

$z_1 - z_2 = (x_1 - x_2) + i(y_1 - y_2)$

Arg $(z_1 - z_2) = \frac{\pi}{6}$

$\tan^{-1}\left(\frac{y_1 - y_2}{x_1 - x_2}\right) = \frac{\pi}{6}$

$\frac{y_1 - y_2}{x_1 - x_2} = \frac{\pi}{\sqrt{3}}$

Equation (1) – (2)

$$y_1^2 - y_2^2 = 2\left(x_1 - x_2\right)$$

$$y_1 + y_2 = 2\left(\frac{x_1 - x_2}{y_1 - y_2}\right)$$

$$= 2\sqrt{3}$$

12. 1

$$z_1 = r_1 e^{i\theta_1} \qquad z_3 = r_2 e^{i\theta_2}$$

$$z_2 = r_1 e^{-\theta_1} \qquad z_4 = r_2 e^{-i\theta_2}$$

$$\frac{z_1}{z_4} = \frac{r_1}{r_2} e^{i\left(\theta_1 + \theta_2\right)}$$

$$\frac{z_2}{z_3} = \frac{r_1}{r_2} e^{-i\left(\theta_1 + \theta_2\right)}$$

AT θ

$$\left(\theta_1 + \theta_2\right) + -\left(\theta_1 + \theta_2\right)$$

$$= 0$$

13. 2

$$z = \left(e^{-i3\theta}\right)^5 \frac{\left(\frac{i\sin 5\theta - \cos 5\theta}{i}\right)^4}{\left(e^{-i4\theta}\right)^6}$$

$$= e^{-i15\theta} \frac{\frac{(-1)^4}{(i)^4}\left(\cos 5\theta - i\sin 5\theta\right)^4}{e^{-i24\theta}}$$

$$z = e^{-i11\theta}$$

$$z = \cos 11\theta - i\sin 11\theta$$

$$= \cos\frac{\pi}{6} + i\sin\frac{\pi}{6}$$

$$= e^{-\frac{\pi}{6}}$$

14. 1

$$z = \frac{(1+i)^2}{a-i}$$

Squaring

$$|z| = \left|\frac{(1+i)^2}{a-i}\right|$$

$$\frac{2}{5} = \frac{4}{a^2+1} \Rightarrow a^2 = 9 \Rightarrow a = 3$$

$$z = \frac{(1+i)^2}{3-i}$$

$$z=-\frac{1}{5}+\frac{3i}{5}$$

$$\overline{z}=-\frac{1}{5}-\frac{3i}{5}$$

15. 2

Let $\sqrt{a+ib}=x+iy$

square

$$a+ib=\left(x^2-y^2\right)+i\left(2xy\right)$$

$$a=x^2-y^2 \ \ \& \ \ b=2xy$$

Compare & solve

16. 3

Using inequality let $\quad |z|=r$

$$\left||z|-\frac{2}{|z|}\right|\le\left|z-\frac{2}{z}\right|\le|z|+\left|\frac{2}{z}\right|$$

$$\left|r-\frac{2}{r}\right| \quad (I) \quad \le 1\le r+\frac{2}{r} \qquad (II)$$

Case. I

$$\left|r-\frac{2}{r}\right|\le 1$$

$$-1\le r-\frac{2}{r}\le 1$$

$$-1\le r-\frac{2}{r} \quad \Rightarrow r\in[1,\infty)$$

$$r-\frac{2}{r}\le 1 \quad \Rightarrow r\in(0,2]$$

Combining

$$r\in[1,2]$$

Case II

$$1\le r+\frac{2}{r}$$

$$\Rightarrow r^2-r+2\ge 0$$

its discriminate is negative.

$\therefore$ always true

Case I $\cap$ Case II

$$[1,2]\cup R$$

$$\Rightarrow[1,2] \qquad a=1,\ \ b=2$$

$$a+b=3$$

17. 1

$$C_3\to C_3-\left(C_1+C_2\right)$$

$$\begin{vmatrix} 1 & x & 0 \\ 2x & x(x-1) & 0 \\ 3x(x-1) & x(x-1) & 0 \end{vmatrix} = 0$$

$\Rightarrow f(100) = 0$

18. 2

Let $C = AB - BA$

$C' = (AB - BA)'$

$= (AB)' - (BA)'$

$= \quad BA - AB$

$\therefore$ *skew – symmetric*

19. 2

Given expression

$2(a^2 + b^2 + c^2) - 2(\bar{a}.\bar{b} + \bar{b}.\bar{c} + \bar{c}.\bar{a})$

$= 6 - 2\left[\dfrac{(\bar{a} + \bar{b} + \bar{c})^2 - (a^2 + b^2 + c^2)}{2}\right]$

$= 6 - \left[(\bar{a} + \bar{b} + \bar{c})^2 - 3\right]$

$= 9 - (\bar{a} + \bar{b} + \bar{c})^2$

Max is 9

Where $\bar{a} + \bar{b} + \bar{c} = 0$

20. 4

Volume $= \dfrac{1}{6}\left[\bar{a}\ \bar{b}\ \bar{c}\right] = \dfrac{3}{4}$

$\left[\bar{a}\ \bar{b}\ \bar{c}\right] = \dfrac{9}{2}$

For new tetradron

Volume $= \dfrac{1}{6}\left[3(\bar{a} \times \bar{b}) \quad 4(\bar{b} \times \bar{c}) \quad 5(\bar{c} \times \bar{a})\right]$

$= \dfrac{1}{6} \times 3 \times 4 \times 5\left[\bar{a} \times \bar{b} \quad \bar{b} \times \bar{c} \quad \bar{c} \times \bar{a}\right]$

$= 10\left[\bar{a}\ \bar{b}\ \bar{c}\right]^2$

$= 10 \times \dfrac{81}{4} = \dfrac{810}{4} = 202.5$ *cubic units*

Statement II is incorrect

21. 3

$xdy = y(dx + \quad ydy)$

$\dfrac{xdy - ydx}{y^2} = dy$

$$-d\left(\frac{x}{y}\right)=dy$$

Integration both sides

$$-\frac{x}{y}+c=y$$

$$\frac{x}{y}+y=c$$

$$x+y^2=cy$$

Put $x=1,\ y=1$

$$\Rightarrow c=2$$

Curve is $\frac{x}{y}+y=2$

Put $x=-3\quad y=-1\ or\ 3$

then, $y>0\quad y=3$

22. 1

Apply King's

Rule & Add

$$f(t)=\int_0^{\pi}\frac{\pi dx}{1}-\cos^2+\sin^2 x$$

$$f(t)=\int_0^{\pi}\frac{\pi\sec^2 x-dx}{\sec^2-\cos^2 t.\tan^2 x}$$

$$f(t)=2\pi\int_0^{\frac{\pi}{2}}\frac{\sec^2 xdx}{\sec^2-\cos^2 t.\tan^2 x}$$

Put $\tan x=m$

$$\sec^2 xdx=dm$$

$$f(t)=2\pi\int_0^{\infty}\frac{dm}{1+m^2-m^2\left(1-\sin^2 t\right)}$$

$$=2\pi\int_0^{\infty}\frac{dm}{1+(m\sin t)^2}$$

$$=2\pi\times\frac{\pi}{2}\times\frac{1}{\sin t}-0$$

$$f(t)=\frac{\pi^2}{\sin t}$$

$$I=\int_0^{\frac{\pi}{2}}\frac{\pi^2 dt}{f(t)}\ =\int_0^{\frac{\pi}{2}}\sin tdt=1$$

23. 1

$$\frac{3}{2+\cos\theta+i\sin\theta}=a+ib$$

Rationalize and comparing

$$a=\frac{6+3\sin\theta}{5+4\cos\theta}, \qquad b=\frac{-3\sin\theta}{5+4\cos\theta}$$

$(a-2)^2+b^2=1$ after simplification

24. 2

$$w=\frac{5+3z}{5-5z}$$

$$\Rightarrow z=\frac{5(w-1)}{3+5w}$$

$$|z|<1$$

$$5|w-1|<|3+5w|$$

$$25(w\overline{w}-w-\overline{w}+1)<9+25w\overline{w}+15w+15\overline{w}$$

$$\Rightarrow 16<40w+40\overline{w}$$

$$\Rightarrow w+\overline{w}>\frac{16}{40}$$

$$\Rightarrow 2\operatorname{Re}(w)>\frac{16}{40}$$

$$\Rightarrow 5\operatorname{Re}(w)>1$$

Min integral value is 2.

25. 1

$$z=r_1e^{i\theta} \qquad w=r_2e^{i\phi}$$

$$|zw|=1$$

$$\left|r_1r_2e^{i(\theta+\phi)}\right|=1$$

$$\Rightarrow r_1r_2=1$$

$$\arg(z)-\arg(w)=\frac{\pi}{2}$$

$$\theta-\phi=\frac{\pi}{2}$$

$$\therefore \overline{z}\ w=r_1r_2e^{-i(\theta-\phi)}$$

$$=1.e^{-i\frac{\pi}{2}}$$

$$=-i$$

$$|\overline{z}w|=1$$

PHYSICS

26. Initial and final states for both the process are same.

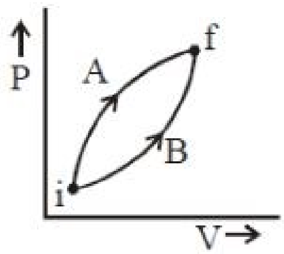
$\therefore \Delta U_A = \Delta U_B$

Work done during process A is greater than in process B.

By first law of thermodynamics

$\Delta Q = \Delta U + W$

$\Rightarrow \Delta Q_A > \Delta Q_B$



27. The peak current in a series RC circuit is given by

$$I_0 = \frac{E_0}{\sqrt{R^2 + \left(\frac{1}{\omega c}\right)^2}}$$

Given that $E_{rms} = 110\ V$, so peak voltage is given by

$E_0 = \sqrt{2} E_{rms} = 1.414 \times 110 = 155.5V$

$$\Rightarrow I_0 = \frac{155.5}{\sqrt{(40)^2 + \left(\frac{1}{376.8 \times 10^{-4}}\right)^2}}$$

$\Rightarrow I_0 = 3.24\ A$

28. In time t heat produced by a DC current i_{dc} is given by

$H_1 = i_{dc}^2 Rt$

$\Rightarrow H_1 = (2)^2 (2) t = 8t$

RMS value of AC is given by

$$i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{2}{\sqrt{2}} = \sqrt{2} A$$

Heat produced by the rms current in time t is given by

$H_2 = i_{rms}^2 Rt$

$\Rightarrow H_2 = \left(\sqrt{2}\right)^2 (1) t = 2t$

$$\Rightarrow \frac{H_1}{H_2} = \frac{8t}{2t} = 4$$

29. Given, phase difference, $\phi = \frac{\pi}{4}$

As we know, for R-L or R-C circuit,

$$\tan\phi = \frac{\textit{Capacitive}\text{ reactance}(X_C)\textit{ or inductive}\text{ reactance}(X_L)}{\text{Resistance}(R)}$$

$$\Rightarrow \tan\frac{\pi}{4} = \frac{X_C \ or \ X_L}{R}$$

$$I = \frac{X_C \ or \ X_L}{R} \Rightarrow R = X_C \ or \ X_L$$

Also, given $e = e_0 \sin(100t)$

Comparing the above equation with general equation of

emf, $i.e.\ e = e_0 \sin\omega t$, we get

$\omega = 100\, rad/s = 10^2\, rad/s$

Now, checking option wise,

For R-C circuit, with

$R = 1k\Omega = 10^3\Omega \ and \ C = 1\mu F = 10^{-6}F$

So, $X_C = \frac{1}{\omega C} = \frac{1}{10^2 \times 10^{-6}} = 10^4\Omega \Rightarrow R \neq X_C$

30. Statement – I is true, statement – II is false

31. Statement – I is false, statement – II is true

32. In the series L-C-R circuit V_R

(voltage across resistance) is in the phase with current (i), while

V_C (voltage across inductance) leads

i by 90^0 , while V_C lags behind

i by 90^0

Resultant emf E is

$E^2 = V_R^2 + \left(V_L - V_C\right)^2$

$Since,\ V_L = V_C = 300V$

$\therefore E = V_R = 220V$

Reading of ammeter,

$i = \frac{E}{R} = \frac{220}{100} = 2.2A$

33. Statement – II is true, statement – I is true; statement –II is not correct explanation for statement – I

34. The equation of a semicircular wave is

$$x^2 + y^2 = I_0^2$$

or

$$y^2 = I_0^2 - x^2$$

$$\therefore \quad i_{rms}^2 = \frac{1}{2I_0}\int_{-I_0}^{I_0} y^2 dx$$

$$=\frac{1}{2I_0}\int_{-I_0}^{I_0}\left(I_0^2-x^2\right)dx$$

$$=\frac{1}{2I_0}\left|I_0^2x-\frac{x^3}{3}\right|_{-I_0}^{I_0}$$

$$=\frac{1}{2I_0}\left[\left(I_0^3-\frac{I_0^3}{3}\right)-\left(-I_0^3+\frac{I_0^3}{3}\right)\right]$$

$$=\frac{2I_0^2}{3}$$

or $I_{rms}=\sqrt{\frac{2I_0^2}{3}}=\sqrt{\frac{2}{3}}I_0$

35. As $M\propto N_1N_2$, therefore , M remains the same.

36. Capacitance of wire

$C=0.014\times10^4 200$

$=2.8\times10^6F=2.84\mu F$

For impedance of the circuit to be minimum

$X_L=X_C$

$\Rightarrow 2\pi vL=\frac{1}{2\pi vC}$

$$L=\frac{1}{4\pi^2v^2C}=\frac{1}{4(3.14)^2\times\left(5\times10^3\right)^2\times2.8\times10^{-6}}\quad=0.35\times10^{-3}H=0.35mH$$

37.

$\vec{p}\propto S^aI^bh^c$

$\left[M^1L^1T^{-1}\right]=k\left[M^1L^0T^{-2}\right]^a\left[M^1L^2T^0\right]^b\left[M^1L^2T^{-1}\right]^c$

$1=a+b+c$ _______(1)

$1=2b+2c$ ________(2)

$-1=-2a-2c$ ______(3)

solving 1,2 & 3

$a=\frac{1}{2}, b=\frac{5}{2}, c=-2$

$\therefore \vec{p}=\left[S^{1/2}I^{5/2}h^{-2}\right]$

38. Given, initial position of particle

$$r_0 = \left(2\hat{i} + 4\hat{j}\right)m,$$

Initial velocity of particle, $u = \left(5\hat{i} + 4\hat{j}\right)m/s$

Acceleration of particle , $a = \left(4\hat{i} + 5\hat{j}\right)m/s^2$

According to second equation of motion,

Position of particle at time t is, $r = r_0 + ut + \frac{1}{2}at^2$

At $t = 2s$, position of particle is,

$$r = \left(2\hat{i} + 4\hat{j}\right) + \left(5\hat{i} + 4\hat{j}\right) \times 2 + \frac{1}{2}\left(4\hat{i} + 4\hat{j}\right) \times 4$$

or $r = (2 + 10 + 8)\hat{i} + (4 + 8 + 8)$

$\Rightarrow \quad r = 20\hat{i} + 20\hat{j}$

$\therefore$ Distance of particle from origin is,

$$|r| = 20\sqrt{2}m$$

39. Substituting, $m_1 = 5kg \;\; and \;\; m_2 = 10kg$

We get, $\mu(10 + m)g \geq 5g \quad \Rightarrow 10 + m \geq \frac{5}{0.15}$

$m \geq 23.33kg$

40. Given, Force, $F = -kv^2$

$\therefore$ Acceleration, $a = -\frac{k}{m}v^2$ or $\frac{dv}{dt} = -\frac{k}{m}v^2 \Rightarrow \frac{dv}{v^2} = -\frac{k}{m}dt$

Now, with limits, we have

$$\int_{10}^{v} \frac{dv}{v^2} = \frac{k}{m}\int_0^1 dt$$

$$\Rightarrow \left(-\frac{1}{v}\right)_{10}^{v} = -\frac{k}{m}t \Rightarrow \frac{1}{v} = 0.1 + \frac{kt}{m} \Rightarrow v = \frac{1}{0.1 + \frac{kt}{m}} = \frac{1}{0.1 + 1000k}$$

$$\Rightarrow \frac{1}{2} \times m \times v^2 = \frac{1}{8} \times v_0^2 \quad \Rightarrow v = \frac{v_0}{2} = 5 \Rightarrow \frac{1}{0.1 + 1000k} = 5$$

$$\Rightarrow 1 = 0.5 + 5000k \Rightarrow K = \frac{0.5}{5000} \Rightarrow k = 10^{-4}kg/m$$

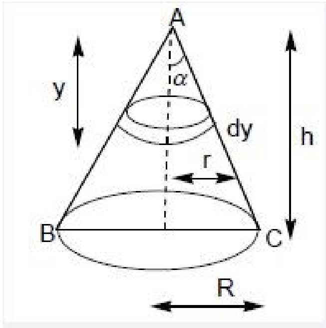
41. Let density of cone $= \rho$

Center of mass, $y_{cm} = \frac{\int ydm}{\int dm} = \frac{\int_0^h y\pi r^2 dy \rho}{\frac{1}{3}\pi R^2 h \upsilon} = \frac{\int_0^h r^2 ydy}{\frac{1}{3}R^2 h} \qquad ....(i)$

For a cone, we know that

$$\frac{r}{R} = \frac{y}{h} \therefore r = \frac{y}{h}R$$

$$y_{cm}=\frac{\int_0^h 3y^3dy}{h^3}=\frac{3\frac{y^4}{4}^h}{h^3}=\frac{3}{4}h$$



42. Maximum possible volume of cube will occur when

$\sqrt{3}a=2R$ (a= side of cube)

$\therefore \quad a=\frac{2}{\sqrt{3}}R$

Now, density of of sphere, $\rho=\frac{M}{\frac{4}{3}\pi R^3}$

Mass of cube, m= (volume of cube) $(\rho)=(a^3)(\rho)$ $=\left[\frac{2}{\sqrt{3}}R\right]^3\left[\frac{m}{\frac{4}{3}\pi R^3}\right]=\left(\frac{2}{\sqrt{3}\pi}\right)M$

Now, moment of inertia of the cube about the said axis is

$$I=\frac{ma^2}{6}=\frac{\left(\frac{2}{\sqrt{3}\pi}\right)M\left(\frac{2}{\sqrt{3}}R\right)^2}{\sigma}=\frac{4MR^2}{9\sqrt{3}\pi}$$

43. $F\propto\frac{1}{R^n}$

$\frac{mv^2}{R}\propto\frac{1}{R^n}$ or $v\propto\frac{I}{R^{\frac{n-1}{2}}}$

$T=\frac{2\pi R}{v}\quad\Rightarrow T\propto\frac{R}{v}\quad\Rightarrow\quad T\propto R^{1+\frac{n-1}{2}}$ or $T\propto R^{\frac{n+1}{2}}$

44. Kinetic energy is minimum at $\frac{T}{4}$

45. Thermal stress $\sigma=Y\alpha\,\Delta\theta$

Given, $\sigma_1=\sigma_2$

$\therefore\quad Y_1\alpha_1\Delta\theta=Y_2\alpha_2\Delta\theta$ or $\frac{Y_1}{Y_2}=\frac{\alpha_1}{\alpha_2}=\frac{3}{2}$

46. Comparing $E=200\sqrt{2}\sin(100t)$ with

$E = E_0 \sin wt;\ E_0 = 200\sqrt{2}V\ and\ \ w = 100(rad/s)$

$$X_C = \frac{1}{wC} = \frac{1}{100\times10^{-6}} = 10^4\Omega$$

$$I_{rms} = \frac{E_{rms}}{Z} = \frac{E_0}{\sqrt{2}X_c} = \frac{200\sqrt{2}}{\sqrt{2}\times10^4} = 20mA$$

47. Wheatstone bridge is balanced so that $R = 4\Omega$.

$$e = iR = Blv$$

$$v = \frac{iR}{Bl} = 2\times10^{-2}ms^{-1}$$

48. For a series LR circuit, impedance is given by

$$Z = \sqrt{R^2 + X_L^2}$$

Inductive reactance X_L is given by

$$X_L = L\omega = 2\pi fL \Rightarrow X_L = 2\left(\frac{22}{7}\right)(50)\left(\frac{175}{11}\times10^{-3}\right)\Omega \Rightarrow X_L = 5000\times10^{-3}\Omega = 5\Omega$$

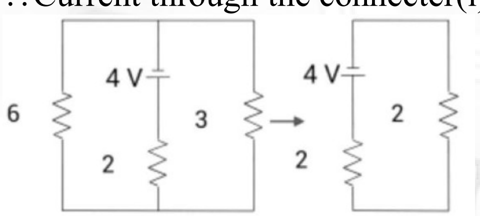
$$\Rightarrow Z = \sqrt{(12)^2 + (5)^2} = \sqrt{169} = 13\Omega$$

49. $E_{eq} = 6 + \frac{12\times4}{12+4} = 9\Omega \therefore i_{main} = \frac{72}{9} = 8amp$

$$\therefore\ i_{10\Omega} = \frac{4}{12+4}\times8 = 2amp$$

$$\therefore Q = CV = 10\times10^{-6}\times(10\times2) = 200\mu C$$

50. $\therefore$Current through the connecter(i)



$$\frac{E}{R_p + r} = \frac{4}{2+2} = 1A$$

Magnetic force on the connecter
= Bil = (1)(1) = 2N
Therefore, to keep the connecter moving with a constant velocity, a force of 2N has to be applied to the right side.

CHEMISTRY

51. $HCOOH \rightleftharpoons HCOO^- + H^+$

$C_1(1-\alpha)C_1\alpha\ C_1\alpha$

$$\left[H^+\right]_L = C_1\alpha = \sqrt{(Ka)_1 \times C_1}$$

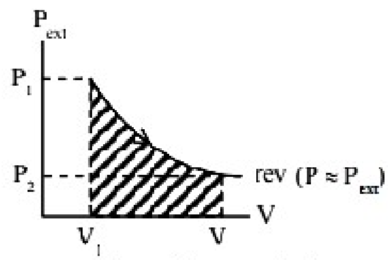
$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$C_2(1-\alpha)C_2\alpha \quad C_2\alpha$

$$\therefore\ \left[H^+\right]_R = \sqrt{(Ka)_2 \times C_2}$$

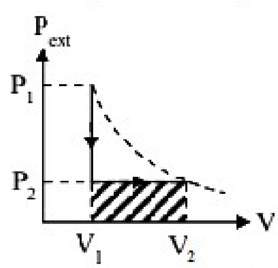
$$E = E^0 - \frac{0.0591}{1}\log\frac{\left[H^+\right]_L}{\left[H^+\right]_R}$$

52. Conceptual

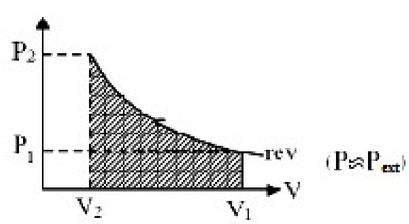


(Reversible expansion)

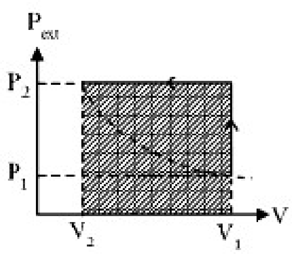
53.



(Single step irreversible)



(Reversible)

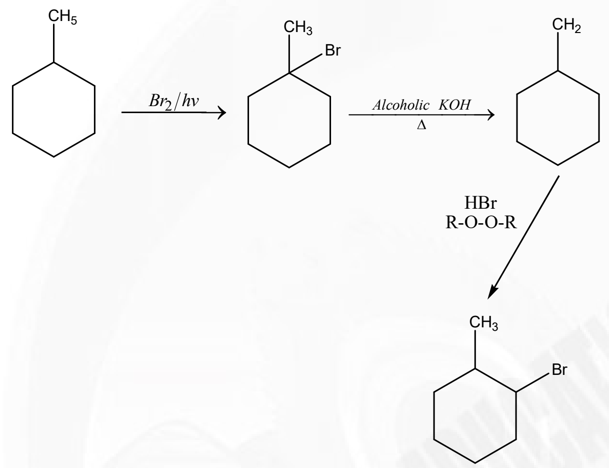


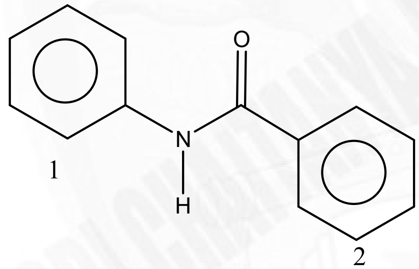
(Single step irreversible)

54.

	B	Al	Ga	In	Tl
Atomic radius (pm)	88	143	135	167	170
Electronegativity	2	1.5	1.6	1.7	1.8
Density (g/cm^3)	2.35	2.7	5.9	7.31	11.85
Ionisation energy (kJ/mol)	801	577	579	558	589

55.





56. Ring 1 is activated by $-\overset{|}{N}H$ group

57. Nitric acid is added to sodium extract before addition of silver nitrate for testing halogens. Because it decomposes NaCN and Na_2S or else they interfere in the test. The reaction are as follows :

$$NaCN + HNO_3 \rightarrow NaNO_3 + HCN \uparrow$$

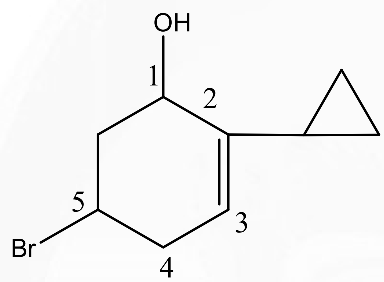
$$\underset{\text{Sodium extract}}{Na_2S} + \underset{\text{Nitric acid}}{HNO_3} \rightarrow NaNO_3 + H_2S \uparrow$$

58. $\lambda = \frac{C}{v} = \frac{3\times 10}{5.16\times 10^{14}} = 581.39\ nm$

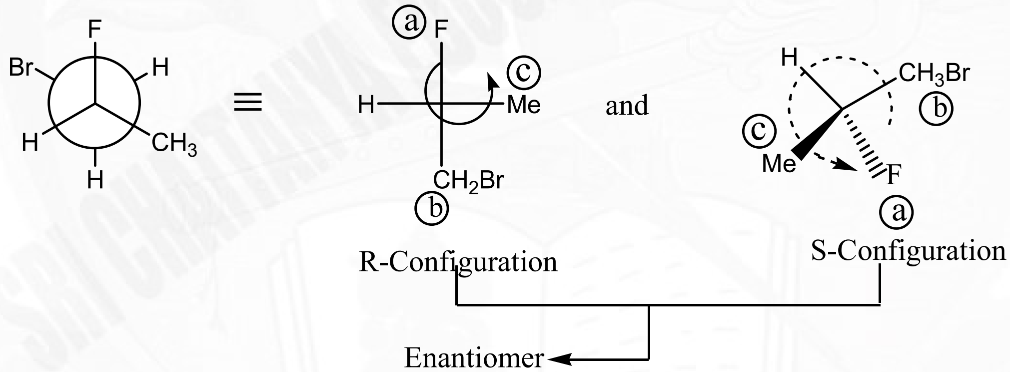
59.

Cations	Group No	Group reaction

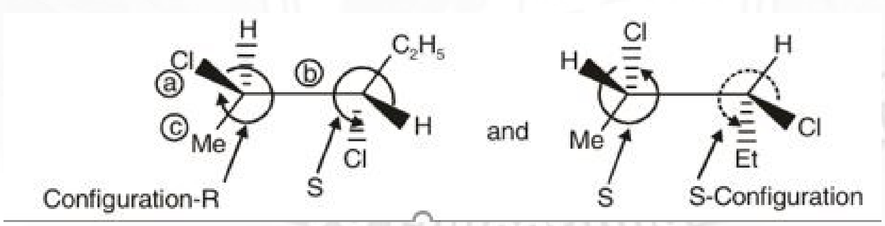
Pb^{2+}, Cu^{2+}	II	i) H_2S gas in presence of dilute HCl
Al^{3+}, Fe^{3+}	III	ii) NH_4OH in presence of NH_4Cl
Co^{2+}, Ni^{2+}	IV	iii) H_2S in presence of NH_4OH
Ba^{2+}, Ca^{2+}	V	iv) $(NH_4)_2 CO_3$ in presence of NH_4OH



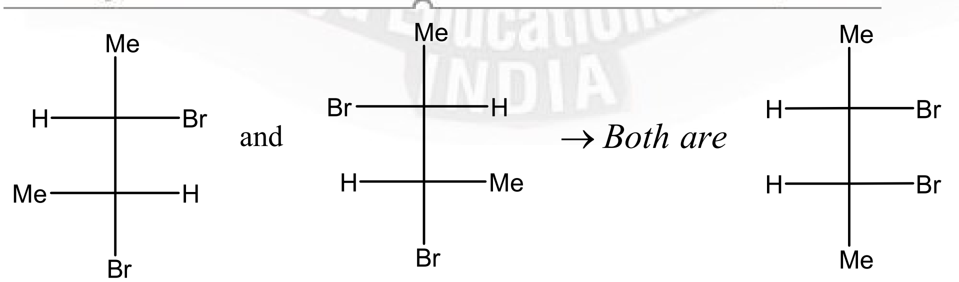
60. Priority sequence is alcohol > alkene > halide



61. I)



II)



III) Identical ← Meso

62. Both Statement I and Statement II are false

On treatment with metal salt, boric anhydride forms metaborate of the metal which gives different colours in oxidizing and reducing flame. For example, in the case of copper sulphate, following reactions occur.

$$CuSO_4 + B_2O_3 \xrightarrow[\text{(oxidising)}]{\text{Non-luminous flame}} Cu(BO_2)_2 + SO_3$$

Two reactions may take place in reducing flame (Luminous flame)

(i) The blue-green $Cu(BO_2)_2$ is reduced to colourless cuprous metaborate as:

$$2Cu(BO_2)_2 + 2NaBO_2 + C \xrightarrow[\text{flame}]{\text{Luminous}}$$
$$2CuBO_2 + Na_2B_4O_7 + CO$$

(ii) Cupric metaborate may be reduced to metallic copper and bead appears red opaque.

$$2Cu(BO_2)_2 + 4NaBO_2 + 2C \xrightarrow[\text{flame}]{\text{Luminous}}$$
$$2Cu + 2Na_2B_4O_7 + 2CO$$

63. Conceptual

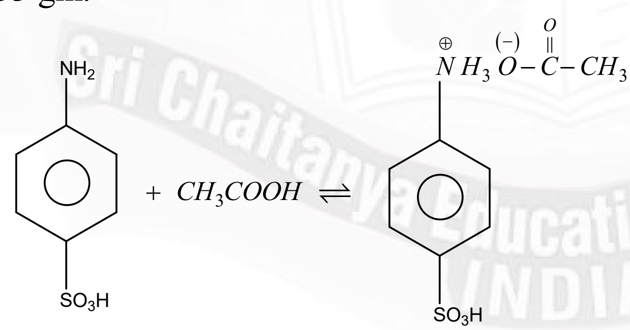
64. SO_2 produce turbidity in Baryta water and turns acidified dichromate solution green.

65. $$\underset{\substack{0.6\\0.6-x}}{A} \rightleftharpoons \underset{\substack{0\\nx}}{nB}$$

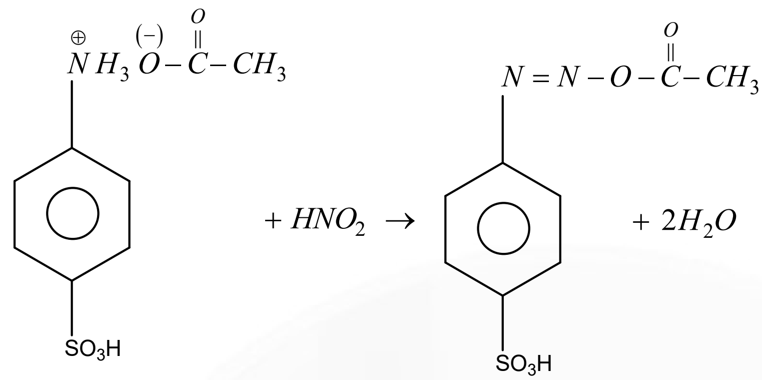
$$(B) = mx = 0.6 \ \ and \ \ [A] = 0.6 - x = 0.3$$
$$So, n = 2 \ \ and \ \ x = 0.3$$
$$K_C = \frac{[B]^2}{[A]} = \frac{0.6 \times 0.6}{0.3} = 1.2$$

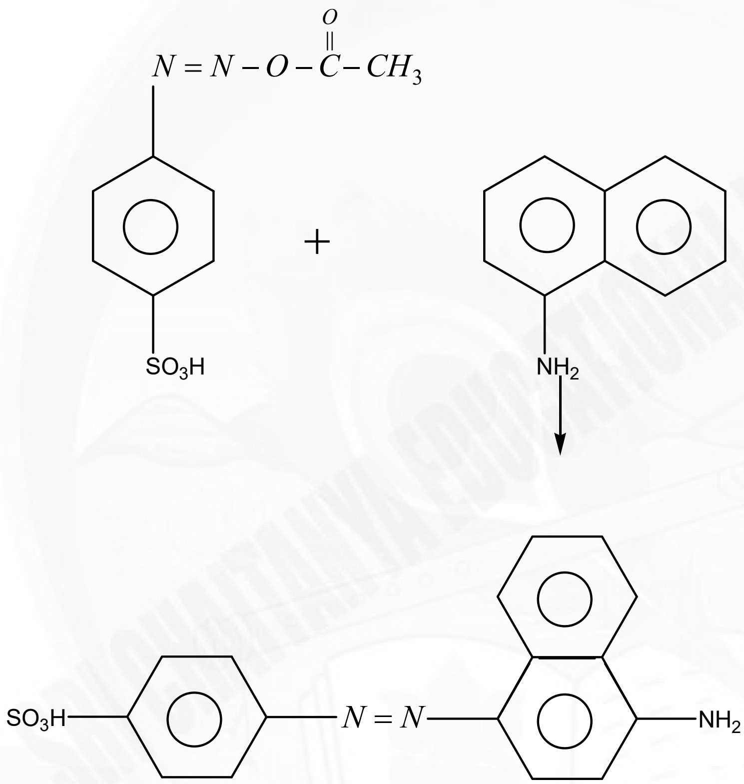
66. The ions of group II of salt analysis are precipitated by HCl and H_2S.

67. 0.1 mole of red-azo dye (Molar Mass = 327 gm/mol) will have 32.7 gm mass. Nearly 33 gm.



(Sulphanilic acid)





(Red-azo dye)

68. $$2CuSO_4 + K_4\left[Fe(CN)_6\right] \xrightarrow{CH_2COOH} Cu_2\left[Fe(CN)_3\right] + 2K_2SO_4$$
(*Chocolate brown ppt*.)

$$4FeCl_3 + 3K_4\left[Fe(CN)_6\right] \rightarrow Fe_4\left[Fe(CN)_6\right]_3 + 12KCl$$
(Prussian *Blue ppt*)

$$3ZnCl_4 + 2K_4\left[Fe(CN)_6\right] \xrightarrow{NH_4OH} K_2Zn_3\left[Fe(CN)_6\right]_2 + 6KCl$$
(*white or bluish* white *ppt*.)

69. Conceptual

70. $Hg^{2+} + 2I^- \rightarrow \underset{red\ ppt}{HgI_2} \downarrow$

$HgI_2 + 2I^- \rightarrow \underset{soluble\ complex}{[HgI_4]^{2-}}$

$Hg^{2+} + CO^{2+} + 4SCN^- \rightarrow \underset{blue\ ppt}{CO[Hg(SCN)_4]} \downarrow$

71. Rate at $(t = 10\ \text{min}) = 0.04\ mol\ L^{-1} = kC_{10} = R_{10}$

Rate at $(t = 20\ \text{min}) = 0.03\ mol\ L^{-1}\sec^{-1} = kC_{20} = R_{20}$

So, $\frac{C_{10}}{C_{20}} = \frac{R_{10}}{R_{20}} = \frac{4}{3}$

$$K = \frac{2.303}{(20-10)}\log\frac{C_{10}}{C_{20}}\min^{-1} = \frac{2.303}{10}\log\frac{4}{3}\min^{-1}$$

$$t_{1/2} = \frac{0.693}{K} = \frac{0.693 \times 10}{2.303\left(\log\frac{4}{3}\right)} = \frac{3}{\log\frac{4}{3}} = \frac{3}{0.124}\min = 24.19\min$$

72. So, bond angles are

1) $\angle N^I CoO^I$
2) $\angle N^I CoO^{II}$
3) $\angle N^I CoO^{III}$
4) $\angle N^I CoO^{IV}$
5) $\angle N^{II} CoO^I$
6) $\angle N^{II} CoO^{II}$
7) $\angle N^{III} CoO^{III}$
8) $\angle N^{II} CoO^{IV}$

So, total asked bond angles are 8.

73. $K_{sp} = [Zn^{2+}][S^{2-}] \quad = \quad [S^{2-}] = \frac{10^{-21}}{10^{-2}} = 10^{-19}$

$$K_{a_1} \times K_{a_2} = \frac{[H^+]^2[S^{2-}]}{[H_2S]}$$

$$10^{-20} \frac{[H^+]^2 \times 10^{-19}}{0.1}$$

$[H^+] = 0.1\ pH = 1$

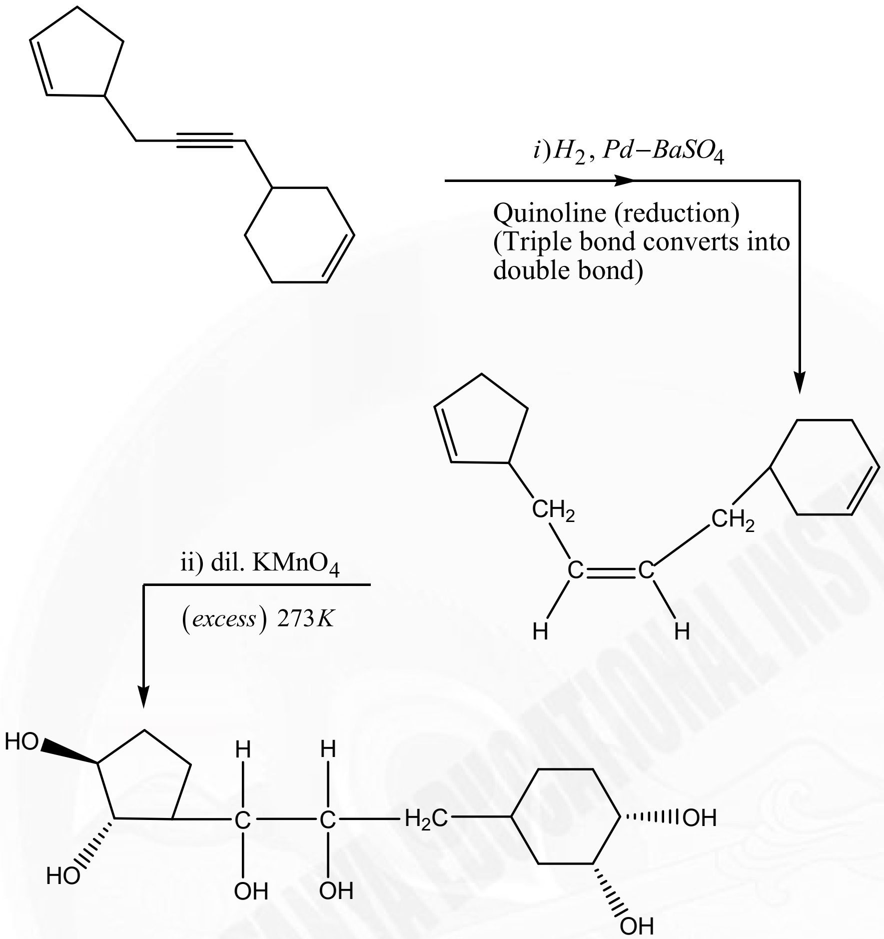
74. $CaSO_4$ does not evolve any gas with concentrated H_2SO_4.

$NaBr \rightarrow evolve\ Br_2$

$NaNO_3 \rightarrow evolve\ NO_2$

$KI \rightarrow evolve\ I_2$

75. 6



(P) (Major product)