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: 07-09-2025**
Time: 02:00PM to 05:00PM	**CTM-02**	**Max. Marks: 300**

KEY SHEET

MATHEMATICS

1	**4**	2	**3**	3	**3**	4	**4**	5	**1**
6	**2**	7	**3**	8	**4**	9	**4**	10	**3**
11	**1**	12	**2**	13	**1**	14	**4**	15	**2**
16	**3**	17	**1**	18	**3**	19	**1**	20	**2**
21	**2**	22	**4**	23	**21**	24	**6**	25	**2520**

PHYSICS

26	**1**	27	**4**	28	**2**	29	**3**	30	**3**
31	**3**	32	**3**	33	**4**	34	**1**	35	**1**
36	**3**	37	**3**	38	**4**	39	**2**	40	**4**
41	**4**	42	**3**	43	**4**	44	**4**	45	**3**
46	**6**	47	**1**	48	**75**	49	**5**	50	**72**

CHEMISTRY

51	**4**	52	**3**	53	**2**	54	**4**	55	**1**
56	**4**	57	**3**	58	**2**	59	**2**	60	**2**
61	**4**	62	**1**	63	**4**	64	**4**	65	**4**
66	**1**	67	**3**	68	**2**	69	**4**	70	**4**
71	**8**	72	**5**	73	**20**	74	**6**	75	**64**

SOLUTIONS
MATHEMATICS

1. replace x by $\frac{1}{x}$

We get $f(x)=\frac{2}{3x^2}-\frac{x^2}{3}+\frac{5}{3}$

$\alpha=\int_1^2 f(x)dx=\frac{11}{9}$

And $2g(x)-3g\left(\frac{1}{2}\right)=x$

$g\left(\frac{1}{2}\right)=\frac{1}{2}\Rightarrow g(x)=\frac{x}{2}+\frac{3}{4}$

$\beta=\int_1^2 g(x)dx=0$

2. Using first derivate test

3. $f(x)$ and $f^{-1}(x)$ can only intersect on the line by $y=x$

$\therefore f(x)=f^{-1}(x)=x$

$3x^2-7x+c=x\Rightarrow 3x^2-8x+c=0$

The above equation has real and equal root

$\therefore \Delta=0\Rightarrow 16-3c=0\Rightarrow c=\frac{16}{3}$

4. $\sin^{-1}x\,i=\frac{\pi}{2};\ 1\le i\le 20$

$x_i=1,\qquad \sum_{i=1}^{20}x_i=20$

5. R.H.L$=\lim_{x\to 0^+} f(x)$

$=\lim_{x\to 0^+}\frac{4+e^{\frac{1}{x}}}{1+e^{\frac{4}{x}}}+\frac{2\sin x}{x}\quad=\lim_{x\to 0^+}\frac{4c^{-\frac{1}{x}}+1}{e^{-\frac{1}{x}}+e^{\frac{3}{x}}}+\frac{2\sin x}{x}=0+2=2$

L.H.L $=\lim_{x\to 0^-} f(x)=\lim_{x\to 0^-}\frac{4+e^{\frac{1}{x}}}{1+e^{\frac{4}{x}}}-\frac{2\sin x}{x}=4-2=2$

6. $\lim_{x\to 0}\left(3-2\cos x\sqrt{\cos 2x}\right)^{\left(\frac{x+3}{x^2}\right)}\left(1^{\infty}\right)$

$$= e^{\lim\limits_{x\to 0} .\frac{x+3}{x^2}\left(3-2\cos x\sqrt{\cos 2}x-1\right)}$$

$$= e^{\lim\limits_{x\to 0}(x+3)=\frac{\left[2-2\left(1-\frac{x^2}{2!}\right)\left(1-\frac{4x^2}{2!}\right)^{\frac{1}{2}}\right]}{x^2}}$$

$$= e^{\lim\limits_{x\to 0} 2(x+3)\frac{\left[1-\left(1-x^2-\frac{x^2}{2}+\frac{x^4}{2}\right)\right]}{x^2}}$$

$$= e^{3\times 3} = e^9$$

7. $f(x) = |2x+1| + |x+2|\left(|x-1|-3\right)$

Critical points are $x = -\frac{1}{2},\ -2,\ -1$

But $x=-2$ making a zero twice in product so, points of non differentiability are $x = -\frac{1}{2}$ and $x=-1$.

Number of points of non differentiability $=2$

8. At $x = 0, 1, 2, 3$ f changes its definition

$$f(x) = \begin{cases} -x-1 & ; & -1 \le x < 0 \\ x & ; & 0 \le x < 1 \\ 2x & ; & 1 \le x < 2 \\ x+2 & ; & 2 \le x < 3 \\ 6 & ; & x = 3 \end{cases}$$

At $x=0$ L.H.L $=-1$ RH.L $=0$

At $x=1$ L.H.L $=1$ RH.L $=2$

At $x=2$ L.H.L $=4$ RH.L $=4$

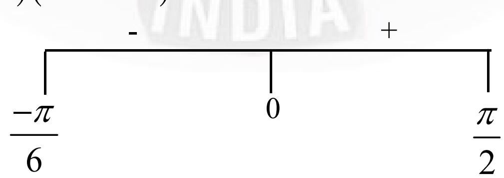
At $x=3$ L.H.L $=5$ $f(3)=6$

$\therefore$ points of discontinuity are 0, 1, 3

9. $f'(x) = 12\sin^3 x\cos x + 30\sin^2 x\cos x + 12\sin x\cos x$

$= 6\sin x\cos x\left(2\sin^2 x + 5\sin x + 2\right)$

$= 6\sin x\cos x\left(2\sin x + 1\right)\left(\sin x + 2\right)$



So the function is decreasing in $\left(\frac{-\pi}{6}, 0\right)$

10. $f\left(1^{+}\right) > f(1)$

$3 > -2 + \log_2^{\left(b^2-4\right)}$

$32 \geq b^2 - 4$ and $b^2 - 4 > 0$

$b^2 \leq 36 \qquad b < -2 \quad or \quad b > 2$

$b \in [-6, 6]$

11. Surface area of a cube $(s) = 6a^2$

$$\frac{ds}{dt} = 12a\frac{da}{dt} = 3.6$$

$$a = 10 \Rightarrow \frac{da}{dt} = 0.03cm/\sec$$

Now, volume of cube $(v) = a^3$

$$\frac{dv}{dt} = 3a^2\frac{da}{dt} = 9.cm^3/\sec$$

12. $$I = \int \frac{x^2-1}{x^2\left(x+\frac{1}{x}\right)\sqrt{x^2+\frac{1}{x^2}}}dx$$

$$= \int \frac{\left(1-\frac{1}{x^2}\right)}{\left(x+\frac{1}{x}\right)\sqrt{\left(x+\frac{1}{x}\right)^2-2}}dx \text{ put } x+\frac{1}{x} = t$$

$$= \frac{1}{\sqrt{2}}\sec^{-1}\left(\frac{t}{\sqrt{2}}\right) + c$$

$$= \frac{1}{\sqrt{2}}\sec^{-1}\left[\frac{x^2+1}{\sqrt{2}x}\right] + c$$

13. $$I = \int \frac{\sin\left(2x+\frac{x}{2}\right)}{\sin\frac{x}{2}}dx$$

$$= \int \frac{\sin 2x \cos\frac{x}{2} + \cos 2x \sin\frac{x}{2}}{\sin\frac{x}{2}}dx$$

$$= \int \left(4\cos^2\frac{x}{2}\cos x + \cos 2x\right)dx$$

$$= \int \left(2(1+\cos x)\cos x + \cos 2x\right)\ dx$$

$$=\int\left(2\cos x+2\cos^2 x+\cos 2x\right)\ dx$$

$$=\int\left(2\cos x+1+\cos 2x+\cos 2x\right)\ dx$$

$$=2\sin x+\sin 2x+x+c$$

14. $I=2\int \underset{II}{x}\,\underset{I}{Tan^{-1}x}\,dx$

Applying integration by parts

$$I=2\left[Tan^{-1}x\frac{x^2}{2}-\int\frac{1}{1+x^2}.\frac{x^2}{2}dx\right]$$

$$=2\left[\frac{x^2}{2}Tan^{-1}x-\frac{1}{2}\int\left(1-\frac{1}{1+x^2}\right)dx\right]$$

$$=2\left[\frac{x^2}{2}Tan^{-1}x-\frac{1}{2}x+\frac{1}{2}Tan^{-1}x\right]+c=-x+\left(x^2+1\right)Tan^{-1}x+c$$

15. $I=\int_0^{\frac{\pi}{4}}\left(\frac{\sin\theta+\cos\theta}{9+16\sin 2\theta}\right)d\theta$

Put $\sin\theta-\cos\theta=t\Rightarrow\left(\cos\theta+\sin\theta\right)d\theta=dt$

$$=\int_{-1}^{0}\frac{dt}{9+16\left(1-t^2\right)}$$

$$=\int_{-1}^{0}\frac{dt}{25-16t^2}$$

$$I=\frac{1}{40}\log_e^9\Rightarrow 80I=2\log_e^9=4\log_e^3$$

16. $I=\int_0^{\pi} f\left(x\right)\sin x\,d\,x\rightarrow(1)$

$$=\int_0^{\pi} f\left(\pi-x\right)\sin\left(\pi-x\right)dx$$

$$I=\int_0^{\pi} f\left(\pi-x\right)\sin x\,d\,x\rightarrow(2)$$

$$(1)+(2)\Rightarrow 2I=\pi^2\int_0^{\pi}\sin x\,d\,x=2\pi^2$$

17. $I = \int_{\frac{-3\pi}{4}}^{\frac{5\pi}{4}} \frac{\cos x + \sin x}{1 + e^{x-\frac{\pi}{4}}} dy \to (1)$

$= \int_{\frac{-3\pi}{4}}^{\frac{5\pi}{4}} \frac{\sin x + \cos x}{1 + e^{\frac{\pi}{4}-x}} dx$

$I = \int_{\frac{-3\pi}{4}}^{\frac{5\pi}{4}} \frac{(\sin x + \cos x) c^{x-\frac{\pi}{4}}}{1 + e^{x-\frac{\pi}{4}}} dy \to (2)$

$2I = \int_{\frac{-3\pi}{4}}^{\frac{5\pi}{4}} (\sin x + \cos x)\, dy = [\sin x - \cos x]_{\frac{-3\pi}{4}}^{\frac{5\pi}{4}} = 0$

18. $g(x) = \int_0^{n^2+n+1} e^{\left\{\frac{x}{2}\right\}} \left\{\frac{x}{2}\right\} .d\{x\} = (n^2+n+1) \int_0^1 e^{\frac{x}{2}} . \frac{x}{2} dx$

$= (n^2+n+1)\left(2x\, e^{\frac{x}{2}} - 4e^{\frac{x}{2}}\right)_0^1 = (n^2+n+1)\left(4 - 2e^{\frac{1}{2}}\right)$

19. Volume of the sphere $v = \frac{4}{3}\pi r^3$

$\frac{dv}{dt} = 4\pi r^2 \frac{dr}{dt}$

$35 = 4\pi r^2 \frac{dr}{dt}$

Surface area of sphere $(s) = 4\pi r^2$

$\frac{ds}{dt} = 8\pi r \frac{dr}{dt} = \frac{70}{r}$

Now $r = 7 \Rightarrow \frac{ds}{dt} = 10$

20. Conceptual

21. $R.H.L = \lim_{x \to -1^+} f(x) = a \sin\left(\frac{-\pi}{2}\right) + 2 = -0 + 2$

$L.H.L = \lim_{x \to -1^-} f(x) = 0 + 3$

$L.H.S = R.H.L \Rightarrow -a + 2 = 3 \Rightarrow a = -1$

$\therefore f(x) = -\sin\left(\frac{\pi}{2}[x]\right) + 2 + [-x]$

Now $\int_0^4 f(x)dx = \int_0^1 f(x)dx + \int_1^2 f(x)dx + \int_2^3 f(x)dx + \int_3^4 f(x)dx$

$= 1 - 1 - 1 - 1 = -2$

22. $\sin^{-1}\left(\frac{2x}{1+x^2}\right) = \pi - 2Tan^{-1}x$ for $x > 1$

$\sin^{-1}\left(\frac{2x}{1+x^2}\right) = -\pi - 2Tan^{-1}x$ for $x < -1$

$\therefore k = -1$

23. $\int_{-6}^{0} f(x)dx = \int_{-6}^{-3} |x+1|dx + \int_{-3}^{0} |x+5|dx$

$= -\int_{-6}^{-3} (x+1)dx + \int_{-3}^{0} (x+5)dx$

$= 21$

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

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

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

25. $n(x) = 5,\ n(y) = 7$

$\alpha =$ number of on to functions from x to $y = 7_{P_5}$

$\beta =$ number of on to functionsa from x to $y = 0$

PHYSICS

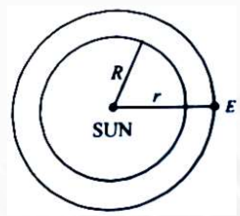
26. As $\alpha = \dfrac{\Delta l}{l\Delta T} = \dfrac{0.02}{100\times 10} \Rightarrow \alpha = 2\times 10^{-5}$

Volume coefficient of expansion, $\gamma = 3\alpha = 6\times 10^{-5}$

$\therefore \rho = \dfrac{M}{V} \Rightarrow \dfrac{\Delta V}{V}\times 100 = \gamma \Delta T$

$= \left(6\times 10^{-5}\times 10\times 100\right) = 6\times 10^{-2}$ volume increase by 0.06% therefore density decrease by 0.06%

27. According to Stefan's law, Energy radiated per unit time per unit area $= \sigma T^4$



$\therefore \dfrac{Energy}{time} = \left(\sigma T^4\right)\times\left(4\pi R^2\right)$

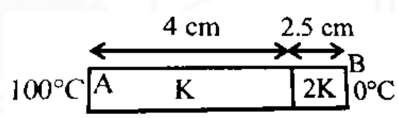
$\therefore$ Energy received on earth per unit time $= 1400\times 4\pi r^2$

$\therefore \sigma T^4 \times 4\pi R^2$

$= 1400\times 4\pi r^2$ or $T^4 = \dfrac{1400\times r^2}{\sigma R^2}$

or $T^4 = \dfrac{1400\times\left(1.5\times 10^{11}\right)^2}{\left(5.67\times 10^{-8}\right)\left(7\times 10^{8}\right)^2}$ or $T^4 = \dfrac{14\times 2.25\times 10^{24}}{5.67\times 49\times 10^{8}}$ or $T = 5803\,K$

28.



In series, $R_{eq} = R_1 + R_2$

$\Rightarrow \dfrac{L}{KA} = \dfrac{L_1}{K_1 A} + \dfrac{L_2}{K_2 A}$

$\Rightarrow \dfrac{L}{K} = \dfrac{L_1}{K_1} + \dfrac{L_2}{K_2} \Rightarrow \dfrac{6.5}{K_{eq}} = \dfrac{4}{K} + \dfrac{2.5}{2K}$

$\Rightarrow \dfrac{6.5}{K_{eq}} = \dfrac{1}{K}\left(\dfrac{8+2.5}{2}\right) \Rightarrow \dfrac{6.5}{K_{eq}} = \dfrac{1}{K}\left(\dfrac{10.5}{2}\right)$

$\therefore \quad K_{eq} = \dfrac{13K}{10.5} = \dfrac{26}{21}K = \left(1+\dfrac{5}{21}\right)K$

So, $\alpha = 21$

29. Conceptual

30. Efficiency, $\eta = \frac{Work\ done}{Heat\ absorbed} = \frac{W}{\Sigma Q}$

$= \frac{Q_1 + Q_2 + Q_3 + Q_4}{Q_1 + Q_3} = 0.5$

Here, $Q_1 = 1915 J, Q_2 = -40\ J$ and $Q_3 = 125\ J$

$\therefore \frac{1915 - 40 + 125 + Q_4}{1915 + 125} = 0.5$

$\Rightarrow 1915 - 40 + 125 + Q_4 = 1020$

$\Rightarrow Q_4 = 1020 - 2000$

$\Rightarrow Q_4 = -Q = -980\ J \Rightarrow Q = 980\ J$

31. (A) Process $A \to B$

This is an isobaric process, $P =$ constant and volume (V) of the gas decreases.
Therefore work is done on the gas.

$W = P(3V - V) = 2PV$

Also V decreases so temperature at B decreases

$\therefore$ Internal energy U decreases.

From, $Q = U + W$ as U and W decreases so Q decreases that means heat is lost.

(B) process $B \to C$

This is an isochoric process $V =$ constant pressure decreases $P \propto T$ so temperature also decreases.

$W = 0; \Delta U =$ negative so ΔQ negative

Hence heat is lost.

(C) Process $C \to D$

This is isobaric, pressure $P =$ constant V increases and $V \propto T$ so T increases. Hence $\Delta W, \Delta U$ and $\Delta Q + ve$ so heat gained by the gas.

(D) Process $D \to A$

Applying $PV = nRT$

For D $P(9V) = 1RT_D \qquad \therefore T_D = \frac{9PV}{R}$

For A $3P(3V) = 1RT_A \qquad \therefore T_A = \frac{9PV}{R}$

i.e., the process is isothermal $\therefore \Delta U = 0$

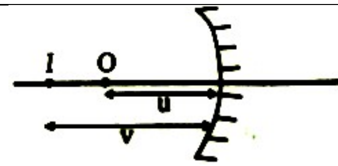
Now, $\Delta Q = \Delta U + W \qquad \therefore \Delta Q = W$

As volume decrease in this process so W negative i.e., worm done on the gas and ΔQ negative hence heat is lost.

32. From the ideal gas equation, $PV = nRT \Rightarrow PV = CT$

Therefore, PV v/s T graph is straight line.

33. The expression of magnification for mirror is



$m = -\frac{v}{u}$

$m = -3 = -\frac{v}{u}$ and $v - u = -20\,cm$

$\Rightarrow u = -10\,cm, u = -30\,cm$

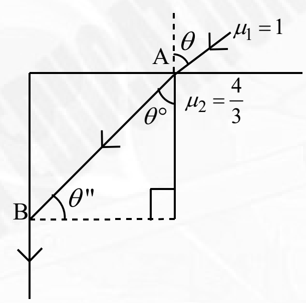
From mirror formula $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$f = \frac{vu}{v+u} = \frac{(-30)(-10)}{-30-10} = -\frac{15}{2}cm$

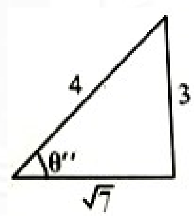
$\therefore \quad R = 2f = -15\,cm$

34. At maximum angle θ, the ray goes along the surface.
For all angles less than θ, total internal reflection occurs. At point B

$\theta'' = \left(\frac{\pi}{2} - \theta'\right)$



At point A, $1 \times \sin\theta = \frac{4}{3} \times \sin\theta'$



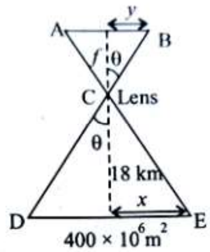
$\Rightarrow \sin\theta = \frac{4}{3} \times \sin\left(\frac{\pi}{2} - \theta^n\right)$

$\Rightarrow \sin\theta = \frac{4}{3}\cos\theta^n$

From the figure, $\cos\theta^n = \frac{\sqrt{7}}{4} \therefore \sin\theta = \frac{4}{3} \times \frac{\sqrt{7}}{4}$

or, $\theta = \sin^{-1}\left(\frac{\sqrt{7}}{3}\right)$

35. For drone camera, size $= (2 \times 2) \times 10^{-4} m^2$

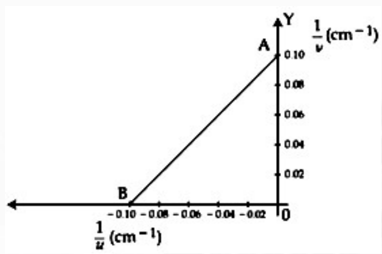


From similar ΔABC & ΔCDE,

$$\frac{y}{f} = \frac{x}{18}; \frac{z}{f} = \frac{20}{18} \Rightarrow f = 1.8cm$$

$$\therefore f = 18 \times 10^{-3} m = 18mm = 1.8cm$$

36.



From graph

$$a - \frac{1}{v} = 0; \frac{1}{u} = -0.1$$

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

$$f = 0 - (-0.1)$$

$$f = 10cm$$

$$R = f = 10cm$$

37. $r_2 < \sin^{-1}\left(\frac{1}{\mu}\right) \Rightarrow \sin r^2 < \frac{1}{\mu}$

$$sin\theta = \mu \sin r_1$$

$$r_1 = \sin^{-1}\left(\frac{\sin\theta}{\mu}\right) \Rightarrow \sin(A - r_1) < \frac{1}{\mu}$$

$$\sin\left(A - \left(\sin^{-1}\left(\frac{\sin\theta}{\mu}\right)\right)\right) < \frac{1}{\mu}$$

$$A - \sin^{-1}\left(\frac{\sin\theta}{\mu}\right) < \sin^{-1}\left(\frac{1}{\mu}\right)$$

$$A - \sin^{-1}\left(\frac{1}{\mu}\right) < \sin^{-1}\left(\frac{\sin\theta}{\mu}\right)$$

$$\left[\sin\left(A - \sin^{-1}\left(\frac{1}{\mu}\right)\right)\right] < \frac{\sin\theta}{\mu}$$

$$\left[\sin^{-1}\left[\mu\left[\sin\left(A-\sin^{-1}\left(\frac{1}{\mu}\right)\right)\right]\right]\right]<\theta$$

38. In interference, $I_1 = 4I,\ I_2 = 9I$

$$I_{max} = \left(\sqrt{I_1}+\sqrt{I_2}\right)^2$$

$$= \left(\sqrt{41}+\sqrt{91}\right)^2 = 251$$

$$\therefore I_{min} = \left(\sqrt{I_1}-\sqrt{I_2}\right)^2 = \left(\sqrt{4I}-\sqrt{91}\right)^2 = I$$

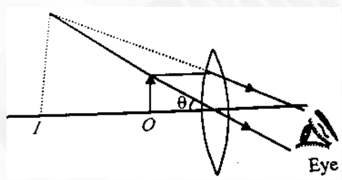
$\therefore I_{max} - I_{min} = 24\,I = xI$ (given)

$\therefore x = 24$

39. Fringe width, $\beta = \dfrac{\lambda D}{d}$

As, $\lambda_R > \lambda_B \therefore \beta_R > \beta_B$

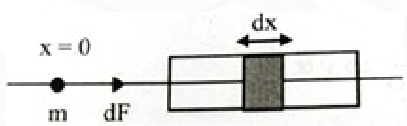
40. Image size is bigger than object size, the angular size of the image is equal to the angular size of object .



41. Given $\lambda = \left(A+Bx^2\right)$,

Taking small element dm of length dx at a distance x from $x=0$

So, $dm = \lambda\, dx$



$$dm = \left(A+Bx^2\right)dx \Rightarrow dF = \frac{Gmdm}{x^2}$$

$$\Rightarrow F = \int_a^{a+L}\frac{Gm}{x^2}\left(A+Bx^2\right)dx$$

$$= Gm\left[-\frac{A}{x}+Bx\right]_a^{a+L}$$

$$= Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)+BL\right]$$

42. Conceptual

43. Conceptual

44. Charge density, $\rho = \rho_0\left(1-\dfrac{r}{R}\right)$

$dq = \rho dv$

$$q_{in} = \int dq = \int \rho dv$$

$$= \int \rho_0 \left(1 - \frac{r}{R}\right) 4\pi r^2 dr \quad \left(\because dv = 4\pi r^2 dr\right)$$

$$= 4\pi\rho_0 \int_0^R \left(1 - \frac{r}{R}\right) r^2 dr$$

$$= 4\pi\rho_0 \int_0^R r^2 \, dr - \frac{r^3}{R} dr$$

$$= 4\pi\rho_0 \left[\left[\frac{r^3}{3}\right]_0^R - \left[\frac{r^4}{4R}\right]_0^R\right] = 4\pi\rho_0 \left[\frac{R^3}{3} - \frac{R^4}{4R}\right]$$

$$= 4\pi\rho_0 \left[\frac{R^3}{3} - \frac{R^3}{4}\right] = 4\pi\rho_0 \left[\frac{R^3}{12}\right]$$

$$q_{in} = \frac{\pi\rho_0 R^3}{3}$$

Using Gauss law, $\oint \vec{E}.\overrightarrow{dA} = \frac{q_{in}}{\epsilon_0}$

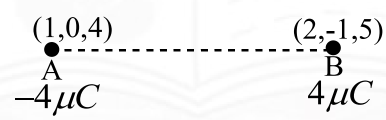
$$\Rightarrow E.4\pi r^2 = \left(\frac{\pi\rho_0 R^3}{3\epsilon_0}\right)$$

$\therefore$ Electric field outside the ball, $E = \dfrac{\rho_0 R^3}{12\epsilon_0 r^2}$

45. $\vec{\tau} = \vec{p} \times \vec{E}$

$$\vec{p} = q\vec{\ell} = 4 \times \left(\hat{i} - \hat{j} + \hat{k}\right)$$

$$= \left(4\hat{i} - 4\hat{j} + 4\hat{k}\right) \mu C - m$$



$$\therefore \vec{\tau} = \vec{P} \times \vec{E}$$

$$= \left(4\hat{i} - 4\hat{j} + 4\hat{k}\right) \times \left(20\hat{i}\right) \times 10^{-6} Nm$$

$$= \left(8\hat{k} + 8\hat{j}\right) \times 10^{-5} = 8\sqrt{2} \times 10^{-5} Nm$$

$= 8\sqrt{\alpha} \times 10^{-5} Nm$ (given) $\therefore \alpha = 2$

46. We have

$V = 3x^2$ volt

$$E_x = \frac{-\partial V}{\partial x} = -6x \Rightarrow E_{x/x=1} = -6$$

$E_y = -\frac{\partial V}{\partial y} = 0$

$E_z = -\frac{\partial V}{\partial_z} = 0$

So, $\left|\vec{E}\right| = \sqrt{(-6)^2 + 0^2 + 0^2} = 6Vm^{-1}$

In vector form,

$\vec{E} = -6\hat{i}V/m$ (a long $-ve\ x-$axis)

47. $U_i + K_i = U_f + K_i$

$-\frac{GMm}{2R} + 0 = -\frac{GMm}{R} + \frac{1}{2}mv^2$

$-\frac{GMm}{2R} + \frac{GMm}{R} = \frac{1}{2}mv^2$

$\frac{GMm}{2R} = \frac{1}{2}mv^2 \Rightarrow v = \sqrt{\frac{GM}{R}} = \sqrt{gR}$

48. Using lens formula

$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{V_1} - \frac{1}{-30} = \frac{1}{+10} \Rightarrow V_1 = 15\,cm$

So, $u_2 = (15-5)cm = 10cm$

$\Rightarrow \frac{1}{V_2} = 0 \Rightarrow V_2 = \infty$

So, $u_3 = \infty$

Then, $V_3 = 30\,cm$

$OV_3 = 75\,cm$

49. Angular width between first and second diffraction minima $\theta = \frac{\lambda}{a}$ and angular width of fringe due to double slit is $\theta' = \frac{\lambda}{d}$

So, number of fringes

$= \frac{\theta}{\theta'} = \left(\frac{\frac{\lambda}{a}}{\frac{\lambda}{d}}\right) = \left(\frac{d}{a}\right) = \frac{19.44}{4.05} = 4.81 = 5$

50. Let a, be the amplitude of light from first slit and a_2 be the amplitude of light from second slit $a_1 = a, a$ Then $a_2 = 2a$

Intensity $I\alpha$ (amplitude)^2

$I_2 = a_1^2 = a^2$

$l = a_2 = 4a^2 = 4l$

$l_r = a_1^2 + a_2^2 + 2a_1a_2\cos\phi =$

$l_{11} + l_2 + 2\sqrt{I_1 I_2}\cos\phi$

$I_r = I_1 + 4I_1 + 2\sqrt{4I_1^2}\cos\phi$

$\Rightarrow I = 5I_1 + 4I_1\cos\phi$

Now $I_{\max} = (a_1 + a_2)^2 = (a + 2a)^2 = 9a^2$

$I_{\max} = 9I_1 \Rightarrow I_1 = \dfrac{I_{\max}}{9}$

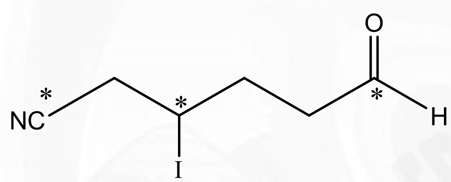
Substituting in equation (i)

$I_r = \dfrac{5I_{\max}}{9} + \dfrac{4l_{\max}}{9}\cos\phi \Rightarrow I_r = \dfrac{I_{\max}}{9}[5 + 4\cos\phi]$

CHEMISTRY

51. If there are two or more parent chains of equal size, then the parent chain with more number of side chains to be selected.

52.



The starred carbons are electrophilic centres as they have partial +ve charge due to polarity of bond

53. Conceptual (Structural Isomers examples)

54. Hyper conjugation can explain the stability of carbocations, Alkenes and Alkyl arenes only.

55. Decarboxylation of sodium acetate gives Methane, remaining method produces higher alkanes.

56. Conceptual

57.

$$CH_3 - \underset{\substack{|\\ Br}}{CH} - CH_2 - Br \xrightarrow[-Br_2]{Z} CH_3 - CH = CH_2 \xrightarrow[(C_6H_5CO)_2O_2]{HI} CH_3 - \overset{\substack{I\\ |}}{CH} - CH_3$$

(Maj)

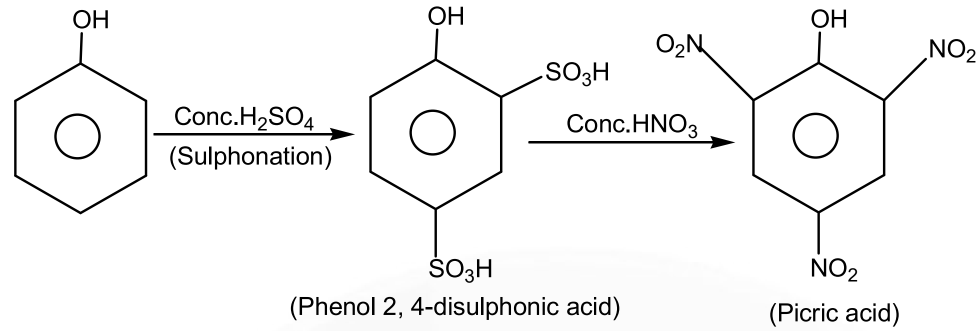
(HI can't show karash effect)

58. $[2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O]$

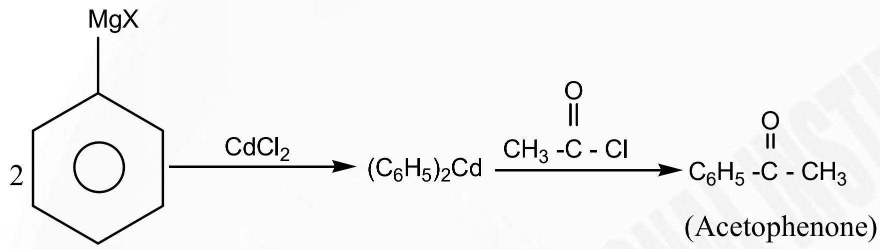
59. $R - X + KNO_2 \rightarrow R - O - N = O$

60. Conceptual

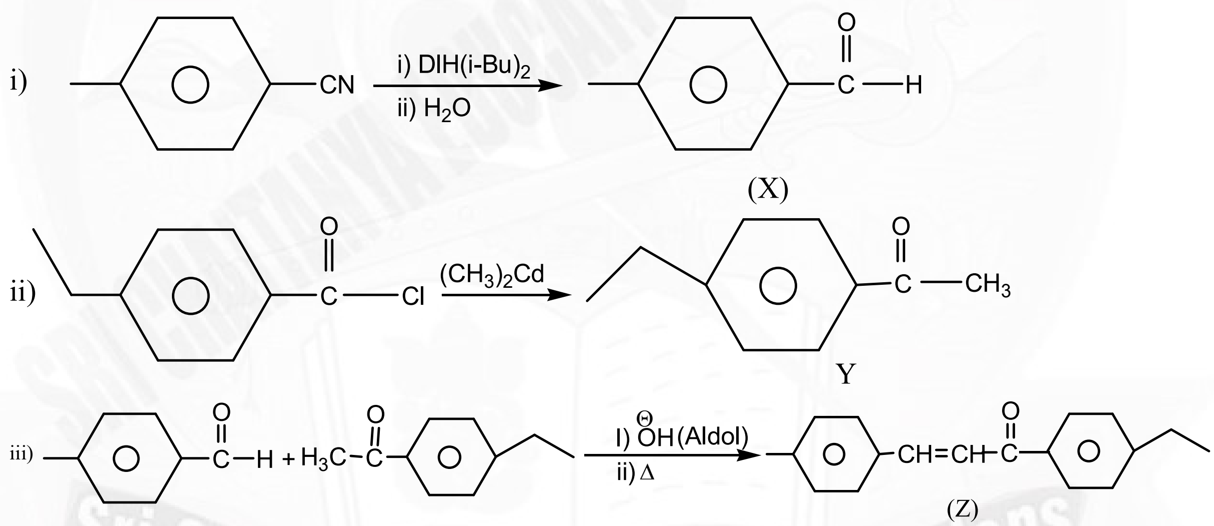
61.



62. Conceptual (Williamson synthesis is favoured by 1°-Alkyl halides)
63. Conceptual
64.



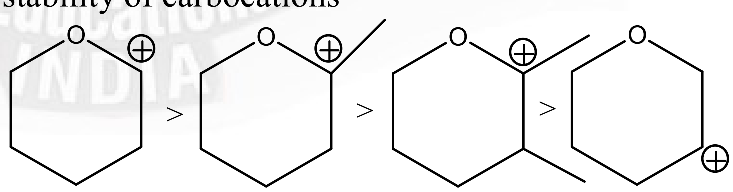
65.



66. Order of strength of acids: $C_2H_5OH < H_2O < CH_3COOH < HI$

Order of strength of conj. bases : $C_2H_5O^{\Theta} > \overset{\Theta}{OH} > CH_3COO^{\Theta} > I^{\Theta}$

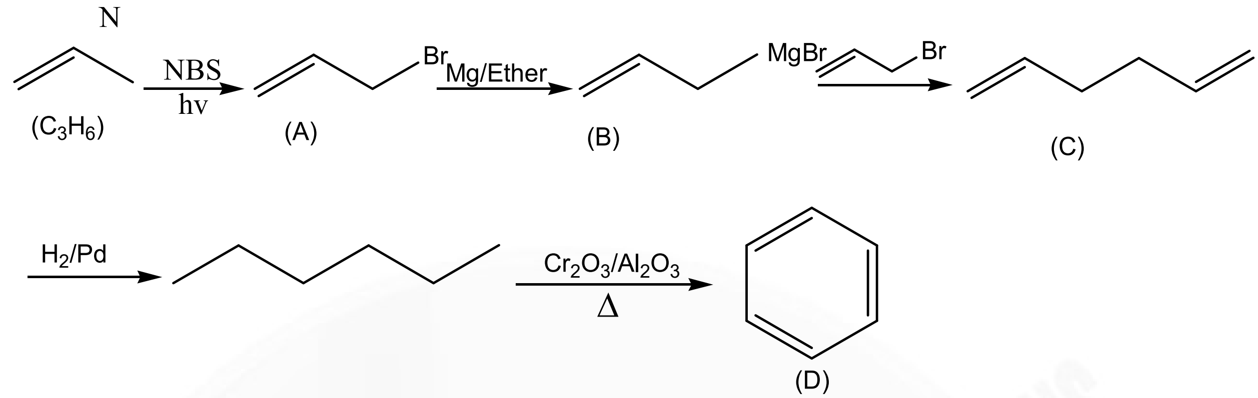
67. Rate of electrophilic addition α stability of carbocations



stability of carbocations:

order of reactivity: P > R > S > Q

68.

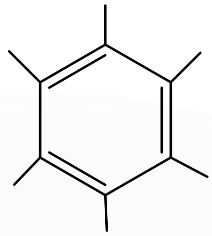


No.of σ bonds, = (12), No.of π bond – (3)

69.

$$2CH_3-CCl_3 \xrightarrow[\Delta]{Ag} \underset{(A)}{CH_3-C\equiv C-CH_3}$$

$$3CH_3-C\equiv C-CH_3 \xrightarrow[tube]{Hot'Fe'}$$



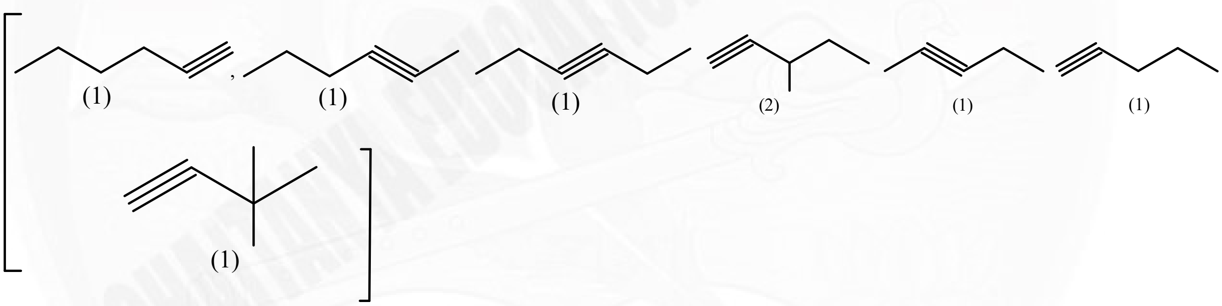
(B)

No.of $\sigma-$bonds (x) = 30, No.of π -bonds (y) = 3 $\therefore \frac{x}{y}=30/3=10$

70.

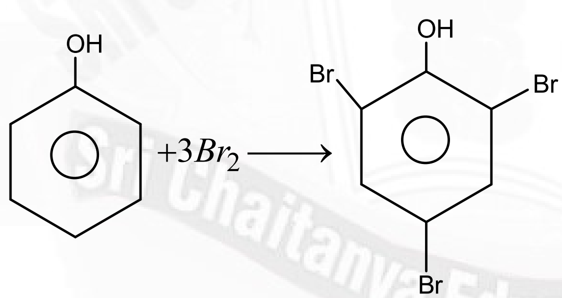
Functional groups -	COOH	$\rangle C=O$	-OH	-CN	$-\underset{\underset{O}{\|\|}}{C}-NH_2$
No. of moles of RMgx -	1	1	1	1	2

71.



72. (b, d, e, f, g)

73.



1 mole of phenol = 3 moles of Br_2

4g of phenol = $\frac{4}{94}=0.0425$ moles of phenol

$\Rightarrow$0.0425 moles of phenol = $0.0425\times 3=0.1276$ moles of Br_2

$\therefore 0.1276$ moles of $Br_2=0.1276\times 160g=20.42g\ of\ Br_2$

74. (a, d, f, g, h, i)

75. No.of chiral units = 6

Total no.of stereoisomers = 2^6 = 64