FT - 22 (FR) (NEET - CBSE, GSEB) (24 - 04 - 2026)

ANSWER KEY

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans	3	2	3	4	1	4	4	4	3	3	1	4	1	1	1	3	1	1	4	4
Q	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans	4	2	2	2	3	1	1	3	3	4	3	1	1	1	3	1	3	2	3	1
Q	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans	2	3	1	1	2	4	3	2	4	2	1	2	3	3	2	3	4	1	2	3
Q	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans	2	2	3	2	1	4	1	1	4	3	4	1	1	3	4	4	4	4	4	1
Q	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans	2	3	2	1	2	1	1	2	1	4	3	2	3	2	2	4	1	3	1	2
Q	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans	4	3	4	1	3	2	1	2	4	4	4	4	3	4	4	3	3	2	2	1
Q	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140
Ans	4	1	1	3	1	2	1	1	4	2	4	4	2	3	4	2	2	1	4	4
Q	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160
Ans	2	3	3	4	2	3	2	2	4	4	1	3	2	4	4	3	4	4	2	1
Q	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
Ans	1	4	2	4	2	3	3	4	4	1	2	3	3	1	2	4	1	1	2	3

PHYSICS:

1. **Sol. (3)**

Equation of displacement of particle executing SHM is given by x = Asin(ωt + ∅)

Potential energy of particle executing SHM is given by

$$U=\frac{1}{2}kx^2$$

$$U=\frac{1}{2}kA^2\sin^2(wt+\phi) \quad .....(ii)$$

From I and II, it is clear that

Time period of x = A sin(wt + ∅) is

$$T_1=\frac{2\pi}{\omega}\Rightarrow \text{Ferquencyn}_1=\frac{\omega}{2\pi}$$

While time period of $x^2 = A^2 \sin^2(wt + \emptyset)$ is

$$T_2=\frac{\pi}{\omega}\Rightarrow \text{Ferquencyn}_2=\frac{\omega}{\pi}$$

Hence $n_2 = 2n_1$

2. **Sol. (2)**

Drift velocity, $v_d=\frac{eE\tau}{m}$

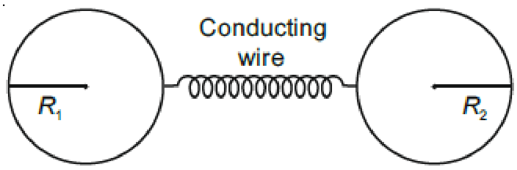
Electrical resistivity, $\rho=\frac{1}{\sigma}=\frac{E}{J}$

Relaxation period, $\tau=\frac{m}{ne^2\rho}$

Current density, $J=\frac{I}{A}=nev_d$

(A – R, B – S, C – P, D – Q)

3. **Sol. (3)**



When two conductors are connected by a conducting wire, then the two conductors should have same potential.

So, $V_1 = V_2$

$$\frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1} = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2}$$

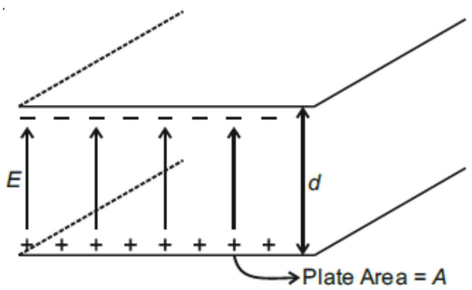
$$\Rightarrow \frac{1}{4\pi\varepsilon_0}\frac{Q_1}{R_1}\times\frac{R_1}{R_1} = \frac{1}{4\pi\varepsilon_0}\frac{Q_2}{R_2}\times\frac{R_2}{R_2}$$

$$\Rightarrow \frac{Q_1R_1}{4\pi R_1^2\varepsilon_0} = \frac{Q_2R_2}{4\pi R_2^2\varepsilon_0}$$

$$\Rightarrow \frac{\sigma_1R_1}{\varepsilon_0} = \frac{\sigma_2R_2}{\varepsilon_0}$$

$$\Rightarrow \frac{\sigma_1}{\sigma_2} = \frac{R_2}{R_1}$$

4. **Sol. (4)**



Energy density associated with electrical field is given by

$$u = \frac{dU}{dV} = \frac{1}{2}\varepsilon_0E^2$$

$$\Rightarrow dU = \frac{1}{2}\varepsilon_0E^2dV$$

Total energy stored in the space between the capacitor will be

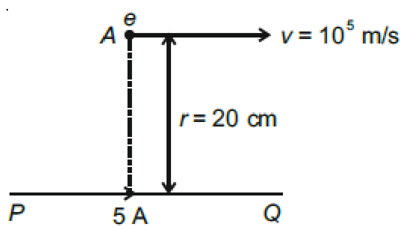
$$U = \int dU = \int\frac{1}{2}\varepsilon_0E^2dV$$

$$= \frac{1}{2}\varepsilon_0E^2\int dV \qquad \text{[E is constant]}$$

$$= \frac{1}{2}\varepsilon_0E^2V = \frac{1}{2}\varepsilon_0E^2Ad \qquad \text{[V = Ad]}$$

5. **Sol. (1)**

Magnetic fields produced due to current carrying wire at point 'A'



$$B = \frac{\mu_0 2I}{4\pi r}$$

$$B = \frac{10^{-7}\times2\times5}{20\times10^{-2}} = \frac{1}{2}\times10^{-5}$$

Upward to the plane of paper

Now, force acting on electron due to this field

$$\vec{F} = q(\vec{v}\times\vec{B})$$

$$|\vec{F}| = 1.6\times10^{-19}\times10^5\times\frac{1}{2}\times10^{-5} = 0.8\times10^{-19}\,N$$

$$|\vec{F}| = 8\times10^{-20}\,N$$

6. **Sol. (4)**

With larger aperture of objective lens, the light gathering power in telescope is high.

Also, the resolving power or the ability to observe two objects distinctly also depends on the diameter of the objective. Thus objective of large diameter is preferred.

Also, with large diameters fainter objects can be observed. Hence it also contributes to the better quality and visibility of images.

Hence, all options are correct.

7. **Sol. (4)**

Root mean square speed of gas molecule

$$= \sqrt{\frac{3RT}{M}}$$

Pressure exerted by ideal gas $= \frac{1}{3}nmv^2$

Average kinetic energy of a molecule $= \frac{3}{2}k_BT$

Total internal energy of a gas is $(U) = \frac{1}{2}nfRT$

Here, n = 1

f = 5 ⇒ $U = \frac{5}{2}RT$

Hence, A – Q, B – P, C – S, D – R

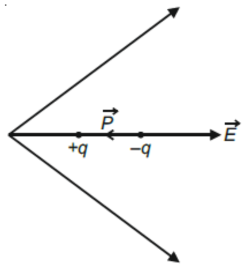
8. **Sol. (4)**

In reverse biased, after breakdown, voltage across the zener diode becomes constant. Therefore zener diode is connected in reverse biased when used as voltage regulator.

Potential barrier of silicon diode is nearly 0.7 V statement A is correct and statement B is incorrect.

9. **Sol. (3)**

Potential energy of electric dipole in external electric field = $U = -\vec{P}\cdot\vec{E}$



Angle between electric field and electric dipole is 180°

U = –PEcosθ

U = –PEcos180°

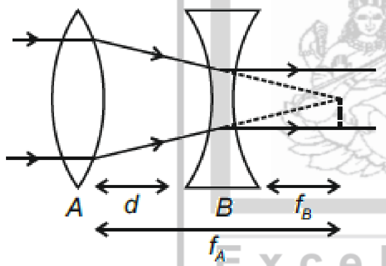
U = +PE

On moving towards right electric field strength decrease therefore potential energy decrease.

Net force on electric dipole is towards right and net torque acting on it is zero.

So, it will more towards right.

10. **Sol. (3)**



Parallel beam of light after refraction from convex lens converge at the focus of convex lens. In question it is given light after refraction pass through concave lens becomes parallel. Therefore light refracted from convex lens virtually meet at focus of concave lens.

According to above ray diagram

d = $f_A - f_B$

= 20 – 5 = 15 cm

11. **Sol. (1)**

Escape velocity from the Earth's surface

$$v_e = \sqrt{\frac{2GM}{R}}$$

$$= \sqrt{\frac{2G\rho\frac{4}{3}\pi R^3}{R}}$$

$$= \sqrt{\frac{8G\rho\pi}{3}R^2}$$

$V_e \propto R$ (For same density)

$$\frac{v}{v_1} = \frac{R}{4R} \Rightarrow v_1 = 4v$$

12. **Sol. (4)**

On β^+ decay atomic number decreases by 1

On β^{-1} decay atomic number increases by 1

On α decay atomic number decreases by 2

$${}^{A}_{Z}X \xrightarrow{\beta^+ \text{ decay}} {}_{Z-1}B \xrightarrow{\alpha \text{ decay}} {}_{Z-3}C \xrightarrow{\beta^- \text{ decay}} {}_{Z-2}D$$

Hence correct order of decay are β^+, α, β^-

13. **Sol. (1)**

Here, pitch of the screw gauge, P = 1 mm

Number of circular division, n = 100

Thus least count

$$LC = \frac{P}{n} = \frac{1}{100} = 0.01\text{mm} = 0.001\text{cm}$$

So, diameter of the wire

= MSR + (CSR × LC)

= 0 + (52 × 0.001 cm)

= 0.052 cm

14. **Sol. (1)**

V_L = 40 volt

V_R = 40 volt

V_C = 10 volt

Now, $V_{RMS} = \sqrt{V_R^2 + (V_L - V_C)^2}$

$$= \sqrt{(40)^2 + (40-10)^2} = 50V$$

$$I_{RMS} = \frac{I_0}{\sqrt{2}} = \frac{10\sqrt{2}}{\sqrt{2}} = 10A$$

$$\therefore V_{RMS} = I_{RMS} \times Z$$

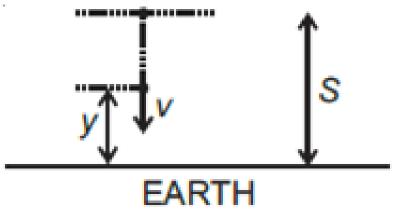
$$\therefore Z == \frac{V_{RMS}}{I_{RMS}} = \frac{50}{10} = 5\Omega$$

15. **Sol. (1)**

Let required height of body is y.

When body from rest falls through height (S – y)

Then under constant acceleration



$$v^2 = 0^2 + 2g(S-y)$$

$$v = \sqrt{2g(S-y)} \qquad ......(1)$$

When body is at height y above ground. Potential energy of body of mass m

U = mgy

As per given condition kinetic energy, K = 3U

$$\frac{1}{2}m(v)^2 = 3 \times mg(y)$$

$$\frac{1}{2}m \times 2g(S-y) = 3 \times mgy \qquad \text{(Using 1)}$$

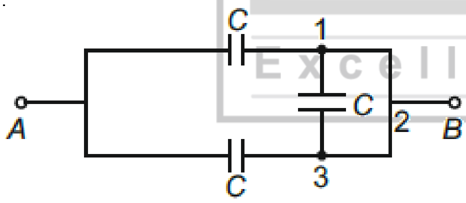
$$S - y = 3y$$

$$\therefore y = \frac{S}{4}$$

$$\therefore v = \sqrt{2 \times g\left(S - \frac{S}{4}\right)} = \sqrt{\frac{3gS}{2}}$$

16. **Sol. (3)**

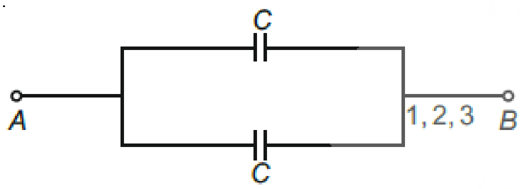
Given circuit is



Points 1, 2, 3 are at same potential (as they are connected by conducting wire)

So the capacitor is short circuited. It does not store any charge.

The circuit can be redrawn as



C_{AB} = C + C = 2C (Parallel combination)

17. **Sol. (1)**

All the wires are identical and of same material so they will have same value of resistance. Let it be R.

When these are (four) connected in parallel.

$$R_P = \frac{R}{4} \qquad \left(\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}\right)$$

Given R_P = 0.25 Ω

$$0.25 = \frac{R}{4}$$

∴ R = 1 Ω

Now these four resistance are arranged in series

R_S = R + R + R + R = 4R

R_S = 4 × 1 = 4 Ω

18. **Sol. (1)**

Mass number of reactant = 240

BE per nucleon = 7.6 MeV

Mass number of products = 120

BE per nucleon of product = 8.5 MeV

Total gain in BE = (BE) of products – (BE) of reactants.

= [120 + 120] × 8.5 – [240] ×7.6

= (240) × 8.5 – 240× 7.6

= (2040 – 1824) MeV

Gain in BE = 216 MeV

19. **Sol. (4)**

The current through a semiconductor is

$$I = neAv_d$$

$$I = neA\mu E$$

$$\frac{I_n}{I_p} = \frac{n_e eA\mu_e E}{n_h eA\mu_h E}$$

$$\frac{I_n}{I_p} = \frac{\mu_e}{\mu_h}$$

$$\because \mu_e > \mu_h$$

$$\Rightarrow I_n > I_p$$

20. **Sol. (4)**

The power of a source is given as

$$P=\frac{E}{t}=\frac{n}{t}\left(\frac{hc}{\lambda}\right)$$

$$\Rightarrow \frac{n}{t}=\frac{P}{\left(\frac{hc}{\lambda}\right)}$$

(Hence n/t is number of photons emitted per second)

$$\frac{n}{t}=\frac{3.3\times10^{-3}\times6\times10^{-7}}{6.6\times10^{-34}\times3\times10^{8}}$$

= 10^{16} photons per second

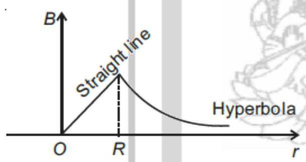
21. **Sol. (4)**

From Ampere's circuital law

$$B=\frac{\mu_0 I}{2\pi R^2}r \quad \text{if } r<R \Rightarrow B_{inside}\propto r$$

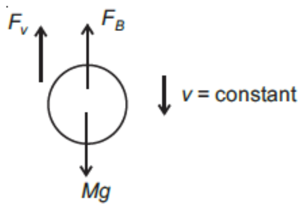
$$B=\frac{\mu_0 I}{2\pi r} \quad \text{if } r\geq R \Rightarrow B_{outside}\propto 1/r$$

Hence the correct plot of magnetic field B with distance r from axis of cable is given as



22. **Sol. (2)**

Let F_v be the viscous force and FB be the Bouyant force acting on the ball.



Then, when body moves with constant velocity

$$Mg=F_B+F_v$$

$$Mg-F_B=F_v$$

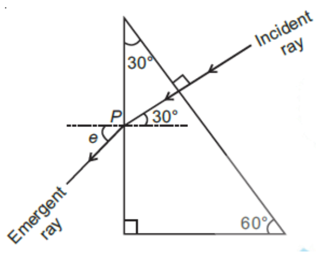
$$=dVg-\frac{d}{2}Vg \quad (M = dVg)\ V = \text{Volume of ball}$$

$$=\frac{d}{2}Vg \Rightarrow F_v=\frac{M}{2}g$$

23. **Sol.(2)**

Form the ray diagram shown in the figure.

At point P, form Snell's law



$$\frac{\sin i}{\sin r}=\frac{\mu_{air}}{\mu_{Prism}}$$

$$\Rightarrow \frac{\sin 30^\circ}{\sin e}=\frac{1}{\sqrt{3}} \qquad \Rightarrow \sin e=\sqrt{3}\,\frac{1}{2}$$

$$\Rightarrow \angle e=60^\circ$$

24. **Sol. (2)**

Given V = $V_0\sin\omega t$

Now displacement current Id is given by

$$I_d=C\frac{dV}{dt}$$

$$=C\frac{d}{dt}(V_0\sin\omega t)$$

$$=C(V_0\omega)\cos\omega t$$

$$I_d=CV_0\omega\cos\omega t$$

25. **Sol. (3)**

Energy, $E\propto F^aA^bT^c$

$[E]=[F^a][A^b][T^c]$

$\Rightarrow [ML^2T^{-2}]=[MLT^{-2}]^a\,[LT^{-2}]^b\,[T]^c$

$[ML^2T^{-2}]=[M^aL^{a+b}T^{-2a-2b+c}]$

Comparing dimensions on both sides.

⇒ a = 1; a + b = 2 and –2 = – 2a – 2b + c

⇒ b = 1 ⇒ –2 = – 2 – 2 + c

⇒ c = 2

$[E]=[FAT^2]$

26. **Sol. (1)**

For Dark Band |D|

D sinθ = n λ [for small angle sinθ ≈ θ = two ≈ y/D]

$$d\frac{y}{D}=n\lambda$$

Second Dark n = 2

$$y=\frac{n\lambda D}{d}$$

∴ y = 2 λ D/d

27. **Sol. (1)**

For a spring, kx = F

Given x = 5 cm, F = 10 N

$\Rightarrow$ k(5 × 10^{-2}) = 10

$\Rightarrow$ k = 1000/5 = 200 N/m

Now, for spring – mass system undergoing SHM

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Given, m = 2 kg

$$T = 2\pi\sqrt{\frac{2}{200}} = \frac{2\pi}{10} = 0.628\,s$$

28. Sol. (3)

Direction of propagation of electromagnetic waves is along $\vec{E}\times\vec{B}$

Given that direction of propagation is along x – axis

(1) $\left(-\hat{j}+\hat{k}\right)\times\left(-\hat{j}+\hat{k}\right)=0$

(2) $\left(\hat{j}+\hat{k}\right)\times\left(\hat{j}+\hat{k}\right)=0$

(3) $\left(-\hat{j}+\hat{k}\right)\times\left(-\hat{j}-\hat{k}\right)=2\hat{i}$

(4) $\left(-\hat{j}+\hat{k}\right)\times\left[-\left(\hat{j}+\hat{k}\right)\right]=0$

Option (3) is correct

29. Sol. (3)

From average form of Newton's law of cooling

$$-\left(\frac{T_1+T_2}{2}-T_s\right)K = \frac{T_1-T_2}{\Delta t}$$

T_1 and T_2 are initial and final temperature and T_s is surrounding temperature.

$$\Rightarrow -K\left(\frac{90+80}{2}-20\right) = \frac{90-80}{t}$$

$$\Rightarrow -K(65) = \frac{10}{t}$$

$$\Rightarrow K = \frac{-2}{13t}$$

In second case,

$$-K\left(\frac{80+60}{2}-20\right) = \frac{80-60}{t_1}$$

$$\Rightarrow -K(50) = \frac{20}{t_1}$$

$$\Rightarrow \frac{2}{13t}(50) = \frac{20}{t_1}$$

$$\Rightarrow t_1 = \frac{13t}{5}$$

30. Sol. (4)

As per Einstein's photoelectric equation

$$\frac{hc}{\lambda} = \phi_0 + k$$

ϕ_0 : work function

K = maximum kinetic energy of photoelectrons

As per questions $\phi_0 \to 0$

$$\therefore \frac{hc}{\lambda} = k = \frac{P^2}{2m} \Rightarrow P = \sqrt{\frac{2mhc}{\lambda}}$$

Now De – Broglie wavelength,

$$\lambda_d = \frac{h}{P} = \frac{h}{\sqrt{\frac{2mhc}{\lambda}}}$$

$$\Rightarrow \sqrt{\lambda} = \lambda_d\sqrt{\frac{2mc}{h}}$$

$$\Rightarrow \lambda = \left(\frac{2mc}{h}\right)\lambda_d^2$$

31. Sol. (3)

Incident power on turbine = $\frac{d(mgh)}{dt}$

$= gh\,\frac{dm}{dt}$

$= 10 \times 60 \times 15 = 9000$ W

Now losses are 10%

∴ Power generated =

$$\left(1-\frac{10}{100}\right)\times 9000 = 8100\,W = 8.1\,kW$$

32. Sol. (1)

Electric potential due to a charged sphere = $\frac{kQ}{R}$

k = 9 × 10^9 N–m^2/C^2

Q : charge on sphere

R : Radius of sphere

Let charge and radius of smaller drop is q and r respectively

For smaller drop, $V = \frac{kq}{r} = 220V$

Let R be radius of bigger drop,

As volume remains the same

$$\left(\frac{4}{3}\pi r^3\right)\times 27=\frac{4}{3}\pi R^3$$

$$\Rightarrow R=\sqrt[3]{27}r=3r$$

Now, using charge conservation,

$$\Rightarrow Q=27q$$

$$V_{\text{big drop}}=\frac{kQ}{R}=\frac{k(27q)}{3r}=9\left(\frac{kq}{r}\right)$$

= 9 × 220 = 1980 V

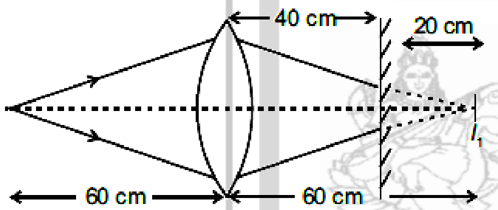
33. Sol. (1)

Using lens formula for first refraction from convex lens

$$\frac{1}{v_1}-\frac{1}{u}=\frac{1}{f}$$

V_1 = ?, u = – 60 cm, f = 30 cm

$$\Rightarrow \frac{1}{v_1}+\frac{1}{60}=\frac{1}{30}\Rightarrow v_1=60\,\text{cm}$$



I_1 here is first image by lens

The plane mirror will produce an image at distance 20 cm to left of it.

For second refraction from convex lens,

u = –20 cm, v = ?, f = 30 cm

$$\frac{1}{v_1}-\frac{1}{u}=\frac{1}{f}\Rightarrow\frac{1}{v}+\frac{1}{20}=\frac{1}{30}$$

$$\Rightarrow\frac{1}{v}=\frac{1}{30}-\frac{1}{20}\Rightarrow v=-60\,\text{cm}$$

Thus the final image is virtual and at a distance, 60 – 40 = 20 cm from plane mirror.

34. Sol. (1)

Given v = kV_e

Where, k < 1

Thus, v < V_e

From conservation of mechanical energy,

$$\frac{1}{2}mv^2-\frac{GmM}{R}=-\frac{GmM}{(R+h)}$$

$$\Rightarrow\frac{v^2}{2}=\frac{GM}{R}-\frac{(GM)}{(R+h)}=\frac{h}{R(R+h)}GM$$

$$\Rightarrow\frac{1}{2}k^2v_e^2=\frac{GMh}{R(R+h)}$$

We know, $v_e=\sqrt{\frac{2GM}{R}}$

$$\Rightarrow\frac{1}{2}k^2\left(\frac{2GM}{R}\right)=\frac{GMh}{R(R+h)}$$

$$k^2=\frac{h}{R(R+h)}$$

$$Rk^2+hk^2=h$$

$$Rk^2=h(1-k^2)$$

$$\therefore h=\frac{Rk^2}{(1-k^2)}$$

35. Sol. (3)

$$\vec{F}=q\left(\vec{\upsilon}\times\vec{B}\right)=q\vec{\upsilon}\times\left(B\hat{i}+B\hat{j}+B_0\hat{k}\right)$$

For q = 1 and $\vec{\upsilon}=2\hat{i}+4\hat{j}+6\hat{k}$ and

$$\vec{F}=4\hat{i}-20\hat{j}+12\hat{k}$$

$$\Rightarrow\left(4\hat{i}-20\hat{j}+12\hat{k}\right)=-1\times\left[\left(2\hat{i}+4\hat{j}+6\hat{k}\right)\times\left(B\hat{i}+B\hat{j}+B_0\hat{k}\right)\right]$$

Thus, calculating values of RHS,

$$\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 4 & 6\\ B & B & B_0\end{vmatrix}$$

$$\Rightarrow i(4B_0-6B)-j(2-6B)+k(2B-4B)$$

Comparing L.H.S and R.H.S

$4B_0-6B=4\Rightarrow 2B_0-3B=2$ ……(1)

$-\left(2B_0-6B\right)=-20\Rightarrow B_0-3B=10$ ……(2)

$2B-4B=12\Rightarrow B=-6$ ……(3)

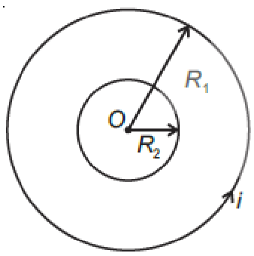
From (2) and (3)

B = -6 and B_0 = -8

Hence, $\vec{B}=-6\hat{i}-6\hat{j}-8\hat{k}$

36. Sol. (1)

Two concentric coils are of radius R_1 and R_2 as shown



Let current in outer loop be i

Magnetic field at centre = $B = \dfrac{\mu_0 i}{2R_1}$

Magnetic flux through inners coil = $B \times \pi R_2^2$

$$\phi = \frac{\mu_0 i}{2R_1} \times \pi R_2^2$$

$$\phi = \frac{\mu_0 i}{2} \times \frac{\pi R_2^2}{R_1}$$

As per definition $\phi = Mi$

$$\Rightarrow M = \left(\frac{\mu_0 \pi}{2}\right) \times \frac{R_2^2}{R_1} \Rightarrow \therefore M \propto \frac{R_2^2}{R_1}$$

37. **Sol. (3)**

Output o combination of logic gates is given as

$$y = A \cdot B + \overline{B \cdot C}$$

	Input Signals					Output Signal
Time duration	A	B	C	AB	$\overline{B \cdot C}$	$y = A \cdot B + \overline{B \cdot C}$
$0 - t_1$	0	0	1	0	1	1
$t_1 - t_2$	1	0	1	0	1	1
$t_2 - t_3$	0	1	0	0	1	1
$t_3 - t_4$	1	1	0	1	1	1
$t_4 - t_5$	0	0	1	0	1	1
$t_5 - t_6$	1	0	1	0	1	1
$t_6 - t_7$	0	0	1	0	1	1

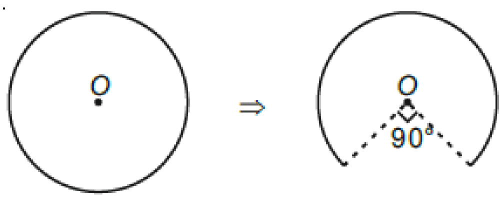
So the output y is high (1) that is v_0 = 5 V

38. **Sol. (2)**

Given that,

Mass of Ring = M; Radius of Ring = R

Now 90° arc is removed from circular ring, then mass removed = M/4



Mass of remaining portion = 3M/4

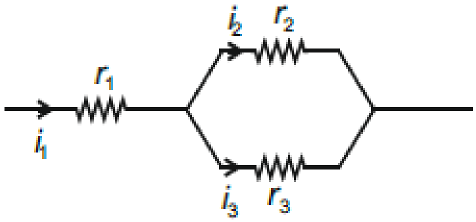
Moment of inertia of remaining part = $\int dmr^2$

$$\Rightarrow I = R^2 \int dm \qquad (\because r = R)$$

$$\Rightarrow I = \frac{3MR^2}{4}$$

So the value of K is 3/4

39. **Sol. (3)**



In parallel combination of resistances r_2 and r_3, potential difference will be equal across both resistance.

So, $i_2 r_2 = i_3 r_3 \Rightarrow i_2 = \dfrac{i_3 r}{r_2}$ .....(1)

As per Kirchhoff's first law

$$\Rightarrow i_1 = i_2 + i_3$$

$$\Rightarrow i_1 = \left(\frac{r_3}{r_2} + 1\right) i_3 \qquad \text{(From eq (1))}$$

$$\Rightarrow \frac{i_3}{i_1} = \frac{r_2}{r_2 + r_3}$$

40. **Sol. (1)**

Initial velocity of car = 0

Acceleration of car = 5 m/s^2

Velocity of car at t = 4 s; v = u + at

⇒ v = 0 + 5 × 4 = 20 ms^{-1}

At t = 4 s, A ball is dropped out of a window so velocity of ball at this instant is 20 ms^{-1} along horizontal.

After 2 seconds of motion :

Horizontal velocity of ball = 20 ms^{-1} ($\because a_x = 0$)

Vertical velocity of ball (v_y) = $u_y + a_y t$

v_y = 0 + 10 × 2 = 20 ms^{-1} ($\because$ ay = g = 10 m/s^2)

So magnitude of velocity of ball

$$(v) = \sqrt{v_x^2 + v_y^2} = 20\sqrt{2}\ m/s$$

Acceleration of ball at t = 6 s is g = 10 m/s^2

As ball is under free fall.

41. **Sol. (2)**

In ideal transformer:

Input power = Output power

$\Rightarrow V_P I_P = V_S I_S$ = Given power

$\Rightarrow 220 \times I_P = 44$

$\Rightarrow I_P = 0.2$ A

42. **Sol. (3)**

Given that :

Mass of ball = 0.15 kg

Height form which ball is dropped = 10 m

Impulse, $\vec{i}$ = Change in linear momentum

$$\Delta\vec{P} = \vec{P_f} - \vec{P_i}$$

Velocity of ball at ground $(v) = \sqrt{2gh}$

$$= \sqrt{2\times10\times10} = 10\sqrt{2}\,m/s$$

$$\vec{i} = 0.15\times10\sqrt{2}(-\hat{j}) = 0.15\times10\sqrt{2}(\hat{j})$$

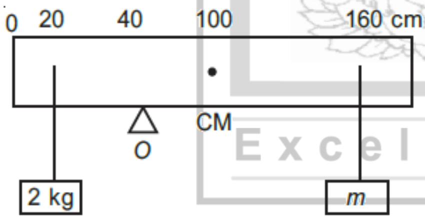
$$\vec{i} = 2\times0.15\times10\sqrt{2}(-\hat{j}) = 4.2(-\hat{j})$$

$\Rightarrow$ Magnitude of impulse = 4.2 kg m/s

43. **Sol. (1)**

Given that

Mass of rod = 500 g; Length of rod = 200 cm



Rod will be in equilibrium, when net torque about point O will be zero.

Torque at point O due to 2 kg mass

$$\vec{\tau} = \vec{r}\times\vec{F} = rf\sin\theta(\hat{n})$$

$$\tau_1 = 20\times20\times10^{-2}\times\sin90^\circ(\hat{k}) = 4\,Nm(\hat{k})$$

Torque due to mass of rod :

$$\tau_2 = 5\times60\times10^{-2}\times\sin90^\circ(-\hat{k}) = 3Nm(-\hat{k})$$

Torque due to mass m :

$$\tau_3 = mg\times120\times10^{-2}\times\sin90^\circ(-\hat{k}) = 12\,Nm(-\hat{k})$$

Net torque about point O will be zero

So, $\vec{\tau_1}+\vec{\tau_2}+\vec{\tau_3} = 0$

$$\Rightarrow 4 - 3 - 12m = 0$$

$$\Rightarrow 12m = 1$$

$$\Rightarrow m = \frac{1}{12}kg$$

44. **Sol. (1)**

To complete a circular path of radius R, time period is T

So speed of particle $(U) = \frac{2\pi R}{T}$ ......(1)

Now the particle is projected with same speed at angle θ to horizontal.

So maximum Height $(H) = \frac{U^2\sin^2\theta}{2g}$

Given that : H = 4R

$$\Rightarrow \frac{U^2\sin^2\theta}{2g} = 4R$$

$$\Rightarrow \sin^2\theta = \frac{8gR}{U^2} \quad ......(2)$$

$$\Rightarrow \sin^2\theta = \frac{8gRT^2}{4\pi^2R^2} = \frac{8gT^2}{\pi^2R} \quad \text{(Using eq (1))}$$

$$\Rightarrow \theta = \sin^{-1}\left(\frac{2gT^2}{\pi^2R}\right)^{1/2}$$

45. **Sol. (2)**

Current in the loop will be V/R = I which is same for both loops.

Now magnetic moment of Triangle loop = NIA

$$M_1 = \left(\frac{12a}{3a}\right)\cdot I\cdot a^2 = \sqrt{3}Ia^2$$

and magnetic moment of square loop = N'IA'

$$= \left(\frac{12a}{4a}\right)\cdot I\cdot a^2$$

$$M_2 = 3\cdot I\cdot a^2$$

CHEMISTRY:

46. Sol. (4)

The cumulative effect of the contraction of the lanthanoid series, known as lanthanoid contraction, causes the radii of the members of the third transition series to be very similar to those of the corresponding members of the second series.

The almost identical radii of Zr (160 pm) and Hf (159 pm) is a consequence of the lanthanoid contraction.

47. Sol. (3)

At constant volume, $q_V = C_V\Delta T = \Delta U$

At constant pressure, $q_P = C_P\Delta T = \Delta H$

For a mole of an ideal gas,

$\Delta H = \Delta U + \Delta(PV)$

$= \Delta U + \Delta(RT)$

$= \Delta U + R\Delta T$

On putting the values of ΔH and ΔU, we have

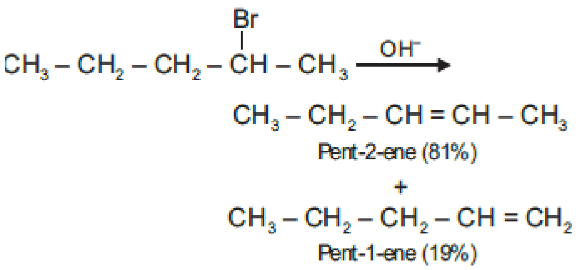
$C_P\Delta T = C_V\Delta T + R\Delta T$

$C_P = C_V + R$

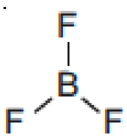
$C_P - C_V = R$

48. Sol. (2)

Major product formed in dehydrohalogenation reaction of 2-bromopentane is pent-2-ene because according to Saytzeff's rule, in dehydrohalogenation reactions, the preferred product is that alkene which has greater number of alkyl group(s) attached to the doubly bonded carbon atoms.



49. Sol. (4)



Number of electrons around boron atom is 6.

Hybridization of B is sp^2.

Shape is trigonal planar.

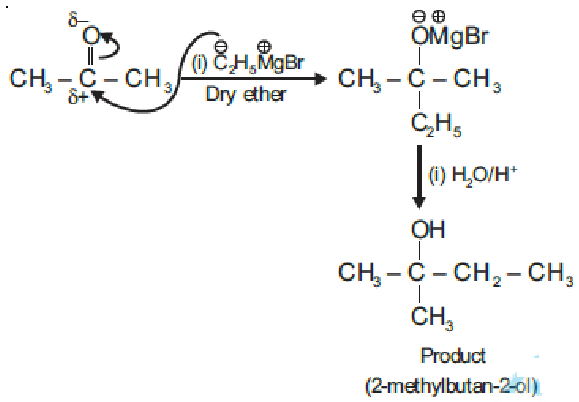
50. Sol. (2)

In the modern periodic table, moving down the group as the size of halogen atom increases, the H – X bond length also increases as a result the bond enthalpy decreases. Hence, The acidic strength also increases.

So, the correct order of acidic strength is

HI > HBr > HCl > HF

51. Sol. (1)



52. Sol. (2)

- Deficiency of vitamin B_2 (Riboflavin) causes cheilosis, digestive disorders and burning sensation of the skin.
- Deficiency of vitamin B_{12} causes Pernicious anaemia which is RBC deficiency in haemoglobin.
- Deficiency of vitamin B_6 (Pyridoxine) causes convulsions.
- Deficiency of vitamin B_1 (Thiamine) causes Beri-Beri (loss of appetite and retarded growth).

53. Sol. (3)

According to Kohlrausch law of independent migration of ions

$\Lambda^0_m(CH_3COOH)$

$= \Lambda^0_m(CH_3COONa) + \Lambda^0_m(HCl) - \Lambda^0_m(NaCl)$

$= 91.0\,S\,cm^2\,mol^{-1} + 426.16\,S\,cm^2\,mol^{-1} - 126.45\,S\,cm^2\,mol^{-1}$

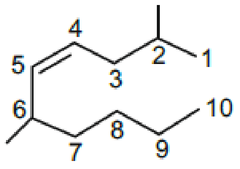
$= 390.71\,S\,cm^2\,mol^{-1}$

54. Sol. (3)

- Actinoids are highly reactive metals, especially when finely divided

- Actinoid contraction is greater from element to element than lanthanoid contraction resulting from poor shielding by 5f electrons
- Many trivalent lanthanoids ions are coloured both in the solid state and in aqueous solutions.
- Lanthanoids have typical metallic structure and are good conductors of heat and electricity

55. **Sol. (2)**



2, 6-Dimethyldec-4-ene

56. **Sol. (3)**

The size of halogen atom increases from F to I hence bond length from C – F to C – I increases

∴ Bond enthalpy from CH_3 – F to CH_3 – I Decreases

C – X Bond	Bond dissociation enthalpies/kJmol^{-1}
CH_3 – F	452
CH_3 – Cl	351
CH_3 – Br	293
CH_3 – I	234

57. **Sol. (4)**

Dimethylammonium acetate is a salt of weak acid and weak base whose pH can be calculated as

$$pH = 7 + \frac{1}{2}(pK_a - pK_b)$$

$$= 7 + \frac{1}{2}(4.77 - 3.27) = 7.75$$

58. **Sol. (1)**

In dilute sulphuric acid solution, hydrogen will be reduced at cathode.

$$H^+ + e^- \rightarrow \frac{1}{2}H_2$$

and H_2O is oxidized at anode.

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$

while in concentrated solution of sulphuric acid, SO_4^{2-} ions are oxidized to tetrahionate $(S_2O_8^{2-})$ ions.

59. **Sol. (2)**

Osmotic pressure (π) = iCRT

Where C is molar concentration of the solution

- With increase in molar concentration of solution osmotic pressure increases.
- Since, weight of all solutes and its solution volume are equal, so higher will be the molar mass of solute, smaller will be molar concentration and smaller will be the osmotic pressure.
- Order of molar mass of solute decreases as Sucrose > Glucose > Urea
- So, correct order of osmotic pressure of solution is $P_3 < P_1 < P_2$

60. **Sol. (3)**

$\Delta H_{rxn} = (E_a)_f - (E_a)_b$

$-4.2 = (E_a)_f - (E_a)_b$

$-4.2 = 9.6 - (E_a)_b$

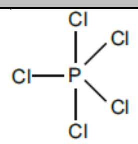
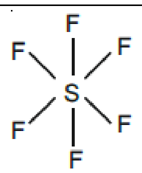
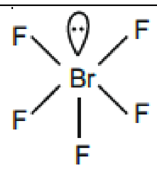
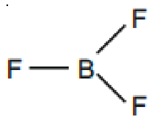
$(E_a)_b = 9.6 + 4.2 = 13.8$ kJ mol^{-1}

Since reaction is exothermic,

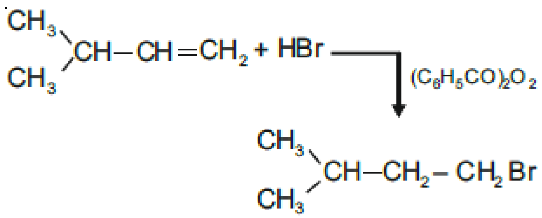
So possible graph is (3) only.

Also $(E_a)_f < (E_a)_b$, so asnwer is option (3).

61. **Sol. (2)**

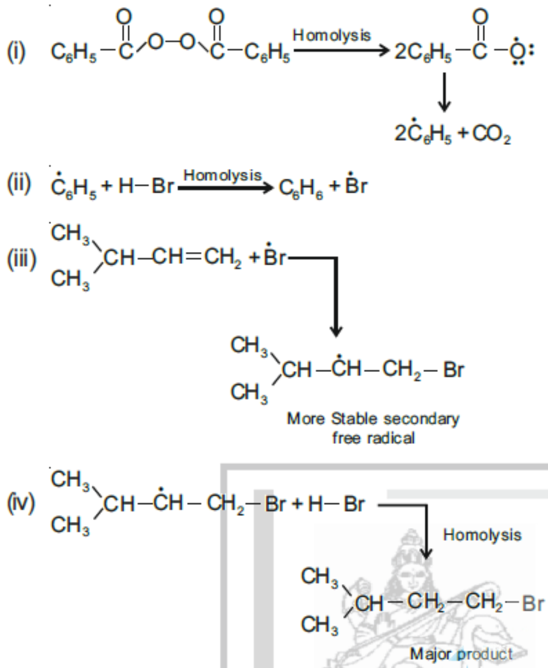
List – I	List – II
 (a)	sp^{3}d hybridised and trigonal bipyramidal in shape
 (b)	sp^{3}d^2 hybridised and octahedral in shape
 (c)	sp^{3}d^2 hybridised and square pyramidal in shape
 (d)	sp^2 hybridised and trigonal planar in shape

62. **Sol. (2)**



Mechanism :

Peroxide effect proceeds via free radical chain mechanism.



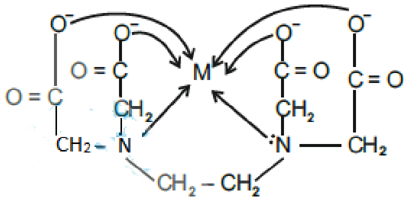
63. Sol. (3)

Both reactions (1) and (2) are examples of decomposition reactions.

Reactions (3) and (4), both are examples of displacement reactions, while reaction (3) is an example of metal displacement reaction.

64. Sol. (2)

Ethylene diaminetetraacetate (EDTA) ion is a hexadented ligand having four donor oxygen atoms and two donor nitrogen atoms.



65. Sol. (1)

Compounds with formula $C_4H_{10}O$ can be ethers which may exhibit metamerism. For example

$CH_3 - CH_2 - O - CH_2 - CH_3$,

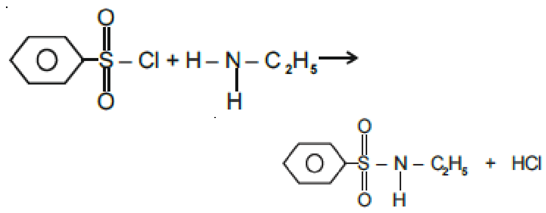
$CH_3 - O - CH(CH_3) - CH_3$

and CH_3 - O - CH_2 - CH_2 - CH_3 are metamers as structure of alkyl chains are different around the functional group.

66. Sol. (4)

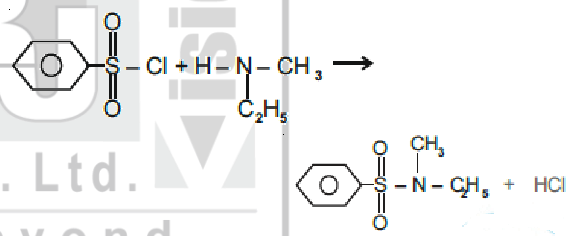
Benzenesulphonyl chloride ($C_6H_5SO_2Cl$) is also known as Hinsberg's reagent.

The reaction of Hinsberg's reagent ($C_6H_5SO_2Cl$) with primary amine ($CH_3CH_2NH_2$) yields N-ethylbenzene sulphonamide.



N-Ethylbenzene sulphonamide
(Soluble in alkali)

The reaction of Hinsberg's reagent ($C_6H_5SO_2Cl$) with secondary amine ($C_2H_5NHCH_3$) gives, N-Ethyl-N-Methyl benzene sulphonamide



Insoluble in alkali due to absence of H - atom

67. Sol. (1)

Except for beryllium chloride all other chloride of alkaline earth metals are ionic in nature.

Due to small size of Be, Beryllium chloride is essentially covalent and soluble in organic solvents.

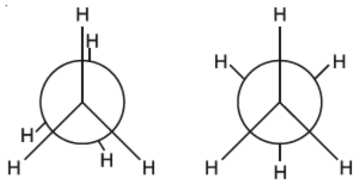
68. Sol. (1)

Ethane has two conformers

(i) Eclipsed

(ii) Staggered

Eclipsed conformer is least stable while staggered conformer is most stable. In eclipsed conformer the dihedral angle is 0°



Eclipsed
Dihedral angle = 0°

Staggered
Dihedral angle = 60°

69. Sol. (4)

Element	Mass percentage	No. of mole	Mole ratio
C	78%	$\frac{78}{12}=6.5$	$\frac{6.5}{6.5}=1$
H	22%	$\frac{22}{1}=22$	$\frac{22}{6.5}=3.38\simeq 3$

Based on above calculation, possible empirical formula is CH_3.

70. Sol. (3)

Noble gases have weak dispersion forces hence they have low melting and boiling points.

71. Sol. (4)

For a spontaneous process, $\Delta S_{total} > 0$ and since irreversible process is always spontaneous therefore $\Delta S_{total} > 0$.

Since $\Delta U = nC_V\Delta T$ and $\Delta T = 0$ for isothermal process therefore $\Delta U = 0$.

72. Sol. (1)

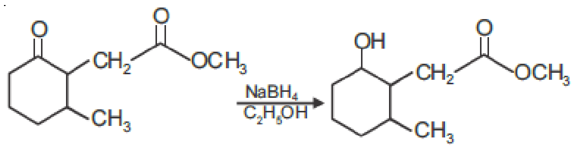
Magnetic moment, $\mu = \sqrt{n(n+2)}\,BM$

Where n = number of unpaired electrons

Complex	No. of unpaired electrons	μ(BM)
(a) $[Fe(CN)_6]^{3-}$	1	1.73
(b) $[Fe(H_2O)_6]^{3+}$	5	5.92
(c) $[Fe(CN)_6]^{4-}$	0	0
(d) $Fe(H_2O)_6]^{2+}$	4	4.90

73. Sol. (1)

$NaBH_4$ is a reducing agent. If reduces carbonyl group into alcohols but does not reduce esters.



74. Sol. (3)

Stronger is the acid, lower is the value of pK_a. On moving down the group, bond dissociation enthalpy of hydrides of group 16 elements decreases hence acidity increases and pK_a value decreases. Correct order of pK_a value will be

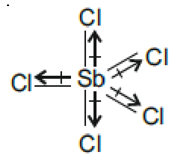
$H_2O > H_2S > H_2Se > H_2Te$

75. Sol. (4)

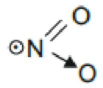
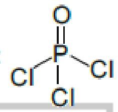
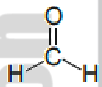
Alkane is produced by heating sodium salt of carboxylic acid with sodalime (NaOH and CaO in the ratio of 3 : 1)

$$CH_3CH_2COO^-Na^+ \xrightarrow[\text{Heat}]{\text{NaOH+CaO}} CH_3CH_3 + Na_2CO_3$$

76. Sol. (4)

$SbCl_5$: 

Net vector summation of bond moments will be zero so $SbCl_5$ is a non-polar molecule.

- NO_2 :  ⇒ polar molecule.
- $POCl_3$:  ⇒ polar molecule.
- CH_2O :  ⇒ polar molecule.

77. Sol. (4)

$$\Lambda_m = 20\,Scm^2mol^{-1}$$

$$\Lambda^o_{m\,CH_3COOH} = \Lambda^o_{CH_3COO^-} + \Lambda^o_{H^+}$$

$$= 50 + 350 = 400\,Scm^2mol^{-1}$$

$$\alpha = \frac{\Lambda_m}{\Lambda^o_m} = \frac{20}{400} = \frac{1}{20}$$

$$K_a = \frac{C\alpha^2}{1-\alpha} \approx C\alpha^2 = 7\times10^{-3}\times\left(\frac{1}{20}\right)^2$$

$$= 7\times10^{-3}\times\frac{1}{4}\times10^{-2}$$

$$= 1.75\times10^{-5}\,mol\,L^{-1}$$

78. Sol. (4)

$$n_{O_2} = \frac{4}{32} = \frac{1}{8}$$

$$n_{H_2} = \frac{2}{2} = 1$$

$$n_t = \frac{1}{8} + 1 = \frac{9}{8}$$

$$P_tV = n_tRT$$

$$P_t = \frac{\frac{9}{8}\times 0.082\times 273}{1} = 25.18\,\text{atm}$$

79. Sol. (4)

Given : $\chi_{C_6H_6} = \frac{3}{5}, \chi_{C_8H_{18}} = 3:2$

So, $\chi_{C_6H_6} = \frac{3}{5}, \chi_{C_8H_{18}} = \frac{2}{5}$

$$p_s = p^o_{C_6H_6}\chi_{C_6H_6} + p^o_{C_8H_{18}}\chi_{C_8H_{18}}$$

$$= 280\times\frac{3}{5} + 420\times\frac{2}{5}$$

= 168 + 168

= 336 mm of Hg

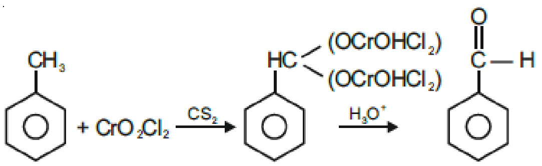
80. Sol. (1)

Isoelectronic species have some number of electrons.

Species	Number of electrons
Fe^{2+}	26 – 2 = 24
Mn^{2+}	25 – 2 = 23
O^{2-}	8 + 2 = 10
F^-	9 + 1 = 10
Na^+	11 – 1 = 10
Mg^{2+}	12 – 2 = 10
Fe^{3+}	26 – 3 = 23

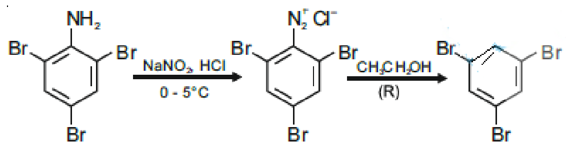
81. Sol. (2)

Etard's Reaction



(X)

82. Sol. (3)



Reagent R is C_2H_5OH with diazonium salt.

83. Sol. (2)

Arrhenius equation

$$k = Ae^{-E_a/RT}$$

$$\ln k = \ln A + \ln e^{-E_a/RT}$$

$$\ln k = \ln A - \frac{E_a}{R}\left(\frac{1}{T}\right)$$

Slope of ln K vs 1/T curve

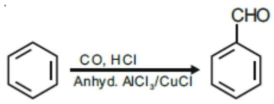
$$m = -\frac{E_a}{R} \Rightarrow -5\times10^3 = -\frac{E_a}{R}$$

$$E_a = 5\times10^3 = 8.314\,J/mol$$

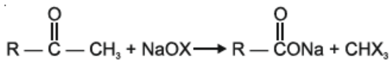
$$= 41.57\times10^3\,J/mol \approx 41.5\,kJ/mol$$

84. Sol. (1)

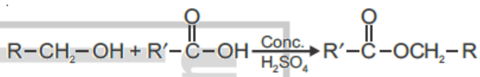
- Gattermann-Koch reaction:



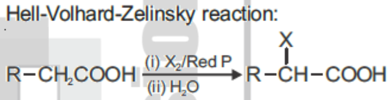
- Haloform reaction:



- Esterification:



- Hell-Volhard-Zelinsky reaction:



85. Sol. (2)

Energy of electromagnetic radiation (E)

$$= \frac{hc}{\lambda} = h\gamma$$

So, $\frac{c}{\lambda} = \gamma \Rightarrow \frac{c}{\gamma} = \lambda$

$$\lambda = \frac{3\times10^8}{1368\times10^3} = 219.3\,m$$

86. Sol. (1)

$E_{a(forward)} =$ is $E_1 + E_2$

Since energy of reactants is less than products and the product is less stable than the reactant.

87. Sol. (1)

A – $1s^2\ 2s^2\ 2p^6$–Noble gas configuration

B –$1s^2 2s^2\ 2p^4$–2 electrons short of stable configuration

C –$1s^2 2s^2\ 2p^6 3s^1$ –Requires one electron to complete s-orbital

D –$1s^2 2s^2\ 2p^5$–Requires one electron to attain noble gas configuration

(i) Noble gases have no tendency to gain electrons since all their orbitals are completely filled. Thus, element A has the least electron gain enthalpy.

(ii) Since element D has one electron less and element B has two electrons less than the corresponding noble gas configuration, hence, element D has the highest electron gain enthalpy followed by element B.

(iii) Since, element C has one electron in the s-orbital and hence needs one more electron to complete it, therefore, electron gain enthalpy of C is less than that of element B.

Combining all the facts given above, the electron gain enthalpies of the four elements increase in the order A <C <B <D.

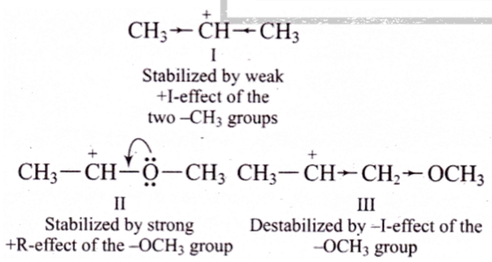
88. **Sol. (2)**

Asymmetric/chiral carbon atom is that in which all of its four valencies with four different groups of atoms.

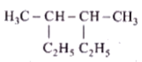
In molecules (i), (ii) and (iii), all have asymmetric carbon as each carbon has satisfied all four valencies with four different groups or atoms.

In molecule (iv), carbon satisfies two of its valencies of two hydrogen atoms. i.e., similar atom. So, it is not an asymmetric carbon atom.

89. **Sol. (1)**

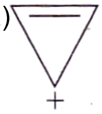


Thus, the stationary of carbocations decreases in the order : II > I > III

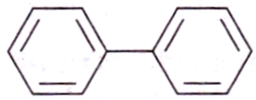


90. **Sol. (4)**

In both these options, rings are planar and follow (4n + 2)π-electrons rule.

(a) 

2delocalized π-electrons, (4n + 2) rule followed (where n = 0)

(b) 

Both rings have 6π-electrons, (4n + 2) rule followed (where n = 1).

Cyclooctatetraene is non-planar and has 8π-electrons. It is not aromatic.

Cyclopropenyl anion is planar but has 4π-electrons. It is not aromatic.