

**PHYSICAL
CHEMISTRY
PART-1
SOLUTIONS**

ATOMIC STRUCTURE

1. (D) Azimuthal quantum number gives the shape of orbital.
2. (D) In the given figure if line 'E' is in visible region then line belonging to ultraviolet region will have more energy than 'E' i.e. line A
3. (A) Let n be the number of photons emitted

$$\Rightarrow \frac{12400}{600} \times 1.6 \times 10^{-19} \times n = 60 \times 10 \times 60 \times 60$$

$$\Rightarrow n = 6.5 \times 10^{24}$$
4. (A) $r_3 = r_1 \frac{3^2}{3}$

$$\Rightarrow r_1 = \frac{r_3}{3} = \frac{x}{3} \text{ cm}$$

$$\therefore \text{De-broglies wavelength} = \frac{2\pi x}{3}$$
5. (A) $\frac{f_1}{f_2} = \frac{z_1^2}{n_1^3} \times \frac{z_2^3}{z_2^2} \quad n_1 = 3 \quad n_2 = 3 \quad \frac{2^2}{3^3} \times \frac{32}{27}$

$$\frac{f_1}{f_2} = \frac{z_1^2}{n_1^3} \times \frac{z_2^3}{z_2^2} \quad z_1 = 2 \quad z_2 = 1, \frac{2^2}{3^3} \times \frac{32}{27}$$
6. (C) Maximum number of electron having same spin quantum number is equal to the number of orbitals = $2\ell + 1$
7. (D) $\lambda = \frac{h}{\sqrt{2m_p eV}} \quad \lambda \alpha = \frac{h}{\sqrt{2m_\alpha (2e) V_\alpha}} \quad 2 \times 4 \times m_p \times 2eV \alpha$

$$\Rightarrow V_\alpha = \frac{V}{8}$$
8. (B) $\ell = 1$ for p and $\ell = 2$ for d.
 Now ${}_{24}\text{Cr}$ has configuration $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
 Hence there are 12, p-electrons and 5, d-electrons.
 $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
9. (A) ${}_{26}\text{Fe} - 1s^2, 2s^2 2p^6, 3s^2 3p^6, 3d^6, 4s^2$
 $\ell + m = 0 \quad \Rightarrow \quad \ell = 0, m = 0 \quad \text{i.e.} \quad \text{s-subshell}$
 $\ell = 1, m = -1 \quad \text{i.e.} \quad \text{one orbital of p.}$
 $\ell = 2, m = 2 \quad \text{i.e.} \quad \text{one of d-orbitals}$
 Hence there are 13 or 14 electron as in d-orbital it may be one or two electron having $m = -2$.
10. (C) Energy of one photon = $\frac{12400}{4000} = 3.1 \text{ eV}$
 Energy supplied by one mole photon in KJ/mole = $3.1 \times 1.6 \times 10^{-19} \times 6 \times 10^{23} \times 10^{-3} = 297 \text{ kJmol}^{-1}$

$$\% \text{ of energy converted to K.E.} = \frac{297 - 246.5}{297} \square 17\%$$

11. (A,C)
$$\bar{v} = RZ^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$x = R \left(\frac{1}{2^2} - \frac{1}{3^2} \right) = \frac{5R}{36}$$

$$\bar{v} = R \times Z^2 \left(1 - \frac{1}{2^2} \right) = 3R = \frac{36}{5} x \times 3 = \frac{108x}{5}$$

12. (A,B,D)

3s orbital has two radial node at the values of radius given by solutions of

$$\left(6 - \frac{4Zr}{a_0} + \frac{4}{9} \cdot \frac{Z^2 r^2}{a_0^2} \right) = 0$$

3p_z orbital has on radial nodal surface at $\left(4 - \frac{4Zr}{3a_0} \right) = 0$ & one angular node at $\theta =$

$\pi/2$

for 3p_z, at r = 0 $\psi = 0$ while for

3s at r = 0 $\psi =$ maximum so, 3s has greater penetrating power than 3p_z orbital

13. (A,B) B.E. of 4th state = $13.6 \frac{Z^2}{n^2} \Rightarrow 13.6 \frac{Z^2}{4^2} = 13.6 \Rightarrow z = 4$

sample is Be³⁺ ∴ energy of electron in 3rd state
state = $1.5 \times 4^2 = 24$ eV
therefore 25 eV photon will cause ionisation.

14. (B, C, D)

$$1^{\text{st}} \text{ excitation energy} = 13.6 z^2 \left(1 - \frac{1}{2^2} \right) = 24 \text{ eV}$$

$$\Rightarrow (13.6 z^2) = 32 \text{ eV}$$

$$\therefore \text{I.E.} = 32 \text{ eV}$$

$$\text{B.E. of } 3^{\text{rd}} \text{ excited state} = \frac{13.6z^2}{4^2} = \frac{32}{16} = 2 \text{ eV}$$

$$2^{\text{nd}} \text{ excitation energy} = 13.6 z^2 \left(1 - \frac{1}{3^2} \right) = 32 \times \frac{8}{9} \text{ eV.}$$

15. (A, B) since it absorbs 'n' photons and it also emits exactly n-photons therefore transition must have taken place from 1 to 2.

∴ Energy of photon = $10.2 Z^2$
where Z = 1, 2, 3, 4.

16. (A, B, C)

Since B is in infrared region and A has more energy than B hence it will have lesser wave length i.e. ultra violet, visible or infrared region.

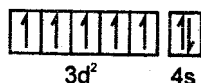
17. (A, C, D)

18. (B, C, D)

19. (B) $\text{Fe}^{2+} - [\text{Ar}] 3d^6$
 $\text{Mn}^{2+} - [\text{Ar}] 3d^5$
 $\text{Cr}^{3+} - [\text{Ar}] 3d^3$

Clearly Mn^{2+} has maximum number of unpaired electrons therefore it has highest magnetic moment.

20. (B) Magnetic moment = $\sqrt{n(n+2)} = 3.873 \Rightarrow$ number of unpaired electron $n = 3$
 \therefore ${}_{25}\text{Mn} - [\text{Ar}] 3d^5 4s^2$ therefore Mn should be in +

21. (D) There is two unpaired electron in 

22. (D) $\text{Mn}^{4+} - [\text{Ar}] 3s^5 4s^3$ 

23. (C) 24. (A) 25. (C)

26. (C) 27. (A) 28. (A)

29. (A - s), (B - p), (C - p), (D - q)

(A) $T_n = -\frac{kze^2}{2r} \Rightarrow T_N \propto r^{-1}$

(B) $T_n = \frac{p_n}{2} \Rightarrow \frac{T_n}{P_n} = \frac{1}{2}$

(C) $\frac{1}{f_n^x} \propto z \Rightarrow f_n^x \propto z$

(D) $T_n \times v_n = \frac{2\pi}{v_n} r \times v_n \Rightarrow t = 1.$

30. (A - q, r), (B - p, s), (C - s), (D - q)

(A) B.E. of He^+ atom = $\frac{13.6 \times 2^2}{n^2}$ $n = 1, 2, 3, \dots$

Hence it can be 13.6 eV, 3.4 eV both

(B) In $7 \rightarrow 3$ transition $\Delta n = 7 - 3 = 4$

\therefore Maximum number of spectral line observed = $\frac{4(4+1)}{2} = 10$

It is line of Paschen series hence infrared region

(C) $5 \rightarrow 1$ - 10 lines

(D) series limit of Balmer series is the last line having 3.4 eV energy.

31. (A - r, s), (B - p, s), (C - q, r), (D - p, q)

(A) $6 \rightarrow 3$ $\Delta n = 3$

\therefore no. of lines = $\frac{3(3+1)}{2} = 6$

All lines are in infrared region

(B) $7 \rightarrow 3$ $\Delta n = 4$

\therefore no. of lines = $\frac{4(4+1)}{2} = 10$

All lines are in infrared region

(C) $5 \rightarrow 2$ $\Delta n = 3$

All lines are in visible region

(D) $6 \rightarrow 2$ $\Delta n = 4$

All lines are in visible region.

32. (3) From Bohr model $mvr = \frac{hr}{2\pi}$ $mv = \frac{hr}{2\pi r}$
 De broglie wavelength $\lambda = \frac{h}{mv} \Rightarrow \lambda = \frac{h}{nh} \Rightarrow \lambda = \frac{2\pi r}{n}$
 \therefore number of waves made in one revolution = $\frac{2\pi r}{\lambda} = \frac{2\pi r}{\frac{2\pi r}{n}} = n = \text{Orbit number} = 3.$

33. (6eV) For the positive particle, applying energy conservation initially and at a point A.

$$K.E._i + P.E._i = K.E._f + P.E._f$$

$$\Rightarrow 4eV + (+4e)(0V) = 0 + (+4e)(x \text{ volt}) \quad \{x = \text{potential at point A}\}$$

$$\Rightarrow x = 1 \text{ volt}$$

Now applying energy conservation for the negative particle at point 'A' and initially

$$\Rightarrow K.E._i + (-2e)(4V) = 0 + (-2e)(1 \text{ volt})$$

$$K.E._i - 8 \text{ eV} = -2eV$$

$$\Rightarrow K.E._i = 6eV.$$

34. (8) We have

$$\Delta E = \frac{3}{4} \times 0.85eV$$

As energy = 0.6375 the photon will belong to bracket series (as for bracket $0.31 \leq E \leq 0.85$)

$$0.85 \times \left(1 - \frac{1}{4}\right) = 13.6 \left(\frac{1}{4^2} - \frac{1}{n^2}\right)$$

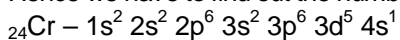
$$0.85 \left(1 - \frac{1}{4}\right) = \frac{13.6}{16} \left[1 - \left(\frac{4}{n}\right)^2\right] \quad \therefore \quad \frac{4}{n} = \frac{1}{2} \Rightarrow n = 8$$

Hence $x = 8.$

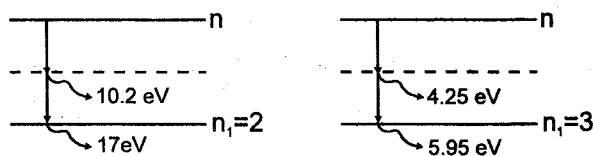
35. Given $\sqrt{\ell(\ell+1)} \frac{h}{2\pi} = \frac{h}{\sqrt{2\pi}}$

$$\Rightarrow \ell = 1$$

Hence we have to find out the number of p-electrons



Hence there are 12 electrons which has this angular momentum.



36. (6)

$$10.2 + 17 = 13.6 Z^2 \left(\frac{1}{2^2} - \frac{1}{n^2}\right) \quad \text{and} \quad 4.25 + 5.95 = 13.6 Z^2 \left(\frac{1}{3^2} - \frac{1}{n^2}\right)$$

Solving the above two equations we get, $Z = 3, n = 6.$

GASEOUS STATE

1. (B) $V_{\text{real}} = \frac{\text{Molar mass}}{\text{density}} = \frac{18}{0.36}$.

$$V_{\text{ideal}} = \frac{nRT}{P} = \frac{1 \times 0.082 \times 500}{1}$$

So, $Z = \frac{V_{\text{real}}}{V_{\text{ideal}}} = \frac{50}{0.082 \times 500} = \frac{50}{41}$.

2. (D) $E_1 = \frac{3}{2} \times \frac{M}{30} RT_1$

$$E_2 = \frac{3}{2} \times \frac{M}{30} RT_2 \quad \Rightarrow \quad \frac{E_1}{E_2} = \frac{30 T_1}{16 T_2} \Rightarrow \frac{3}{1} = \frac{30 T_1}{16 T_2}$$

$$\Rightarrow \quad \frac{T_1}{T_2} = \frac{8}{5}$$

3. (B) At constant pressure

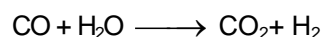
$$PV = nRT.$$

$$V = \left(\frac{nR}{P} \right) T \quad \text{So,} \quad \log V = \log \left(\frac{nR}{P} \right) + \log T.$$

4. (B) Let suppose we use x-litre water gas at S.T.P.

So it contain 0.5x litre H₂.

Now according to given equation



$$0.45x \text{ Excess} \quad \quad 0.05x \quad 0.5x$$

$$0 \quad \quad \quad (0.05x + 0.45x) \quad (0.5x + 0.45x)$$

So total volume of H₂ = 0.95x

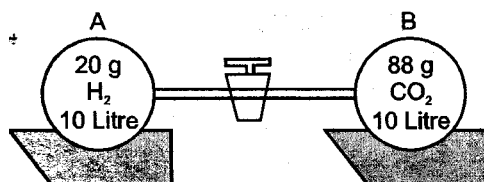
But according to question

It is 5 litre

$$\text{So } 0.95x = 5$$

$$x = 5.263 \text{ litre}$$

5. (B)



$$\text{No. of mole of H}_2 \text{ in flask A} = \frac{20}{2} = 10 \text{ mole}$$

$$\text{No. of mole of CO}_2 \text{ in flask B} = \frac{88}{44} = 2 \text{ mole}$$

Now pressure of Gas in flask A

$$PV = nRT$$

$$P_A \times 10 = 10 \times R \times 500$$

$$P_A = 500 R$$

Now pressure of Gas in flask B

$$P_B \times 10 = 2 \times R \times 200$$

$$P_B \times 40R$$

Because flask A is on higher pressure that why H_2 is flow from flask A to flask B.

Let suppose x mole of H_2 move from flask A to B.

So mole of H_2 remain in A = $(10 - x)$ and total mole in B = $(2 + x)$

Now after opening stop cock pressure of both flask become equal.

$$n_A T_A = n_B T_B$$

$$(10 - x) \times 500 = (2 + x) \times 200$$

$$x = 6.57$$

$$\text{Composition of } H_2 \text{ in B} = \frac{6.57 \times 2}{101.14} \times 100 = 13\%$$

6. (B) 7. (A) 8. (B) 9. (B)

10. (B)

11. (B) $PV = nRT$

$$V = \frac{nR}{P} \cdot T \Rightarrow V = KT$$

$$\therefore \log P = \log T + \log K$$

Linear dependence with positive slope

At the Y-intercept $P/T \rightarrow 0$ and $p \rightarrow 0$ implying $p \rightarrow 0$, under such conditions all gases show ideal behaviour.

12. (A) $P_{\text{mix}} = \frac{PM_{\text{mix}}}{RT} \Rightarrow M_{\text{mix}} = \frac{1.7 \times 0.0821 \times 273}{1} = 1.7 \times 22.4 \text{ gms}$

$$M_{\text{mix}} = X_{\text{CO}} \times M_{\text{CO}} + (1 - X_{\text{CO}}) \cdot M_{\text{CO}_2}$$

$$= X_{\text{CO}} \times 18 + (1 - X_{\text{CO}}) \times 44$$

$$\Rightarrow X_{\text{CO}} = 0.37$$

13. (B)

14. (C) $b = \frac{16}{3} \pi r^3 \times N_a$

15. (C)

16. (A) $b = \frac{16}{3} \pi r^3 \times N_a$

$$0.72 \times 1000 = \frac{16}{3} \times 6.023 \times 10^{23} \times \pi r^3$$

Calculate r.

17. (A) For equal weights, N_2 will have more number of moles and hence more molecules.

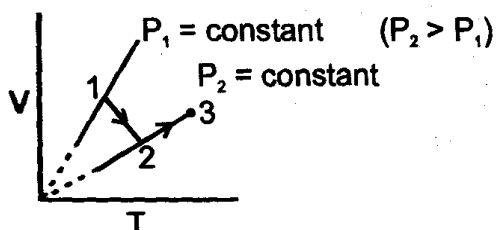
18. (B)

19. (B) According to KTG

$$PV = \frac{1}{3} mN (V_{rms})^2 \text{ so } p = \frac{1}{3} \times 10^6 \text{ Pa and } KE_T = \frac{1}{2} m (V_{rms})^{2 \times N} = 5 \text{ kJ}$$

20. (A, B, C)

V-T curve for a given mass of gas is given



21. (A, C, D)

22. (A, D)
$$\frac{P}{t+273} = \frac{1.2P}{t+273 \times 2}$$

23. (A, C, D)

$$\frac{P}{t+273} = \frac{1.2P}{t+273 \times 2}$$

$$(V_{rms})_{N_2} = (V_{rms})_{O_2}$$

$$1.2t + 273 \times 1.2 = t + 273 \times 2$$

$$\Rightarrow 0.2t = 273 \times 0.8$$

$$t = 273 \times 4$$

24. (A, C, D)

25. (A, B, D) $(V_{rms})_{N_2} = (V_{rms})_{O_2}$

$$\sqrt{\frac{3RT_{N_2}}{M_{N_2}}} = \sqrt{\frac{3RT_{O_2}}{M_{O_2}}} \frac{T_{N_2}}{M_{N_2}} = \frac{T_{O_2}}{M_{O_2}}$$

Then V_{av} and V_{rms} is also same

$$d_{N_2} = \frac{P_{N_2} M_{N_2}}{RT_{N_2}} \quad d_{O_2} = \frac{P_{O_2} M_{O_2}}{RT_{O_2}} \quad \text{if } P_{N_2} = P_{O_2} \quad \text{then } d_{N_2} = d_{O_2}$$

26. (A, D)

$$PV = \frac{W}{M} RT$$

$$M = \frac{WRT}{PV} = \frac{11 \times 0.08 \times 400}{2 \times 4} = 44$$

Gases are N_2O & CO_2

27. (B, C) At const temperature $V \propto 1/p$

28. (A) $P_T = P_A + P_B = 3P_B$
 So, $P_a = \frac{2}{3}$ and $P_A = 2 - \frac{2}{3} = \frac{4}{3}$
 Now $\frac{P_A}{P_a} = \frac{n_1}{n_2} = 2$
 So, $n_1 = 2n_2$... (1)
 $P_T V = n_T R_T$
 $2 \times 8.21 = n_T \times 0.082 \times 50$
 $n_T = 4 = n_1 + n_2$
 So, $n_2 = \frac{4}{3}$ $n_1 = \frac{8}{3}$

29. (A) A \longrightarrow B
 $t = 0$ $\frac{8}{3}$ $\frac{4}{3}$
 $t = 5 \text{ min}$ $\frac{4}{3}$ $\frac{8}{3}$
 Now a after two half life
 $n_A = \frac{2}{3}$ and $n_B = \frac{10}{3}$
 $P_T V = (n_A + n_B)RT$
 $P_T \times 8.21 = \frac{12}{3} \times 0.082 \times 50$
 $P_T = 2 \text{ atm}$

30. (A) $\frac{r_A}{r_B} = \frac{P_A}{P_B} \sqrt{\frac{M_B}{M_A}}$
 $\frac{r_A}{r_B} = \frac{n_A}{n_B} \sqrt{\frac{M_B}{M_A}} = \frac{(8/3)}{(4/3)} \sqrt{\frac{1}{1}}$
 $\frac{r_A}{r_B} = 2.$

31. (C) $\frac{n_A/t}{n_B/t} = \frac{P_A}{P_B} \sqrt{\frac{M_B}{M_A}}$ $\frac{n_1 M_1 + n_2 M_2}{x_1 + x_2} = M_{\text{mix}}$
 $X_1 M_1 + (1 - X_1) M_2 = M_{\text{mix}}$
 $\Rightarrow X_1 = \frac{2}{5}, X_2 = \frac{3}{5}$
 $\Rightarrow \frac{X_A}{X_B} = \frac{2}{3} \sqrt{\frac{72}{128}} = \frac{1}{2}$

$$\Rightarrow X_A = \frac{1}{3}, X_B = \frac{2}{3}$$

32. (A) Initially $r_A = \frac{1000 - 900}{5} = 20 \text{ torr/s}$

In the mix.

$$M_{\text{mix}} = X_A M_A + (1 - X_A) M_B$$

$$\Rightarrow \frac{472}{5} = X_A \times 128 + (1 - X_A) 72$$

$$\frac{472}{5} = 56X_A + 72$$

$$472 = 280X_A + 360$$

$$X_A = \frac{112}{280} = \frac{2}{5}, X_B = \frac{3}{5}$$

The mix.

$$\frac{r_A}{r'_A} = \frac{1}{2} \times \frac{X^2}{X \times \frac{3X}{2}} = \frac{1}{3}$$

$$r_A' = 3r_A = 3 \times 20 = 60 \text{ torr/s}$$

$$\frac{r_{A^0}}{r_{B^0}} = \frac{P_A'}{P_B'} \sqrt{\frac{M_B}{M_A}} = \frac{2}{3} \times \sqrt{\frac{72}{128}} = \frac{1}{2}$$

$$r_B' = 120 \text{ torr/s}$$

After 10 sec

$$P_A'' = 2000 - 60 \times 10 = 1400 \text{ torr}$$

$$P_B'' = 3000 - 120 \times 10 = 1800 \text{ torr}$$

$$\frac{n_A''}{n_B''} = \frac{7}{9}$$

33. (D) $2000 - 60t = 3000 - 120t$

$$60t = 1000 \quad \Rightarrow \quad t = \frac{50}{3} \text{ sec.}$$

34. (C) 35. (A, B, C, D) 36. (D) 37. (A, B) 38. (D)

39. (A) 40. (B) 41. (B) 42. (B)

43. (B) $200 < T_B < 1000$

$$\Rightarrow 200 < \frac{a}{Rb} < 1000$$

$$\Rightarrow 400 \text{ cal} < \frac{a}{b} < 2000 \text{ cal}$$

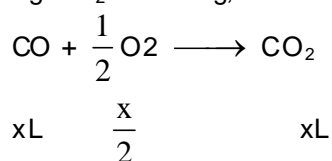
44. (A) In the high pressure region

$$z = + \frac{Rb}{RT}$$

solve for the two points.

45. (C) Use $z = \frac{P_{VM}}{RT} \Rightarrow U_m = \frac{z \cdot RT}{P}$
46. (C) At boyles temp, a real gas shows ideal behaviour in the low pressure region.
47. (B) $z = \frac{1+Pb}{RT}$, slope $z \frac{b}{RT}$ and hence is inversely proportional to T.
48. (A - r), (B - q, r, s), (C - r), (D - p, r). 49. (A - p, r), (B - q, s), (C - r), (D - p, s)
50. (A - p, s), (B - p, r, s), (C - q), (D - p, r, s) 51. (A - p, s), (B - r, s, t), (C - r, s, t), (D - p, s)
52. (A - s), (B - p), (C - q), (D - r)
- (A) 4 g of the He $\frac{4}{4} = 1$ mole
- $$KE = \frac{3}{2} \times nRT = \frac{3}{2} \times R \times T = 1.5 RT$$
- (B) 32 gram of O₂ = $\frac{32}{32} = 1$ mole
- KE = KE (Translational) + KE rotational
- $$\frac{3}{2} RT + \frac{2 \times RT}{2} \text{ (Two rotational degree of freedom)}$$
- (C) NO₂ is triatomic and non linear molecule and thus possesses three translational and three rotational degree of freedom vibrational degree of freedom do not contribute at ordinary temperature
- (D) At constant pressure increase in energy = $\Delta E + P \Delta V = 3R + R = 4R$
- 53.
- | | | | | | |
|-------|------------------------|---|--------------------|---|--------------------------|
| | 2NO(g) | + | O ₂ (g) | ⇌ | 2NO ₂ (g) |
| Moles | 2 | | 0.5 | | 0 |
| | 2 - 2 × 0.5 | | 0 | | 2 × 0.5 |
| | 1 | | 0 | | 1 |
| | n _f = 1 + 1 | | | | n _f = 2 + 0.5 |
- ∴ $\Delta n = (2.5 - 2) = 0.5$ moles
- ∴ Change in pressure
- $$\Delta p = \frac{\Delta nRT}{V} = 0.5 \times \frac{1}{12} \times \frac{300}{6.25} = 2 \text{ atm.}$$
54. Average Translational kinetic energy (per mole of gas)
- $$= \frac{3}{2} RT = \frac{3M}{2} \times \frac{RT}{M} = \frac{3\pi M}{16} \times \frac{8RT}{\pi M}$$
- $$= \frac{3\pi M}{16} \times \left(\sqrt{\frac{8RT}{\pi M}} \right)^2 = \frac{3\pi M}{16} \times (V_{av})^2$$
- ∴ For one mole of gas mixture,
- Average translational kinetic energy
- $$= \frac{3\pi M_{mix}}{16} \times (V_{av})^2$$
- $$= \frac{3}{16} \times \frac{22}{7} \times \left[\frac{(2 \times 20 + 5 \times 4) / 7}{1000} \right] \times (7 \times 10^2)^2 \text{ [} \because M_{mix} \text{ is in Kg/mole]}$$
- $$= 2475 \text{ Joules.}$$
- Reported answer = $2475 \times 0.002 = 4.95 \approx 5$.

55. Let volume of CO, CO₂ and N₂ in the initial mixture be xL, yL and (1 - x - y)L respectively. Upon mixing 1L O₂ and burning, CO will combine with O₂ to form CO₂O

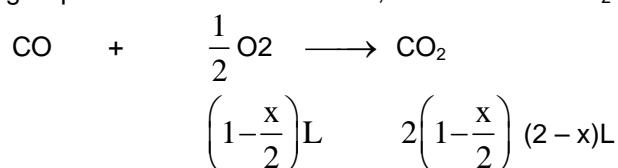


∴ Product gas mixture will be composed of CO₂ produced, CO₂ initial, unreacted N₂ and left O₂ having volume xL, yL, (1 - x - y)L and $\left(1 - \frac{x}{2}\right)L$.

Upon passing subsequently through KOH solution and alkaline pyragallo, all CO₂ and O₂ will be absorbed.

$$\therefore x + y + 1 - \frac{x}{2} = 1.6 \quad \therefore x + 2y = 1.2 \quad \dots (1)$$

On mixing the product mixture with excess CO, whole of unreacted O₂ via convert into CO₂



$$\therefore \text{Total CO}_2 \text{ in the final gas mixture} = (x + y) + (2 - x) = 2.3$$

$$\therefore y = 0.3$$

Put y = 0.3 in equation (1)

$$\therefore x = 0.6$$

$$\therefore \text{Vol \% of CO in original mixture} = \frac{0.6}{1} \times 100 = 60\%$$

$$\therefore \text{Reported answer} = 60/10 = 6.$$

56.
$$\text{N}_2 + 3\text{H}_2 \longrightarrow 2\text{NH}_3$$

 t = 0 a_{atm} b_{atm} 0 (At constant V & T, n ∝ P)
 t = f (a - x)_{atm} (b - 3x)_{atm} (2x)_{atm}

$$\therefore a + b = 1 \text{ and } (a - x) + (b - 3x) + 2x = a + b - 2x = 0.85$$

$$\therefore 2x = 0.15$$

$$\therefore y = \text{Partial pressure of NH}_3 = 2x = 0.15 \text{ atm}$$

$$\therefore y = (\text{Partial pressure of NH}_3) \times 20 = 0.15 \times 20 = 3.$$

57. At constant temperature, decreases in molecular masses causes flattening of the graph. For same molecular mass of gas, increase in temperature causes flattening of the graph. From the above graph.

$$\left(V_{\text{mp}}\right)_{T_1} < \left(V_{\text{mp}}\right)_{T_2}$$

$$\therefore \frac{T_1}{M_A} < \frac{T_2}{M_B} \therefore \frac{T_2}{T_1} > \frac{M_B}{M_A}$$

But $\frac{M_B}{M_A}$ may be less than or greater than 1.

$$\therefore \text{Statements (1), (2) \& (3) are wrong}$$

$$\therefore \text{Reported answer} = 1 + 2 + 3 = 6.$$

58.
$$\frac{r_A}{r_B} = \frac{n_A}{n_B} \times \sqrt{\frac{M_B}{M_A}}$$

$$\therefore \frac{(\text{Moles of A coming out initially}) \Delta t}{(\text{Moles of B coming out initially} / \Delta t)} = \frac{2x}{\frac{1x}{M_B}} \times \sqrt{\frac{M_B}{M_A}}$$

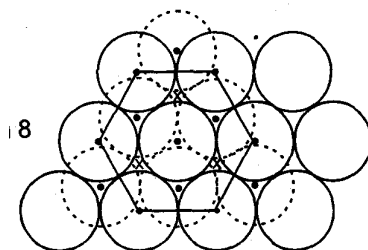
$$\therefore \frac{1}{4} = \frac{2}{1} \left(\frac{M_B}{M_A} \right)^{3/2} \quad \therefore \frac{M_B}{M_A} = \frac{1}{4}$$

$$\begin{aligned} \therefore \text{Ratio of Mole fractions} &= \frac{X_A}{X_B} = \left(\frac{\frac{n_A}{n_A + n_B}}{\frac{n_B}{n_A + n_B}} \right) = \frac{n_A}{n_B} = \left(\frac{\frac{2x}{M_A}}{\frac{1x}{M_B}} \right) = \frac{2M_B}{M_A} \\ &= 2 \times \frac{1}{4} = \frac{1}{2} \end{aligned}$$

$$\therefore \text{Reported answer} = \left(\frac{1}{2} \right) \times 6 = 3$$

SOLID STATE

1. (A)
2. (D) When all particle along are body diagonal one removed, these 2 X atoms from corner are removed, one Y particle removed & 2 Z particle removed.
 Hence new arrangement, X particle = $\frac{1}{8} \times 6 + \frac{1}{2} \times 6 = \frac{15}{4}$; Y particle = 6 ; Z particle = 3
 Hence formula = $X_{15/4}Y_3Z_6 = X_{5/4}YZ_6 = X_5Y_4Z_8$
3. (C) From the sizes of octahedral and tetrahedral voids, it is clear that the atoms occupying these voids will not touch each other as we have along body diagonal of FCC.
4. (B) HCP = AB AB AB pattern repeat
 For calculating voids between two layers A and B.
 Total tetrahedral voids = 12 (represented by dots) out of which 8 are completely inside but rest are shared by other unit cells. Total octahedral voids = 6 (represented by cross).
 All are completely inside.



5. (A) $d_{c-c} = \sqrt{\frac{1}{16} + \frac{1}{16} + \frac{1}{16}} = \sqrt{\frac{3}{16}}$ and $a_{FCC} = 1$

6. (A) 7. (B)

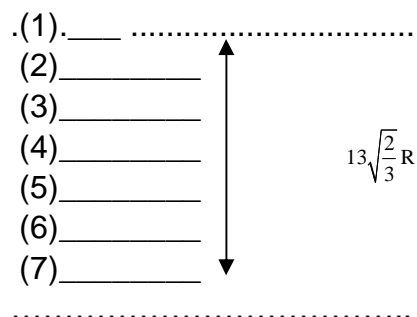
8. (A) Formula $Zn Al_2O_4$

$$\text{Packing fraction} = \frac{\text{Total volume of particles present in one unit cell}}{\text{volume of one unit cell}}$$

$$= \frac{\left(\frac{4}{3} \pi r_{Zn^{2+}}^3\right) + \left(\frac{2 \times 4}{3} \pi r_{Al^{3+}}^3\right) + \left(\frac{4 \times 4}{3} \pi r_{O^{2-}}^3\right)}{a^3}$$

$$= \frac{\left(\frac{4}{3} \pi \frac{a^3 (0.225)^3}{(2\sqrt{2})^3}\right) + \left(2 \times \frac{4}{3} \pi \frac{a^3 (0.414)^3}{(2\sqrt{2})^3}\right) + \left(4 \times \frac{4}{3} \pi \frac{a^3}{(2\sqrt{2})^3}\right)}{a^3} = 0.77$$

9. (C) Parallel layer are at a distance of $2\sqrt{\frac{2}{3}}R$



$$10^{-5} = \frac{x^2}{C-x} = \frac{(10^{-5})^2}{C-10^{-5}}$$

$$C = 2 \times 10^{-5} \text{ mol/lit}$$

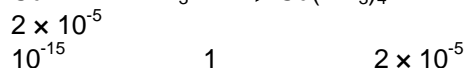
$$\therefore \text{moles of CuSO}_4 \text{ dissolved } 2 \times 10^{-5} \times 0.5 = 10^{-5}$$

$$\therefore \text{Number of unit cells} = \frac{10^{-5} \times N_A}{4} = \frac{6}{4} \times 10^{18} = 1.5 \times 10^{18}$$

$$\text{Number of unit cells along one edge of the cube} = \sqrt[3]{1.5 \times 10^{18}} = 1.14 \times 10^6$$

If edge length of FCC unit cell is a

$$\therefore a \times 1.14 \times 10^6 = 17.1 \text{ nm} \Rightarrow a = 150 \text{ \AA}$$



$$K_f = \frac{[\text{Cu}(\text{NH}_3)_4^{2+}]}{[\text{Cu}^{2+}][\text{NH}_3]^4} = \frac{2 \times 10^{-5}}{10^{-15} \times 1} = 2 \times 10^{10}$$

25. (A) 26. (C) 27. (D)

28. (A – p, q, r s), (B – p, q, s), (C – p, q, s), (D – p, q, r)

29. (A – p, q, s), (B – p, q, r), (C – s), (D – p, q, s)

30. (A – r, s), (B – r, s), (C – p), (D – q)

31. (A – p, q, r, s), (B – p, q, r, s), (C – p, q, r), (D – p, q, r).

32. (A – q), (B – s), (C – p), (D – r)

$$\begin{aligned} 33. \quad (2) \quad & 2(r_m + r_x) = 7.2 \\ & 2(1.6 + r_x) = 7.2 \\ \Rightarrow & r_x = 2.0 \text{ \AA} \end{aligned}$$

34. (6) Fraction of unoccupied sites

$$\begin{aligned} &= \frac{\text{X-ray density} - \text{pyknometric density}}{\text{X-ray density}} \\ &= \frac{2.178 \times 10^3 - 2.165 \times 10^3}{2.178 \times 10^3} \\ &= 5.97 \times 10^{-3} \approx 6 \times 10^{-3} \end{aligned}$$

35. (8) There are four body diagonals. Atoms on the body diagonals are not shared by any other unit cell.

$$\text{Contribution by atoms on corners} = 8 \times \frac{1}{8} = 1$$

$$\text{and contribution by atoms on body diagonals} = 2 \times 4 = 8$$

36. (5) In rock salt like crystal AB, there are four AB units per unit cell.

Therefore density is

$$\begin{aligned} &= \frac{4 \times 6.023y}{6.02 \times 10^{23} \times 8y \times 10^{-27}} \\ &\left[\because a = 2y^{\frac{1}{3}} \text{ nm} = 2y^{\frac{1}{3}} \times 10^{-9} \text{ m} \right] \\ &= 5 \times 10^3 \text{ g m}^{-3} = 5 \text{ kg m}^{-3} \end{aligned}$$

SOLUTION & COLLIGATIVE PROPERTIES

1. (C) The loss in weight should be proportional to vapour pressure above that solution:

$$\text{So, } P_{S_A} \propto 2\text{gm}$$

$$P_{S_B} \propto 1.5\text{gm}$$

$$P_{S_C} \propto 2.5\text{gm}$$

So, maximum vapour pressure is above C solution hence, it is having minimum lower and hence minimum mole fraction (hence minimum number of moles of solute) So max, molar mass of substance.

2. (C) Boiling point of solution = boiling point of pure solvent + $\Delta T_b = 100 + \Delta T_b$

$$\text{Freezing point of solution} = \text{freezing point of pure solvent} - \Delta T_f = 0 - \Delta T_f$$

$$\text{Difference in temperature (given)} = 100 + \Delta T_b - (-\Delta T_f)$$

$$103.57 = 100 + \Delta T_b + \Delta T_f = 100 + \text{molality} \times K_b + \text{molality} \times K_f$$

$$= 100 + \text{molality} (0.52 + 1.86)$$

$$\therefore \text{Molality} = \frac{103.57 - 100}{2.38} = \frac{3.57}{2.38} = 1.5 \text{ m}$$

$$\text{and molality} = \frac{\text{moles} \times 1000}{W_{\text{gm(solvent)}}}; 1.5 = \frac{\text{moles} \times 1000}{500}$$

$$\therefore \text{Moles of solute} = \frac{1.5 \times 500}{1000} = 0.75 \text{ moles}$$

Ans. 750 mmoles

3. (D) 4.(C) 5. (B)

6. (A) [Apply Clausius – Clapyeron equation].

7. (C) $\frac{\Delta P}{P} X_{\text{solute}} = i \times \frac{2}{5} = \frac{1}{2}$

$$\text{so, } i = 1.25 \quad \Rightarrow \quad \text{Hence degree of dissociation} = \frac{1}{4}$$

$$\text{so, moles of Cl}^- \text{ ions} = 2 \times \frac{1}{4} = \frac{1}{2} \text{ moles}$$

$$\text{so, moles of AgCl ppt} = \frac{1}{2} \text{ moles}$$

8. (A) Higher freezing point \Rightarrow lesser ΔT_f
 \Rightarrow lesser molality
 \Rightarrow lesser number of particles

9. (B) $(\text{molality})_i = \frac{x \times 1000}{100} = 10x = 0.2 \times \frac{0.2}{K_f}$

$$(\text{molality})_f = \frac{x \times 1000}{W} = 10x = 0.2 \times \frac{0.25}{K_f}$$

so $\frac{0.2}{0.25} = \frac{W}{100} \Rightarrow$ so $w = 80 \text{ gm}$

Hence ice separated = 20 gm

10. (D) $\frac{P_A^0}{2} + \frac{P_B^0}{2} = 1 \text{ atm} \Rightarrow P_A^0 + P_B^0 = 2 \text{ atm}$
 $\frac{P_A^0}{4} + \frac{3P_B^0}{4} > 1 \text{ atm} \Rightarrow P_A^0 + 3P_B^0 > 4 \text{ atm}$
 & $\frac{P_A^0}{8} + \frac{3P_B^0}{8} + \frac{4P_C^0}{8} = 1 \text{ atm} \Rightarrow P_A^0 + 3P_B^0 + 4P_C^0 = 8 \text{ atm}$
 So $P_A^0 + 3P_B^0 = (8 - 4 \times 0.8) \text{ atm} = 4.8 \text{ atm}$
 Hence $P_B^0 = 1.4 \text{ atm}$
 $P_B^0 = 0.6 \text{ atm}$

11. (C) Pressure of air = 750 – 100 = 650 mm of Hg
 on compressing $P_f = 650 \times 3 \text{ mm of Hg} = 1950 \text{ mm of Hg}$
 so $P_T = (1950 + 100) = 2050 \text{ mm of Hg}$

12. (A) Let volumes taken to be 'x' & 'y' litres,
 so $\frac{0.1x + 0.4y}{x + y} = 0.34$ & $V_g = (x + y)$ (to be maximised)
 so $y = 4x$ so for maximum volume
 $y = 2L$ & $x = \frac{1}{2} L$.

13. (B) $\pi = CRT$
 $C = (0.34 + \frac{0.1 \times 0.5}{2.5} + \frac{0.2 \times 2}{2.5}) = 0.34 + 0.02 + 0.16 = 0.52$
 so $\pi = 0.52 \times 0.082 \times 300 \text{ atm} = 12.792 \text{ atm}$

14. (B) As $m \rightarrow 0$, NaHSO_4 will generate three particles while NaCl will generate only two particles.

15. (A) $3S \rightarrow S_3$
 $1 - \alpha \quad \frac{\alpha}{3} \Rightarrow i = 1 - \frac{2\alpha}{3}$
 Now $0.1 \left(1 - \frac{2\alpha}{3}\right) = 0.08$
 $\Rightarrow \alpha = 0.3$. hence 30% trimerization.

16. (D) $P_T = \frac{1}{2} (75 + 22) = 48.5 \text{ torr}$
 $P_T = \frac{1}{2} (75 + 10) = 42.5 \text{ torr}$
 $P_T = \frac{1}{2} (22 + 10) = 16 \text{ torr}$
 $P_T = \frac{1}{3} (75 + 22 + 10) = 35 \frac{2}{3} \text{ torr}$

17. (B) $0.0558 = i \times \frac{3.24}{324} \times 1.86 \Rightarrow i = 3$ (100% dissociated)
 $0.0744 = i \times \frac{21.68}{271} \times \frac{1000}{2000} \times 1.86 \Rightarrow i \approx 1$ (almost undissociated)

18. (A) $1.24 = 34.3 \left[\frac{0.849}{\frac{M}{0.050}} \right] \Rightarrow M = 469.68$

19. (A, B, C)

$$\frac{P-20}{20} = \frac{6}{m} \times \frac{18}{180} = \frac{6}{m} \times \frac{1}{10}$$

$$\frac{P-20.02}{20.02} = \frac{6}{m} \times \frac{18}{198} = \frac{6}{m} \times \frac{1}{11}$$

calculation gives $m \sqsupseteq 54$ gm/mole
 $p = 20.22$ torr

& on dilution ΔP decreases (lowering) so net pressure increases.

20. (A, C, D)

$$x_A P_A^\circ + x_B P_B^\circ = 700 \quad \dots (i)$$

$$x_A P_A^\circ + x_B P_B^\circ = 0.30 P_A^\circ + 0.70 P_B^\circ = 600 \quad \dots (ii)$$

if moles of A & B initially are x & y then

$$x = 0.75 \times \frac{2}{3} (x+y) + 0.30 \times \frac{1}{3} (x+y)$$

& $x_A = \frac{x}{x+y}$ or $x_B = \frac{y}{x+y}$

solving gives

$$x_A = 0.6, \quad x_B = 0.4, \quad P_A^\circ = \frac{2500}{3} \text{ torr} \quad \& \quad P_B^\circ = 500 \text{ torr}$$

21. (A, B, C, D)

Acetone is more volatile than chloroform due to greater molar mass of chloroform and both forms solution which shows negative deviation. Hence the results follow.

22. (B) When liquid just starts forming vapours we have Rault's law valid with X_b & X_c as mole fraction in liquid state so equation of curve obtained by collecting such points will be

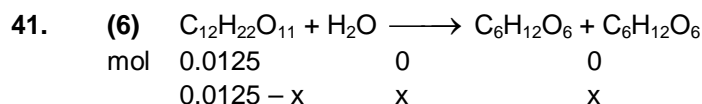
$$P = X_B^\ell P_B^\circ + X_C^\ell P_C^\circ = X_B^\ell P_B^\circ + (1 - X_B^\ell) P_C^\circ + P_C^\circ + (P_B^\circ - P_C^\circ) X_B^\ell = P_C^\circ + (P_B^\circ - P_C^\circ) X_B^\ell$$

The second curve will not be a straight line having equation

$$P = \frac{P_B^\circ - P_C^\circ}{X_B^\ell (P_C^\circ - P_B^\circ) + P_B^\circ}$$

23. (A) Form solution of above question

37. (A – p, s, r), (B – p, q, t), (C – p), (D – p, q, t)
- (A) Acetone + CHCl_3 - ve deviation from Raoult's law $\Delta S > 0$
 $\Delta H < 0$ $\Delta V < 0$
 Maximum Boiling Azeotropes.
- (B) Ethanol + Water + ve Deviation from Raoult's law $\Delta S > 0$
 $\Delta H > 0$ $\Delta V > 0$ Minimum Boiling Azeotropes
- (C) $\text{C}_2\text{H}_5\text{Br} + \text{C}_2\text{H}_5\text{I}$ Ideal solution no Azeotropes
 $\Delta H = 0$ $\Delta V = 0$
 Acetone + Benzene
 $\Delta H > 0$ $\Delta V > 0$ $\Delta S > 0$
 Minimum Boiling Azeotropes
38. (A – q, s), ; (B – q, s), (C – q, s), (D – q, s)
39. (A – q), (B – p), (C – r, s) (D – p)
- (A) $P_A^0 > P_B^0$ means A is more volatile than B and therefore A will be richer in vapour phase.
 [or $Y_A = X_A \frac{P_A^0}{P_T}$]
- (B) For Azeotropes, composition of vapour phase and liquid phase is same
- (C) For $P_A^0 < P_B^0$, $X_B < Y_B$ and $Y_B > Y_A$ for an equimolar ratio.
- (D) For $P_A^0 = P_B^0$, $X_A = Y_A$ for an equimolar ratio.
40. (3.5) In solution, $x_A = 0.3$; $x_B = 0.7$
 In vapour phase, $x'_A = 0.6$; $x'_B = 0.4$
- $$x'_A = \frac{P_A}{P} = 0.6$$
- $$\frac{P_A}{P_A + P_B} = \frac{P_A^0 x_A}{P_A^0 x_A + P_B^0 x_B}$$
- $$0.6 = \frac{0.3 P_A^0}{0.3 P_A^0 + 0.7 P_B^0} \quad \dots (1)$$
- $$x'_B = \frac{P_B}{P} = \frac{P_B}{P_A + P_B} = 0.4$$
- $$\Rightarrow \frac{0.7 P_B^0}{0.3 P_A^0 + 0.7 P_B^0} = 0.4 \quad \dots (2)$$
- Dividing (1) by (2)
- $$\frac{0.3 P_A^0}{0.7 P_B^0} = \frac{0.6}{0.4}$$
- $$\Rightarrow \frac{P_A^0}{P_B^0} = \frac{0.6 \times 0.7}{0.4 \times 0.3} = \frac{7}{2} = 3.5$$



$$\Delta T_b = m_1 K_b + m_2 K_b + m_3 K_b$$

$$m_1 + m_2 + m_3 = \frac{0.104}{0.52} = 0.2$$

$$\frac{0.125 - x + x + x}{100} \times 100 = 0.2$$

$$x = 0.0075$$

$$\text{mol \%} = \frac{0.0075}{0.0125} \times 100 = 60$$

$$\frac{1}{10} \text{ th of mol\%} = \frac{60}{10} = 6.$$

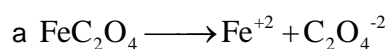


$$X_{Fe^{+2}} + X_{C_2O_4^{-2}} = X_{KMnO_4}$$

$$1 \times n + 2 \times n = \frac{0.4 \times 5 \times 30}{1000}$$

$$n = \frac{2 \times 10}{1000} = 0.02$$

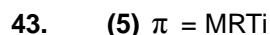
$$\Delta T_F = m K_f i = \frac{25 \times 2}{1000} \times \frac{1000}{186} \times 1.86 \times 2 = \frac{100}{100} = 1$$



$$n_{FeC_2O_4} = \frac{MV}{1000}$$

$$0.02 = \frac{M \times 10}{1000}$$

$$M = 2$$



$$\pi = 2 \times 0.0821 \times 300 \times 4$$

$$\text{For He } PV = nRT$$

$$\pi V = nRT$$

$$i = 1 + (y - 1)\alpha$$

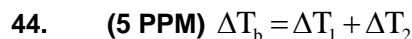
$$i = 1 + (5 - 1)0.75$$

$$i = 1 + 3$$

$$i = 4$$

$$2 \times 0.0821 \times 300 \times 4 \times 100 \times \ell \times 10^{-3} = \frac{16}{4} \times 0.0821 \times 300$$

$$\ell = \frac{4}{8 \times 10^{-1}} = \frac{40}{8} = 5$$



$$\Delta T_b = 0.0000104 = (m_1 i_1 + m_2 i_2) \times k_b$$



$$i = i_1$$

$$n = n_1$$



$$i' = i_2$$

$$n' = n_2$$

$$0.000052 = \frac{(n_1 + n_2) \times 0.52 \times 2}{10^6} \times 1000$$

$$n_1 + n_2 = 0.05$$

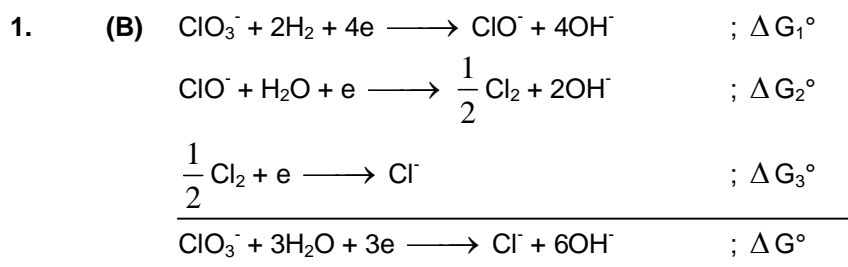
for degree of Hardness

$$n_{CaSO_4} + n_{MgSO_4} = n_{CaCO_3}$$

$$n_{CaCO_3} = 0.05$$

$$m_{CaCO_3} = 0.05 \times 10^6 = 5 \text{ ppm}$$

ELECTROCHEMISTRY

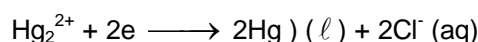
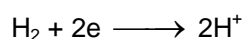


$$\therefore \Delta G^\circ = \Delta G_1^\circ + \Delta G_2^\circ + \Delta G_3^\circ$$

$$= -6FE^\circ = -4F \times 0.54 - 1F \times 0.45 - 1F \times 1.07$$

$$\therefore E^\circ = + \frac{3.68}{6} = +0.61 \text{ V}$$

2. (B) considering the cell reaction



$$\Delta S = nF \left(\frac{\partial E}{\partial T} \right)_P = 2 \times 96500 \times 3.4 \times 10^{-4} = 65.223 \text{ J/K/mole}$$

3. (A) $2\text{Ag}^+ + \text{H}_2 \longrightarrow 2\text{H}^+ + 2\text{Ag}$

$$E = E^\circ - \frac{0.0591}{2} \log \frac{(\text{H}^+)^2}{P_{\text{H}_2} \times (\text{Ag}^+)^2}$$

$$0.222 = 0.7995 - \frac{0.0591}{2} \log \frac{1}{(\text{Ag}^+)^2}$$

$$(\text{Ag}^+) = 10^{-9.8}$$

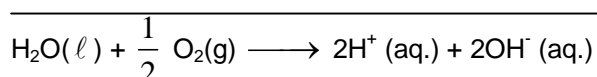
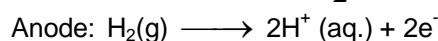
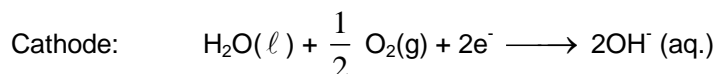
$$K_{\text{sp}} = (\text{Ag}^+) (\text{Cl}^-) = (10^{-9.8}) \times (1) = 10^{-9.8}$$

4. (B)

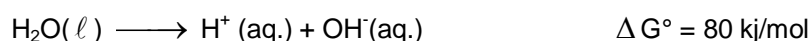
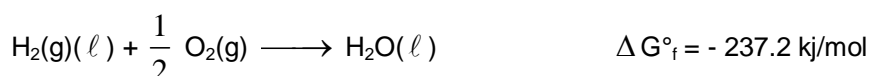
5. (A) The solubility of AgBr in presence of 10^{-7} molar AgNO₃ is 3×10^{-7} M. Therefore $[\text{Br}^-] = 3 \times 10^{-4} \text{ M}^3$, $[\text{Ag}^+] = 4 \times 10^{-4} \text{ M}^3$ and $[\text{NO}_3^-] = 10^{-4} \text{ M}^3$

$$\text{Therefore } K_{\text{total}} = K_{\text{Br}^-} + K_{\text{Ag}^+} + K_{\text{NO}_3^-} = 39 \text{ Sm}^{-1}$$

6. (A) Cell reaction



Also we have



Hence for cell reaction

$$\Delta G^\circ = -77.20 \text{ kJ/mole}$$

$$\text{So, } E = -\frac{77200}{2 \times 96500} = 0.40 \text{ V}$$

7. (D) $E_{\text{cell}} = -\frac{0.0591}{1} \log \frac{[\text{H}^+]_a}{[\text{H}^+]_c}$

For E_{cell} to be highest $[\text{H}^+]_a$ should be lower and $[\text{H}^+]_c$ should be higher and that why anode compartment should be more basic and cathodic compartment should be acidic.

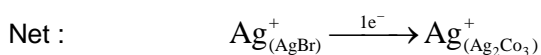
8. (C) pH changes from 0 to 7.

\therefore $[\text{H}^+]$ changes from 1 to 10^{-7} M.

Accordingly E_{red} Decreases by $0.059 \log 10^{-7}$ i.e. $0.059 \times (-7) = -0.41$ volt.

9. (B) anode : $\text{Ag(s)} \longrightarrow \text{Ag}^+(\text{aq}) + 1e^-$

Cathode : $\text{Ag}^+(\text{aq}) + 1e^- \longrightarrow \text{Ag}$

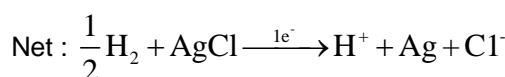


$$0 = 0 + \frac{0.059}{1} \log \frac{\left(\frac{K_{\text{SP}} \text{AgBr}}{[\text{Br}^-]} \right)}{\sqrt{\frac{K_{\text{SP}} \text{Ag}_2\text{CO}_3}{[\text{CO}_3^{2-}]}}} \Rightarrow \frac{K_{\text{SP}} \text{AgBr}}{[\text{Br}^-]} = \sqrt{\frac{K_{\text{SP}} \text{Ag}_2\text{CO}_3}{[\text{CO}_3^{2-}]}}$$

$$\Rightarrow \frac{4 \times 10^{-13}}{\sqrt{8 \times 10^{-12}}} = \frac{[\text{Br}^-]}{\sqrt{[\text{CO}_3^{2-}]}} \Rightarrow \frac{[\text{Br}^-]}{\sqrt{[\text{CO}_3^{2-}]}} = \sqrt{2} \times 10^{-7}$$

10. (A) Anode : $\frac{1}{2} \text{H}_2 \longrightarrow \text{H}^+ + 1e^-$

Cathode : $\text{AgCl} + 1e^- \longrightarrow \text{Ag} + \text{Cl}^-$



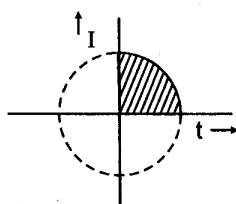
$$E_{\text{cell}} = +0.222 + \frac{0.059}{1} \log \frac{1}{[\text{H}^+][\text{Cl}^-]}$$

$$= +0.222 + 0.059 \log \frac{[\text{OH}^-]}{[10^{-14}][\text{Cl}^-]} = +0.222 + 0.059 (14) = +1.048 \text{ volt}$$

11. (A) m (theoretical) = $\frac{63.5 \times 0.1 \times 7200}{96500} = 0.4738 \text{ g}$

$$\therefore \% \text{ efficiency} = \frac{0.3745}{0.4738} \times 100 = 79 \%$$

12. (A)

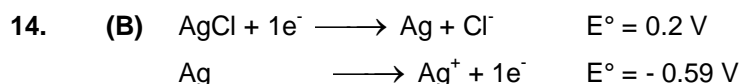


$$Q = \frac{\pi(25)}{4} C = \frac{\pi \times 25}{4 \times 96500} F$$

$$\therefore m = \frac{108}{1} \times \frac{\pi \times 25}{4 \times 96500} \text{ g} = 0.02197 \text{ g} = 21.97 \text{ mg} \approx 22 \text{ mg}$$

13. (A) $R = \frac{1 \ell}{K A}$

The k is halved while the A is doubled. Hence R remain 50 Ω .



$$\text{AgCl} \xrightarrow{1e^-} \text{Ag}^+ + \text{Cl}^- \quad E^\circ = -0.59 \text{ V}$$

$$E^\circ = \frac{0.059}{n} \log K \quad \Rightarrow \quad -0.59 = \frac{0.059}{1} \log K_{\text{SP}}$$

$$\Rightarrow \quad K_{\text{SP}} = 10^{-10}$$

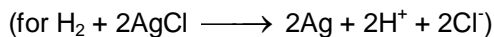
Now solubility of AgCl in 0.1 M AgNO₃

$$S(S + 0.1) = 10^{-10} \quad \Rightarrow \quad S = 10^{-9} \text{ mol/L}$$

Hence 1 mole dissolves in 10⁹ L solution

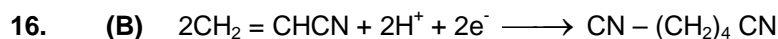
Hence in 10⁶ L amount that dissolves in 1 mol.

15. (A) $\Delta G_{\text{cell reaction}}^\circ = 2(-130.79) - 2(-109.56)$
 $= -42.46 \text{ KJ/mole}$



$$\therefore E_{\text{cell}}^\circ = \frac{-42460}{-2 \times 96500} = +0.220 \text{ V}$$

$$\text{Now } E_{\text{cell}} = +0.220 + \frac{0.059}{2} \log \frac{1}{(0.01)^4} = 0.456 \text{ V} = 456 \text{ mV.}$$



$$m = \frac{\left(\frac{108}{2}\right) \times 10^{-3} \times 3000 \times 9.65 \times 3600}{96500} = 58.32 \text{ kg}$$

Ans. 58 Kg

17. (B) $E_{\text{bck}} = \frac{0.059}{2} \log \frac{0.12}{0.08} = 5.19 \text{ mV}$

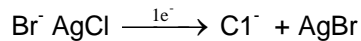
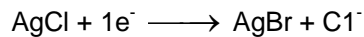
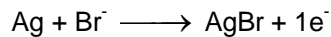


$$\therefore E = \frac{0.059}{1} \log \frac{2.1 \times 10^{-4}}{1.8 \times 10^{-5}} = 0.0629 \text{ V}$$

19. (A) $E_{\text{Br}^-/\text{AgBr}/\text{Ag}}^0 = E_{\text{Ag}^+/\text{Ag}/\text{Ag}}^0 + \frac{0.059}{1} \log K_{\text{SP}}\text{AgBr} = E_{\text{Ag}^+/\text{Ag}}^0 - 0.7257$

and $E_{\text{Cl}^-/\text{AgCl}/\text{Ag}}^0 = E_{\text{Ag}^+/\text{Ag}}^0 + \frac{0.059}{1} \log K_{\text{SP}}\text{AgCl} = E_{\text{Ag}^+/\text{Ag}}^0 - 0.59$

Now cell reaction is



$$0 = (0.7257 - 0.59) + \frac{0.059}{1} \log \frac{[\text{Br}^-]}{[\text{Cl}^-]}$$

$$\Rightarrow \frac{[\text{Br}^-]}{[\text{Cl}^-]} = 0.005$$

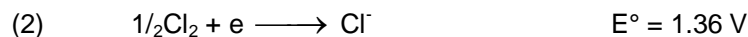
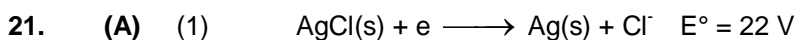
20. (A) $\rho_m = \rho_m^0 - b\sqrt{c}$

$$260 = \rho_m^0 - 0.5b \dots (1)$$

$$250 = \rho_m^0 - b \dots (2)$$

On solving (1) & (2), we get

$$\rho_m^0 = 270 \Omega^{-1} \text{cm}^2 \text{mol}^{-1}$$



We get



$$\therefore \Delta G = -nEF^\circ = - (1) (96500) (1.4) = - 110 \text{ KJ/mol}$$

22. (B) if reduction potential of metal ion is greater than $\text{O}_2/\text{H}_2\text{O}$ couple, the ion is stable in water. So Co^{3+} is stable in water

23. (A) [Hint: Reverse of (B) & (C) is spontaneous; weakest Oxidizing Agent here is Mg^{2+}]

24. (B) $\alpha = \frac{\lambda_m}{\lambda_m^\infty} = \frac{7.8}{390} = 0.02$

$$\Rightarrow K_a(\text{CH}_3\text{COOH}) = C \alpha^2 = 0.04 \times (4.8)$$

$$\Rightarrow \text{p}K_a = 6 - \log 2.4 = 6 - 4 \times 0.3 = 4.8$$

$$\Rightarrow \text{p}K_a(\text{H}_3\text{COO}^-) = 14 - \text{p}K_a = 9.2$$

25. (A) $\therefore \Delta H = \Delta G + T \Delta S$

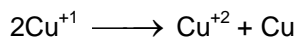
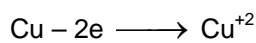
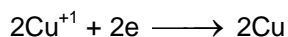
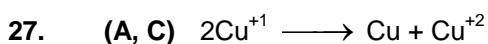
$$= -nFE_{\text{cell}} + nFT \left(\frac{\partial E}{\partial T} \right)_p$$

$$= -199.35 \text{ KJ/mol} \quad [n = 2 \text{ for } \text{Cd}^{2+} + 2e^- \rightarrow \text{Cd} \text{ \& \text{ putting other values}]$$

Now $\Delta H < 0 \quad \Rightarrow \text{Exothermic reaction}$

$$\Rightarrow \text{Heat will be released increasing the temperature.}$$

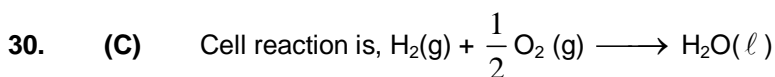
26. (A, B, D)



$$\therefore E^\circ = \frac{2 \times 0.521 + 2(-0.337)}{2} = 0.184$$

28. (A, B, C, D)

29. (B, C, D) the SRP should be high for a species to be a good oxidizing agent.

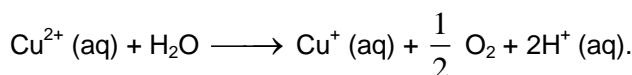


$$E_{\text{cell}} = 1.246 - \frac{0.06}{2} \log \frac{1}{P_{\text{H}_2} \times \sqrt{P_{\text{O}_2}}} = 1.246 - \frac{0.06}{2} \log \frac{1}{20\sqrt{10}}$$

$$= 1.246 + \frac{0.06}{2} \left(1.3 + \frac{1}{2}\right) = 1.246 + 0.054 = 1.3 \text{ V.}$$

31. (A) $i = \frac{V}{R} = \frac{1.3}{26.94} = 0.04825 \text{ A.}$

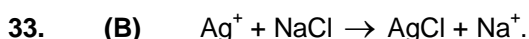
$$\text{Time of electrolysis} = \frac{5}{10 \times 10^{-3}} = 500 \text{ minutes.}$$



$$\therefore \text{moles of H}^+ \text{ formed} = \frac{ixt}{F} = \frac{0.04825 \times 500 \times 60}{96500} = 0.015 \text{ M}$$

32. (B) In resulting solution, $[\text{Cu}^{2+}] = 0.0075 = 0.0425 \text{ M}$, $[\text{H}^+] = 0.015 \text{ M}$ and $[\text{SO}_4^{2-}] = 0.05 \text{ M}$.

$$\begin{aligned} \kappa &= \kappa_{\text{Cu}^{2+}} + \kappa_{\text{H}^+} + \kappa_{\text{SO}_4^{2-}} = \frac{\lambda_{\text{Cu}^{2+}}^\infty \times [\text{Cu}^{2+}]}{1000} + \frac{\lambda_{\text{H}^+}^\infty \times [\text{H}^+]}{1000} + \frac{\lambda_{\text{SO}_4^{2-}}^\infty \times [\text{SO}_4^{2-}]}{1000} \\ &= \frac{0.01 \times 10^4 \times 0.0425}{1000} + \frac{0.35 \times 10^4 \times 0.015}{1000} + \frac{0.016 \times 10^4 \times 0.05}{1000} \\ &= 0.00425 + 0.00525 + 0.008 \\ &= 0.0175 \text{ S cm}^{-1} = 1.75 \text{ S m}^{-1}. \end{aligned}$$



34. (B) SRP zinc = - 0.76

SRP iron = - 0.44

SRP copper = + 0.34 (highest); Hence only copper deposits, others do not.

35. (A) Increasing voltage would cause deposition of Fe^{+2} and Zn^{+2} also to occur.

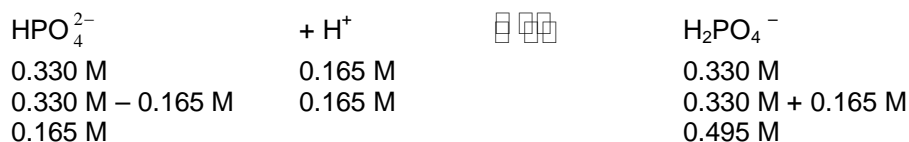
36. (D) 99.95% pure Cu in obtained.

37. (B) Water (pure) is a poor electrical conductor.

38. to 40.

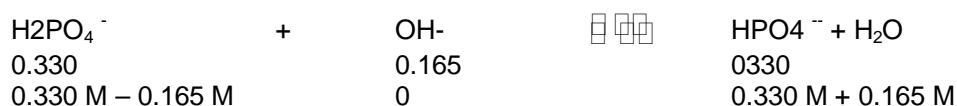
$$[H^+] = [OH^-] = \frac{it}{96500} = \frac{1.25 \times 212 \times 60}{96500} = 0.165 \text{ M}$$

At anode



$$pH = 7.2 + \log \frac{[HPO_4^-]}{[H_2PO_4^-]} = 7.2 + \log \frac{0.165}{0.495} = 7.2 - \log 3 = 7.2 - 0.4771 = 6.72$$

At cathode



$$pH = 7.2 + \log \frac{0.495}{0.165}$$

$$pH = 7.2 + \log 3 = 7.2 + 0.477$$

$$pH = 7.67.$$

38. (A) 39. (B) 40. (C)

41. (A - p, q, s); (B - r, s); (C - p, q), (D - p, q, s)
Based on facts.

42. (A - q), (B - r), (C - s), (D - t), (E - p)
Factual question.

43. (A - p, q, r, s), (B - p, q), (C - p, q, r, s), (D - p, q, r, s)

44. (A - p, s) ; (B - q, r) ; (C - p, s) ; (D - q, s)
- A) $PbCl_2$, Cathode: $Pb^{2+} + 2e^- \longrightarrow Pb(s)$
Anode: $2Cl^- \longrightarrow Cl_2(g) + 2e^-$
- B) Cathode: $H_2O + 2e^- \longrightarrow H_2(g) + 2OH^-$
Anode: $2Cl^- \longrightarrow Cl_2(g) + 2e^-$
(OH⁻) in increased solution become basic
- (C) Cathode: $Ag^+ + e^- \longrightarrow Ag(s)$
Anode: $Ag(s) \longrightarrow Ag^+ + e^-$
Neutral solution
- (D) Cathode: $H_2O + 2e^- \longrightarrow H_2(aq) + 2OH^-$
Anode: $H_2O \longrightarrow 1/2 O_2 + 2H^+ + 2e^-$
Neutral solution

45. (A – p, q, r), (B – p, q, r), (C – p, q, r), (D – r)

46. (2) $\text{pH} = \frac{\text{pKa}_2 + \text{pKa}_3}{2} = 10.5$

$E_{\text{cell}} = E^{\circ}_{\text{cell}} + 0.059 \text{ pH} = 1.3805 + 0.059 \times 10.5 = 2\text{V}.$

47. (2) Time taken to electrolysed Cu-metal completely

$\frac{ixt}{96500} = \text{equivalents of Cu-deposited}$

$\frac{0.965 \times t}{96500} = 0.005 \times 2$

$t = 1000 \text{ sec}.$

after 1000 sec pH of solution is not change because after this time only water is reduced and water is oxidized.

$\therefore \text{equivalents of H}^+ \text{ produced} = \text{equivalents of Cu}^{2+} \text{ ion deposited} = 10^{-2}.$

$\text{pH} = -\log 10^{-2} = 2.$

48. (9) $E^{\circ}_{\text{cell}} = 0.76 \text{ volt}$

Applying nernst equation

$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{0.0591}{2} \log \frac{[\text{Zn}^{2+}][\text{H}_2]}{[\text{H}^+]^2}$

$0.26 = 0.76 - \frac{0.0591}{2} \log \frac{(0.1)(1)}{[\text{H}^+]^2}$

$\log \frac{0.1}{[\text{H}^+]^2} = \frac{2 \times 0.50}{0.0591}$ or $\log 0.1 - \log [\text{H}^+]^2 = 17$ or $2\text{pH} = 17 - \log 0.1$

$\text{pH} = \frac{18}{2} = 9.$

49. (8) $\text{CH}_4 + 10\text{OH}^- \longrightarrow \text{CO}_3^{2-} + 7\text{H}_2\text{O} + 8\text{e}^-$

No. of Faradays required = $\frac{80 \times 3600 \times 0.96}{96500}$

Hence mol. Of CH_4 required $\frac{1}{8} \times \frac{80 \times 3600 \times 0.96}{96500}$

$V_{\text{CH}_4} = \frac{1}{8} \times \frac{80 \times 3600 \times 0.96}{96500} \times 22.4 \text{ L} = 8.356 = 8.02 \text{ L}$

Ans. 8

50. (5) Radius of ball = $\frac{0.1}{2} = 0.5$

Surface area of electrodes = $0.12 \text{ m}^2 = 1200 \text{ cm}^2$

60% of $1200 = 2000 \text{ cm}^2.$

Weight of jewellery = $\frac{4}{3} \pi r^3 \times 10,000 \times \text{density} = \frac{4}{3} \times 3.14 \times (0.05)^3 \times 10000 \times 10.5 = 54.9 \text{ gram}$

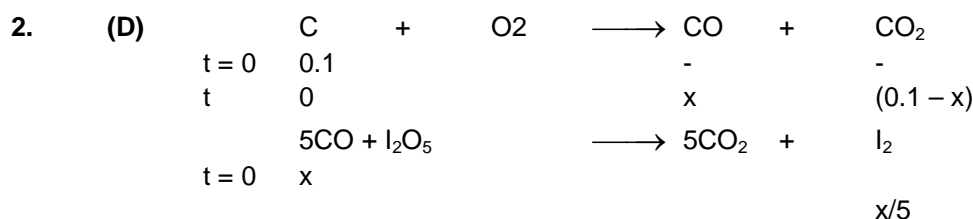
Now amount of electricity in faraday = $\frac{\text{wt. of Ag}}{\text{Equivalent wt. of Ag}} = \frac{54.9}{108} = 0.50\text{F} = 48250 \text{ coulomb}.$

So applied electricity amount = $\frac{48250 \times 100}{96.5} = 50,000 \text{ coulomb} = 5 \times 10^4 \text{ coulomb}$

So, Ans is 5.

STIOCHIMESTRY

1. (C) $N = \frac{11.2}{5.6}$
 Milli equivalents $\text{Ba}(\text{MnO}_4)_2$ reacted \Rightarrow equivalents of H_2O_2 reacted
 $\Rightarrow 2 \times 100 \Rightarrow 200 \text{ m eq}^n \Rightarrow 0.2 \text{ eq}^n$
 Moles of $\text{Ba}(\text{MnO}_4)_2 \Rightarrow \frac{0.2}{10} = 0.02$
 \therefore wt. of $\text{Ba}(\text{MnO}_4)_2 = 0.02 \times 375$.
 $\% \text{ purity of } \text{Ba}(\text{MnO}_4)_2 = \frac{375 \times 0.02}{15} \times 100 = 50\%$



moles of I₂ liberated = $\frac{1}{2}$ moles of hypo consumed = $\frac{1}{2} \times 120 \times 10^{-3} \times 0.1 = 60 \times 10^{-4}$

So $x = 5 \times 60 \times 10^{-4} = 0.03$ moles

So % of C forming CO = 30%.

3. (A) 4. (C) 5. (B)

6. (A) **H₃BO₃** is a mono basic acid

So $\frac{M}{1} = \text{equivalent mass}$

7. (B) **5As₂S₃ + 28KMnO₄ + H⁺ → 10H₃AsO₄ + 28Mn²⁺ + SO₄²⁻**

mmoles of KMnO₄ = $50 \times 0.1 = 5$

28 mmoles of KMnO₄ → 5 Moles of As₂S₃

1 mmoles of KMnO₄ → $\frac{5}{28}$ moles of As₂S₃

Mass of As₂S₃ = $x = 246 \times \frac{5}{28} \text{ g} = 43.92 \text{ g}$

8. (D) Equivalents of FeC₂O₄ = equivalents of KMnO₄

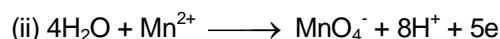
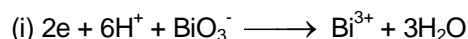
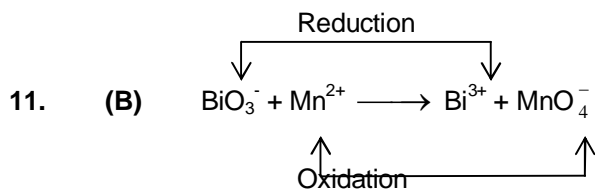
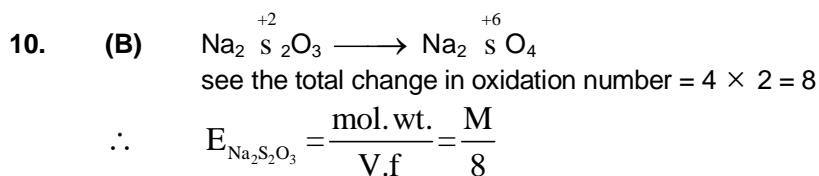
$x (\text{mole}) \times 3 = 1 \times 5$

$x = \frac{5}{3}$

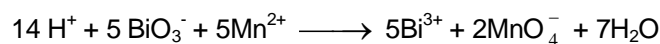
9. (A) Equivalents of KMnO₄ = equivalent of FeSO₄ + equivalent of FeC₂O₄

$x \times 5 = 1 \times 1 + 1 \times 3$

$x = \frac{4}{5} \text{ mole}$

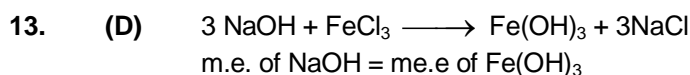


(i) $\times 5$ + (ii) $\times 2$ we get



is the correct balanced reaction.

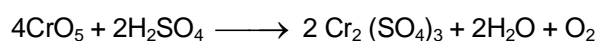
12. (A)



$$100 \times N = \frac{W}{E} \times 1000 \left(E_{\text{Fe(OH)}_3} = \frac{\text{mol. wt.}}{3} \right)$$

$$N = \frac{1.425 \times 10 \times 3}{107} = 0.3999 = 0.4 \text{ N}$$

14. (D) The balance reaction is



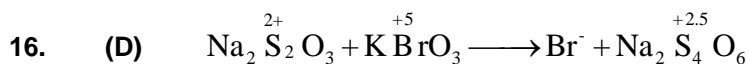
\therefore 1 mole CrO₅ can liberate only $\frac{1}{4}$ mole O₂

15. (C) Eq of Acid = eq of base

$$n \times \frac{0.4}{96} = \frac{0.5}{40}$$

$$n = \frac{1}{80} \times \frac{96}{0.4} = \frac{96}{32} = 3$$

\therefore wt of A = $96 - 3 = 93$.



v.f = 1 v. = 6
 by m.e. of Na₂S₂O₃ = m.e. of KBrO₃
 molarity of Na₂S₂O₃ = 0.1 M

17. (C) M.e. of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in 25 ml = m.e. of KMnO_4 used = 2 m.e.
M.e. of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in 1000 ml = 80 m.e.
mass of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ in solution = $\frac{80}{1} \times 2787 \times \frac{1}{1000} = 22.24 \text{ gm}$
% of $\text{FeSO}_4 \cdot 7\text{H}_2\text{O} = \frac{22.24}{25} \times 100 = 88.96 \text{ 89\%}$
18. (B) Let moles of FeO and Fe_2O_3 in the mixture is a and b respectively, then by POAC we get following two equation.
 $a + 3b = 0.65 \times 2 = 1.3 \quad \dots(i)$
 $a + 2b = 1 \quad \dots(ii)$
by solving (i) & (ii) we get a : b = 4 : 3
19. (B) Let normality of HCl is N_1 and H_2SO_4 is N_2 .
 \therefore M.e. of $\text{HCl} + \text{M.e. of H}_2\text{SO}_4 = \text{M.e of NaOH}$
 $25 \times N_1 + 25 \times N_2 = 10 \times 1 \quad \dots (1)$
 $N_1 + N_2 = 0.4 \quad \dots (1)$
BY POAC
Moles of $\text{Cl}^- = \text{moles of AgCl}$
 $\frac{20 \times N_1}{1000} = \frac{0.1435}{143.05} = 10^{-3}$
 $N_1 = 0.05 \text{ N}$
 $N_2 = 0.35 \text{ N}$
20. (A) $6e^- + 10\text{H}^+ + \text{V}_2\text{O}_5 \longrightarrow 2\text{V}^{2+} + 5\text{H}_2\text{O}$
 $\text{Zn} \longrightarrow \text{Zn}^{2+} + 2e^- \quad 3 \times 3$

 $\text{V}_2\text{O}_5 + 3\text{Zn} + 10\text{H}^+ \longrightarrow 3\text{Zn}^{2+} + 2\text{V}^{2+} + 5\text{H}_2\text{O} \quad \dots (1)$
Now $\text{H}_2\text{O} + \text{V}^{2+} \longrightarrow \text{VO}^{2+} + 2\text{H}^+ + 2e^-$
 $2e^- + \text{I}_2 \longrightarrow 2\text{I}^-$

 $\text{V}^{2+} + \text{I}_2 + \text{H}_2\text{O} \longrightarrow \text{VO}^{2+} + 2\text{H}^+ + 2\text{I}^-$
so we have 12 moles of V_2O_5 will reduce 2 moles of iodine
so $\left(\frac{10}{102+80} \right) \times 2$ moles of will be reduced by given amount of $\text{V}_2\text{O}_5 = 0.11$ moles of I_2
21. (A, D)
22. (A, B, C, D)

$$\text{Final molarity} = \frac{V_1 \times 1 + V_2 \times 0.25}{(V_1 + V_2)}$$

$$0.75(V_1 + V_2) = V_1 + V_2 \times 0.25$$

$$0.75V_1 + 0.75V_2 = V_1 + V_2 \times 0.25$$

$$0.5V_2 = 0.25V_1$$

$$\frac{V_1}{V_2} = 2$$

23. (A,B,C) MCl_x
 In each mole of MCl_x there are x moles of Cl^-
 $\Rightarrow [Cl^-] = x \times 0.01$
 conc. of $[M^{x+}] = 0.01$
24. (A,B,D)
- (A) Molarity of second solution is $= \frac{10 \times d \times x}{M} = 1M$
 (B) Volume = 100 + 100 = 200 ml
 (D) Mass of $H_2SO_4 = \frac{200 \times 1}{1000} \times 98 = 19.6$ gm.
25. (B,C) Moles of $C_2H_6 = 3$
 moles of C_2H_6 mixed $= \frac{60}{30} = 2$
 total mole of $C_2H_6 = 5$
 moles removed $= \frac{2.4 \times 10^{24}}{6 \times 10^{23}} = 4$
 \therefore moles of C_2H_6 left = 1
 Now, $C_2H_6 + 7/2 O_2 \longrightarrow 2CO_2 + 3H_2O$
 Clearly 3 moles of H_2O or 54 gm H_2O will be formed
 volume of $H_2O = 54$ ml
Ans. 54
26. (A,B,C) For same number of molecules, number of moles should be same.
27. (A,B,D) When mixture is passed through hot graphite the following reaction will occur.
- $$CO_2(g) + C(s) \longrightarrow 2CO(g)$$
- x ml 2x ml will formed
- \therefore Total volume of mixture = 160
 $100 - x + 2x = 160$
 $x = 60$ ml
 volume of CO = $100 - x = 40$ ml
28. (B)
29. (C) Moles of $Na_2S_2O_3$ used = $0.4 + 0.6 + 1.2 = 2.2$
 Moles of $Na_2S_2O_3$ left unreacted $= \frac{632}{158} - 2.2 = 1.8$
30. (A) No moles of $Na_2S_2O_3$ would remain in step (i) so further reaction will stop because $Na_2S_2O_3$ is required in excess.

Sol. (31. to 33.)

On applying POAC for A & B respectively, we get

$$1 \times n_A = 2x \ n_{A_2B_5} \quad \dots (1)$$

$$2 \times n_{B_2} = 5 \times n_{A_2B_5} \quad \dots (2)$$

$$\text{By (1) \& (2), } \frac{n_A}{4} = \frac{n_{B_2}}{5} = \frac{n_{A_2B_5}}{2}$$

∴ Balanced equation: $4A + 5B_2 \rightarrow 2A_2B_5$

∴ $q = 1.25$

on applying POAC for X and Y respectively, we get

$$1 \times n_x = 1 \times n_{XY_3} \dots (3)$$

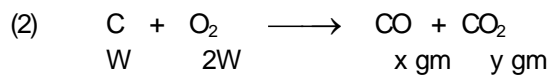
$$2 \times n_{Y_2} = 3 \times n_{XY_3} \dots (4)$$

by (3) & (4), $n_{Y_2} = 1.5 \times n_x$

from (3) and (4)

$$\frac{n_x}{2} = \frac{n_{Y_2}}{3} = \frac{n_{XY_3}}{2}$$

$$\begin{aligned} \therefore \text{Balanced equation: } 2X &+ 3Y_2 \rightarrow 2XY_3 \\ n_{Y_2} &= \frac{120}{60} & \therefore n_{XY_3} &= \frac{4}{3} \\ &= 2 & \therefore m_{XY_3} &= \frac{4}{3} \times 100 = 133.3\text{g} \end{aligned}$$



POAC for C

$$\frac{w}{12} = \frac{x}{28} + \frac{y}{44}$$

$$\frac{w}{3} = \frac{x}{7} + \frac{y}{11} \dots (1)$$

POAC for O

$$2 \times \frac{2w}{32} = \frac{x}{28} + 2 \times \frac{y}{44}$$

$$\frac{w}{4} = \frac{x}{14} + \frac{y}{11} \dots (2)$$

$$\text{So now } \frac{3y}{11} + \frac{3x}{7} = \frac{4x}{14} + \frac{4y}{11}$$

$$\frac{3y}{7} - \frac{3x}{7} = \frac{y}{11}$$

$$\frac{x}{7} = \frac{y}{11}, \frac{x}{y} = 7:11$$

31. (B) 32. (B) 33. (A)

34. (B) $SO_3 + H_2O \longrightarrow H_2SO_4$;
 18 g water combines with 80 g SO_3
 ∴ 4.5 g of H_2O combines with 20 g of SO_3
 ∴ 100 g of oleum contains 20 g of SO_3
 or 20% free SO_3

35. (C) $H_2SO_4 + Na_2CO_3 \longrightarrow Na_2SO_4 + H_2O + CO_2$

$$\text{Moles of } CO_2 \text{ formed} = \text{moles of } Na_2CO_3 \text{ reacted (it is limiting reagent)} = \frac{5.3}{106} = 0.05$$

$$\text{volume of } CO_2 \text{ formed at 1 atm pressure and 300 K} = 0.05 \times 24.63 = 1.23 \text{ L.}$$

36. (B) Equivalent of H_2SO_4 + equivalent of SO_3 = equivalent of NaOH

$$\frac{x}{98} \times 2 + \frac{(1-x) \times 2}{80} = 54 \times 0.4 \times 10^{-3}$$

$$x = 0.74$$

$$\% \text{ of free } \text{SO}_3 = \frac{1-0.74}{1} \times 100 = 26\%$$
37. (C) Mass of oxygen in oxide = $9.44 - 5 = 4.44$
 Eq. wt. of metal = mass of metal which combine with 8 gm of oxygen

$$= \frac{5}{4.44} \times 8 = 9.00 \text{ gm}$$
38. (A)
$$\left(\frac{W}{E}\right)_{\text{H}_3\text{PO}_4} = \left(\frac{W}{E}\right)_{\text{Mg(OH)}_2}$$

$$\frac{W}{98} \times 3 = \frac{58}{58} \times 2$$

$$W = 65.33 \text{ gm}$$
39. (B) Equilibrate the m.e. of NaOH by m.e. of acid.
40. (C) M.e. of H_3PO_2 = m.e. of NaOH
 $100 \times 0.1 \times 1 = V \times 0.1$
 $V = 100 \text{ ml}$
 H_3PO_2 is monbasic acid
41. (B) Number of moles of water produced = 0.2 moles
 \therefore 0.2 equivalent of acid should be reacted

$$\frac{W_{\text{acid}}}{E_{\text{acid}}} = 0.2 \Rightarrow E_{\text{acid}} = 49$$
42. (D) Use formula $\frac{x_A \times 1000}{(1-x_A)m_A}$ and get answer.
43. (B) $m_{\text{Na}_2\text{CO}_3} = 12$
 $n_{\text{Na}_2\text{CO}_3} = 12$
 $n_{\text{N}_2\text{O}} = \frac{1000}{18} = 55.55$

$$x_{\text{Na}_2\text{CO}_3} = \frac{12}{12 + 55.55} = 0.177$$
44. (A) Let wg water is added to 16 g CH_3OH

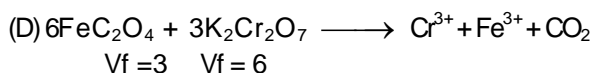
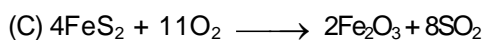
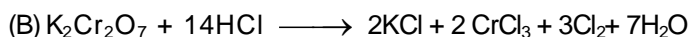
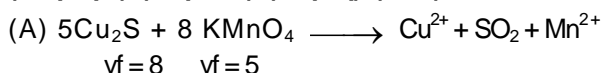
$$\text{Molality} = \frac{16 \times 1000}{W \times 32} = \frac{500}{W}$$

$$\frac{500}{W} = \frac{x_A \times 1000}{(1-x_A)m_B} = \frac{0.25 \times 1000}{0.75 \times 18} \quad W = 27 \text{ gm}$$

45. (A) % (w/v) volume of NaOH = $\frac{300 \times 0.3 + 500 \times 0.4}{800} \times 100 = 72.5$
 $\frac{800}{2}$

46. (B) Mole of solute = $\frac{300 \times 0.3 + 500 \times 0.4}{40} = 72.5$
 Mass of solvent = 800 - 290 = 510
 Molality = $\frac{7.25}{510} \times 1000 = 14.22$.

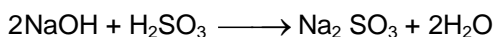
47. (A - p, q, r), (B - p, r, s), (C - p, q), (D - r).



48. (A - q, r), (B - p, s), (C - q, r), (D - r).

49. (A - p, s), (B - q, r, t); (C - p, q, s, t), (D - r, t)

(A) $4.1 \text{ gm} = \frac{4.1}{82} \text{ mole H}_2\text{SO}_3 = 50 \text{ m mole}$



m mole of NaOH requires = $2 \times \text{m mole of H}_2\text{SO}_3$
 = 100
 = m mole of NaOH present (200 ml \times 0.5 N)

Highest O.N. of S = + 6

(B) $4.9 \text{ gm} = \frac{4.9}{98} \text{ mole} = 50 \text{ m mole of H}_3\text{PO}_4 = 200 \text{ m mole 'O' atom}$

Highest O.N. of P = + 5

(C) $4.5 \text{ gm} = \frac{4.5}{90} = 50 \text{ m mole of H}_2\text{C}_2\text{O}_4$ (di basic acid)

m mole of NaOH requires = $2 \times 50 = 100$
 Highest O.N. of C = + 4

(D) $5.3 \text{ gm} = \frac{1}{20} \text{ mole Na}_2\text{CO}_3$ It do not react with NaOH and m mole of O atom = $\frac{1}{20} \times 3$
 = 150

50. (A - p, q, r), (B - p, q, r, s), (C - r, s), (D - r, s)

51. (A - r); (B - s); (C - p); (D - q, r, (E - t)

(A) 4.5, H₂SO₄ means

4.5 moles of CaCO₃ is present in 1000 g solvent.

mass of solute = 4.5 × 100 = 450 g

mass of solution = 1000 ml

Hence molarity = 4.5 M

$$(B) \text{ Resultant molarity} = \frac{3 \times 100 + 1 \times 300}{400} = \frac{3}{2} = 1.5 \text{ M}$$

$$(C) \text{ mole fraction} = \frac{14.5}{14.5 + 55.5} = 0.2$$

(D) moles of NaOH in 2 ltr = 4 × 2 = 8 mole

$$\text{moles of NaOH added} = \frac{40}{40} = 1 \text{ mole}$$

$$\therefore \text{ Molarit} = \frac{9}{2} = 4.5 \text{ M}$$

mass of NaOH = 9 × 40 = 360 g

$$(E) \% \text{ (w/w) NaOH} = \frac{5 \times 40}{5 \times 40 + 1000} \times 100 = 16.66\%$$

$$52. \quad (40) \% \text{ of carbon} = \frac{144}{144 + m + 36.5(10 - m)} \times 100 = 40$$

On solving

53. (2 ppm) M₁V₁ = M₂V₂

$$50 \times M_1 = \frac{1}{50} \times 0.1$$

$$M_1(\text{HCO}_3^-) = \frac{1}{25 \times 10^3}$$

$$\text{mmole of HCO}_3^- = \frac{1}{25 \times 10^3} \times 50 = \frac{1}{500}$$

$$\text{mmole of Ca}^{2+} = \frac{1}{1000}$$

$$\text{mmole of CaCO}_3 = \frac{1}{1000}$$

$$\text{weight of CaCO}_3 = \frac{1}{1000} \times 10^{-3} \times 100 = 10^{-4}$$

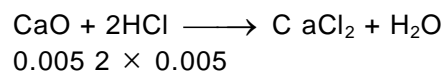
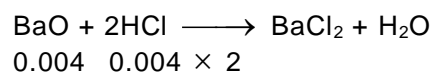
$$\text{hardness} = [\text{weight of CaCO}_3 / \text{weight of water}] \times 10^6$$

$$= \frac{10^{-4}}{50} \times 10^6 = 2 \text{ ppm.}$$

54. (9 mL) wt of BaO = $\frac{1 \times 61.2}{100} = 0.004$

$$\text{mole} = \frac{0.612}{100} = 0.004$$

$$\text{wt of CaO} = \frac{0.28}{56} = 0.005 \text{ mol.}$$



Number of moles of HCl required = 0.008 + 0.018

$$MV_L = 0.018$$

$$3 \times \frac{V_{\text{mL}}}{1000} = 0.018$$

$$V = 9 \text{ mL.}$$

SURFACE CHEMISTRY

1. (A) Physical adsorption is a multilayer phenomenon
2. (B) Rate of physical adsorption gradually decreases with increase the temperature.
3. (C) Total surface area of eight cubes = $8 \times 6 \times \left(\frac{1}{2} \times \frac{1}{2}\right)^2$
Apply the formula
Surface area on n split of a cube = $8^n \times 6 \times \left(\frac{1}{2}\right)^{2n}$
 $6291456 = 8^n \times 6 \times \left(\frac{1}{2}\right)^{2n}$
4. (C) Chemical adsorption is a mono layer phenomenon.
5. (A)
6. (C) Lower is the value gold number; greater will be the protecting power.
7. (C) 10 ml of 1 M NCl contains NaCl = $10 \times 1 = 10$ milli mole
200 ml of As_2S_3 required NCl for the coagulation = 10 milli mole
 \therefore 1000 ml of As_2S_3 required NaCl for the coagulation = $10 \times 1000\%200 = 50$ milli mole
8. (C) 9.(A) 10.(A) 11. (D)
12. (C) $0.03 = \text{weight of Hb in mg} \times 10 / 100$
13. (A)
14. (A) It is because of more surface area of colloidal Pd
15. (A, C) (A) $\Delta G = \Delta H - T \Delta S < 0$ as $\Delta S < 0$ so ΔH has to be negative
(B) Micelles formation will take place above T_k and above CMC
(C) This solution will be negatively charged.
(D) Fe^{3+} ions will have greater flocculability power so smaller flocculating value.
16. (A, C)
17. (C, D) In gel, liquid is dispersed in solid,
18. (A, B, C) 19. (B) 20. (B)
21. (B) 22. (A) 23. (C)
24. (A – s); (B – r); (C – q); (D – p)
25. (A – s); (B – r); (C – q); (D – p)

26. (1) 5 ml of gold sols, required gelatin for protection from coagulation = 0.5 mg.
 10 ml of gold soil. ,, ,, ,, = $\frac{0.5 \times 10}{5} = 1$

27. (5) M Mole of NaCl = $M \times V = 0.5 \times 1 = 0.5$
 Coagulation Value = $100 \frac{0.5 \times 1000}{100} = 5$

28. (4) Gold no. = $1000 \times 0.00399 = 4$

29. (5) A minimum of 5 ml of AB is required to coagulate the soil, the moles of AB in sol. is
 $= \frac{5 \times 0.01}{10} = 0.005$ moles

this means that a minimum of 0.005 moles or $0.005 \times 1000 = 5$ milli moles are required for coagulation 1 litre of sol. flocculation value of AB for As_2S_3 sol = 5.