PART (B) : CHEMISTRY

SOLUTION

21. (B)

22. (B)
No of molecuels is too less to predict α.

23. (C)
NO_2^+ has no lone pair.
NO_2 has lone electron.
NO_2^- has lone pair electron.
Bond angle decreases with lone pairs.
Due to high electronegativity of F, bond pair of e^- s is OF_2 is pulled away from O. So, the bond angle is less.

24. (C)
For K, 2^{nd} I.E. should be considerably higher than 1^{st} I.E.
For Mg, 3^{rd} I.E. should be considerably higher than 2^{nd} I.E.

25. (B)
No of moles of $SO_2 \neq$ no. of moles of O_2

26. (D)
No. of radial nodes = $n - \ell - 1$
No. of planar nodes $= \ell$
$S_1 = 3s$ (spherically symmetrical so $\ell = 0, n = 3$)
For S_2, $E = E_H \times \frac{25}{100} = \frac{E_H}{4}$
$E_{He^+} = E_H \times \frac{Z^2}{n^2} = E_H \times \frac{4}{n^2} \left(Z = 2 \text{ for } He^+\right)$
$\Rightarrow n = 4$
Since no. of radial nodes = 2
$= n - \ell - 1$
$\Rightarrow \ell = 1 =$ No. of angular nodes.
Degenerally of 51 = $n^2 = 3^2 = 9$

27. (D)
Since ideal gas has no molecular forces of attraction, it can not be liquefied.

28. (A, B, C, D)
(A) Bond order = 0
(B) Maximum oxidation state can not be achieved with H
(C) d-orbitals unavailable.
(D) Br is too bid for coordination no. = 6 around P.

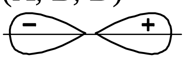
29. (B)
Size of oxygen is too small, so, it repels the incoming electron.

30. (A, B, D)
Higher Z implies lesser compressibility.

31. (A, B, D)

32. (A, B, C, D)
(A) Check bond order hybridized
(B) electronegativity of sp π carbon is highest.
(C) heavier isotope lowers zero point energy.
(D) Bond length of C==O is smallest.

33. (B, D)
At Boyle temperature,
$$\left\{\frac{\partial(PV)}{\partial P}\right\}_T = 0$$

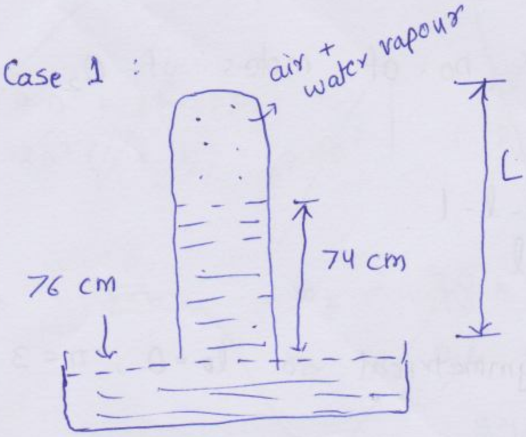
34. (A, B, D)

σ 2p

35. (29.80)
$$I.E._1 = \frac{13.6 \times Z^2}{n^2} \text{ eV} \text{ for H0like } (He^+)$$
$$E_2 = \frac{13.6 \times 4}{1} \text{eV} = 54.4 \text{ eV}$$
Given: $I.E._1 + I.E._2 = 79$
$\Rightarrow \quad 54.4 + E_1 = 79 \Rightarrow E_1 = 24.6$
$E_2 - E_1 = 54.4 - 24.6 = 29.8 \text{ eV}$

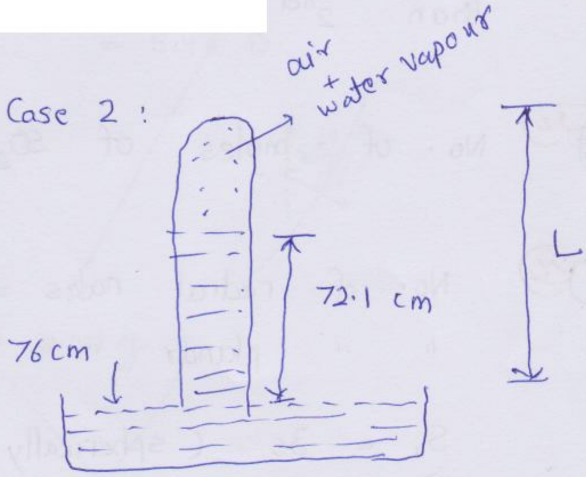
36. (8.50)
Bond order in $O_2, O_3, O_2^-, O_2^{2-}, O_2^+$ are 2, 1.5, 1.5, 1, 2.5

37. (91.10)

Case 1 :



Case 2 :



$(p_{air})_1 + p_{water} + 74 = 76$

$\Rightarrow (p_{air})_1 = 1$ cm of Hg

$(p_{air})_2 + p_{water} + 72.1 = 76$

$(p_{air})_2 = 0.9$

Use $p_{water} = 1$ cm of Hg . (Given)

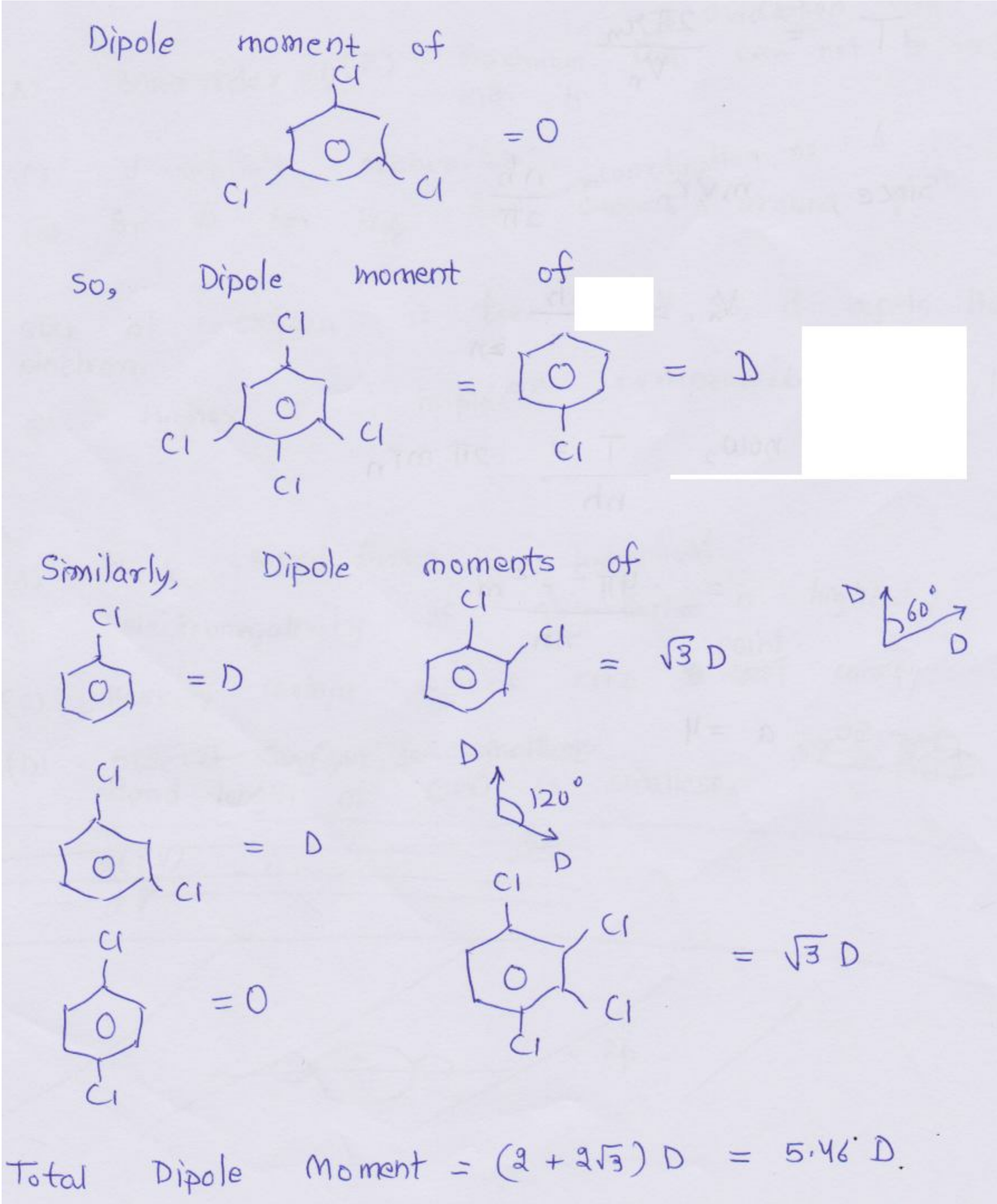
$(p_{air})_1 \propto 1/(L - 74)$ Case 1

$(p_{air})_2 \propto 1/(L - 72.1)$ Case 2

$$\frac{(p_{air})_1}{(p_{air})_2} = \frac{L - 72.1}{L - 74} = \frac{1}{0.9}$$

$\Rightarrow L = 91.1$ cm

38. (5.46)



39. (64.00)

$$m_X = \frac{20}{100} \times 12 = 2.4 \text{ g}$$

$$m_Y = 9.6 \text{ g}$$

Their moles are in the rtio of 2 : 5

$$\frac{n_X}{n_Y} = \frac{2}{5} \Rightarrow \frac{2.4 / M_X}{9.6 / m_Y} = \frac{2}{5}$$

$\Rightarrow \quad M_Y = 64$ (Use $M_X = 40$)

40. (4.00)

$T = \dfrac{2\pi r_n}{V_n}$

Since, $mV_{rr_n} = \dfrac{nh}{2\pi}$

$V_n = \dfrac{nh}{2\pi m r_n}$

Now, $T = \dfrac{2\pi r_n}{nh} \times 2\pi m r_n$

$= \dfrac{4\pi^2 r^2 m}{nh}$

So, $a = 4$

PART (B) : CHEMISTRY

SOLUTION

21. (B, D)

Let y mL C_3H_8 is present in the mixture.

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Volumes y 5y 3y

$$C_xH_{2x} + \frac{3x}{2}O_2 \rightarrow xCO_2 + xH_2O$$

Volumes $(72-y)$ $\frac{3x}{2}(72-y)$ $(72-y)x$

Volume of $O_2 = 342 = 5y + (72-y)\frac{3x}{2}$

Volume of $CO_2 = 216 = 3y + (72-y)x$

Solving for x & y,

$x = 3$

$y = 36$

(B) Volume of C_3H_8 = 36 mL

C_3H_6 = 36 mL

(D) Molecular mass of mixture before mixing (X = mole fraction)

$= M_1X_1 + M_2X_2$

$= 44 \times \frac{1}{2} + 42 \times \frac{1}{2} = 43$

22. (C, D)

$$KE = \frac{3}{2}RT \times n$$

(C) both 1 mole

(D) Both 2 mole

23. (A, B)

Everything else same, bond angle decreases with decrease in electronegativity

24. (B, D)

PH_3 and SF_4 are pyramidal and see-saw shaped respectively and are not planar.

25. (B, C, D)

(B) size decreases with increases in oxidation state

(C) size decreases with increase in atomic no. for isoelectronic species.

(D) Anion is larger than cation

26. (C, D)

$HIO_4 + 2H_2O \rightarrow H_5IO_6$

Since only 9 g weight has increased, only 0.5 moles of H_2O has been absorbed.

Hence, only 0.25 moles of HIO_4 has been converted to 0.25 moles of H_5SP_6.
(C) Only half of HIO_4 (initial moles = 0.5) has converted to H_5IO_6.
(D) % HIO_4 (by mass) $=\frac{48}{105}\times 100=45.7\%\neq 50\%$

27. (B, C)
H bonding is formed between H & F, H & O, H & N

28. (A, C, D)
(B) Correct order is $CH_3Cl > CH_3F > CH_3Br > CH_3I$

29. (D)
According to Graham's law of Diffusion& Effusion,

$$\frac{r_2}{r_1}=\sqrt{\frac{M_1}{M_2}}\times\frac{P_2}{P_1}$$

$$r_{He}=\frac{\Delta P}{t}=\frac{250}{25}=10\text{ torr/min}$$

$$\frac{r_X}{r_{He}}=\sqrt{\frac{M_{He}}{M_X}}\times\frac{P_X}{P_{He}}$$

$$\frac{r_{D_2}}{r_{He}}=\frac{P_{D_2}}{P_{He}}=\frac{2000}{1000}=2 \qquad \left(\therefore\ \frac{P_{F_2}}{P_X}=\frac{2}{1}\ \&\ P_{D_2}+P_r=3000\right)$$

$\Rightarrow\ r_{D_2}=2\times 10$ torr/min.

$\Rightarrow\ \frac{\Delta P}{50}=20\ \Rightarrow\ \Delta P=1000$ for D_2

After 50 min,
P_{D_2} = Initial partial pressure – ΔP
= 2000 – 1000 = 1000 torr
Since, residual mixture contains D_2 & X in the ratio of 10 : 9
The pressure of X after 50 min $=\frac{9}{10}\times 1000=900$ torr

30. (A)

$$\frac{r_X}{r_{He}}=\sqrt{\frac{M_{He}}{M_X}}\times\frac{P_X}{P_{He}}$$

$\Rightarrow\ m_X=100$

Also, KE / mole = 8000 J / mole $=\frac{3}{2}RT$

$u_{rms}=\sqrt{\frac{3RT}{M}}$ using above values,
= 400 m/s

31. (C)
$A = XeF_4$

$B = NF_3$

$C = SO_3$

$D = NH_3$

(C) NCl_3 is sp^3 hybridised but it's bond angle is larger duel to larger size of Cl.

32. (B)

$XeF_4 =$ square planar

$NF_3 =$ planar triangular

33. (D)

According to the equations,

$$\frac{n_{HNO_3}}{n_{NH_3}} = \frac{2}{3}$$

$$\Rightarrow \quad nlNH_3 = \frac{3}{2} \times n_{HNO_3} = \frac{3}{2} \times \frac{1575}{63}$$

$$\Rightarrow \quad \frac{V}{22.4} = \frac{3}{2} \times \frac{1575}{63} \Rightarrow V = 840\ L$$

34. (A)

$$\frac{n_{HNO_3}}{n_{NH_3}} = \frac{2}{3} \times 0.8 \times 0.6 \times 0.5$$

$$\Rightarrow \frac{V}{22.4} = \frac{3}{2} \times \frac{1575/63}{0.8 \times 0.6 \times 0.5} = 3500L$$

35. (5.00)

36. (8.00)

37. (5.00)

At high P,

$P(V - b) = RT$

On rearranging,

$$Z = \frac{PV}{RT} = 1 + \frac{Pb}{RT}$$

So, Z vs P will be a straight line with slope $= \frac{b}{RT}$

$$\Rightarrow \frac{b}{RT} = \frac{\pi}{492}$$

Replace $b = \frac{4}{3} \times \pi r^3 \times N_A \times 4$

On solving,

$2r = 5Å$

38. (4.00)

Applying POAC for Fe,

$$2\times n_{Fe_2O_3} = 5\times n_{Fe_3[Fe(CN)_6]_2}$$

$$\frac{2}{5}\times\frac{1600}{160} = n_{Fe_3[Fe(CN)_6]_2} = 4$$

39. (8.00)

$BH_4^-, NH_2^-, NH_2^+, NH_3, H_2O, I_3^+, NO_2^-, SO_2$

40. (5.00)

$$E_n = -\frac{R_H}{n^2}$$

So, $n_1 = 2, n_2 = 3$

Degeneracy = n^2

$X = 4$

$Y = 9$

So, $Y - X = 5$