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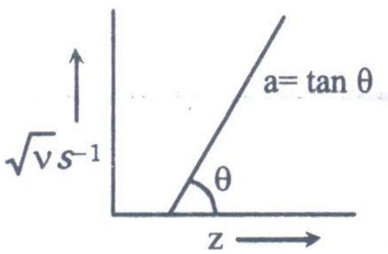
Class: 11
Subject: chemistry
Topic: OASK1511SA101
No. of Questions: 30

Q1. How many molecules of water are present in 9 gram of water?

Sol. 3.011×10^{23}

Q2. If the straight line is at an angle 45° with b = 1 calculate frequency when atomic number Z is 50.



Sol. $\sqrt{v} = tan\ 45° = 1 = a$

$b = 1$

$\therefore \sqrt{v} = 50 - 1 = 49$

$v = 2401 s^{-1}$.

Q3. According to IUPAC system of naming elements, the symbol of the element of atomic number 121 will be

Sol. Ubu

Q4. The IUPAC name of the element with atomic number Z = 109 is

Sol. Une

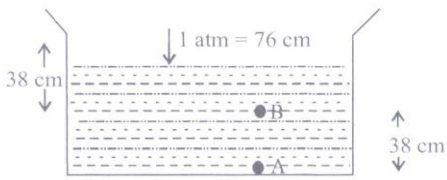
Q5. Bond order of Be_2 is:

Sol. 0

Q6. An open tank is filled with Hg up to a height of 76 cm. Find the pressure at the

(1) Bottom of the tank
(2) Mid of the tank

Atmospheric pressure = 1 atm



Sol. $2\ atm, 1.5\ atm$

Q7. Calculate energy of electron which is moving in the orbit that has its radius, sixteen times the radius the radius of first Bohr orbit for H-atom.

Sol. $r = r_0\, n^2 \qquad \Longrightarrow n^2 = 16 \qquad \Longrightarrow n = 4$

$E = \frac{-2.18\times10^{-18}}{n^2} = -1.36 \times 10^{19}\, J/atom$

Q8. The $\Delta_f H°(N_2O_5, g)$ in kJ/mol on the basic of the following data is:

$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \qquad \Delta_r H° = -114 kJ/mol$
$4NO_2(g) + O_2(g) \rightarrow 2N_2O_5(g) \qquad \Delta_r H° = -102.6\ kJ/mol$

Sol $.\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \rightarrow NO(g) \quad \Delta_f H° = 90.2$

$N_2(g) + O_2(g) \rightarrow 2NO(g) \qquad \Delta_r H° = 90.2 \times 2$

$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \quad \Delta_r H° = -114$

$2NO_2(g) + \frac{1}{2}O_2(g) \rightarrow N_2O_5(g) \ \ \Delta_r H° = \frac{-102.6}{2} = 51.3$

Addition of (1), (2) and (3) equation

$N_2(g) + \frac{5}{2}O_2(g) \rightarrow N_2O_5(g) \quad \Delta_f H° \quad (N)_2\, O_5, g) = 15.1\ kJ/mol$

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Q9. If an aqueous solution at 25°C has twice as many OH^- as pure water is pOH will be

Sol. $[OH^-] = 2 \times 10^{-7}$

$pOH = 14 - ph \quad or \quad -log[OH^-]$

6.699

Q10. At 25°C, the vapour pressure of methyl alcohol is96.0 torr. What is the mole fraction of CH_3OH in a solution in which the (partial) vapor pressure of CH_3OH is 23.0 torr at 25°C?

Sol. $X_{CH_3OH} = \frac{P_{CH_3OH}}{P^0_{CH_3OH}} = \frac{23}{96} = 0.24$

Q11. Calculate the amount of oxalic acid $(H_2C_2O_4.2H_2O)$ required to obtain 250 ml of semimolar solution.

Sol. Molarity of solution = 0.5 M

Volume of solution = 250 ml

∴milli mole oxalic acid = M x V (ml) $= \frac{1}{2} \times 250 \quad or \ \frac{w}{M} \times 1000 = 0.5 \times 250$

$\therefore w = \frac{250 \times 126}{2 \times 1000} = 15.76\ g$

Q12. Calculate the atomic mass (average) of chlorine using the following data:

	% Natural Abundance	Molar Mass
^{35}Cl	75.77	34.9689
^{37}Cl	24.23	36.9659

Sol. The average atomic mass chlorine

$$= \left[\begin{pmatrix} Fractional\ abundance \\ of\ ^{35}Cl \end{pmatrix} \begin{pmatrix} Molar\ mass \\ of\ ^{35}Cl \end{pmatrix} + \begin{pmatrix} Fractional\ abundance \\ of\ ^{37}Cl \end{pmatrix} \begin{pmatrix} Molar\ mass \\ of\ ^{37}Cl \end{pmatrix} \right]$$

$$= \left[\left\{ \left(\frac{75.77}{100} \right) (34.9689\ u) \right\} + \left\{ \left(\frac{24.23}{100} \right) (36.9659\ u) \right\} \right]$$

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$= 26.4959 + 8.9568$

$= 35.4527\ u$

∴ The average atomic mass of chlorine $= 35.4527\ u$

Q13. The mass of an electron is $9.1 \times 10^{-31} kg$. If its K.E. is $3.0 \times 10^{-25}\ J$, calculate its wavelength.

Sol. From de Broglie's equation,

$\lambda = \frac{h}{mv}$

Given,

Kinetic energy (K.E) of the electron $= 3.0 \times 10^{-25} J$

Since K. E $= \frac{1}{2} mv^2$

∴ Velocity (v) $= \sqrt{2 \frac{K.E}{m}}$

$= \sqrt{\frac{2(3.0 \times 10^{-25} J)}{9.10939 \times 10^{-31}\ kg}}$

$= \sqrt{6.5866 \times 10^4}$

$v = 811.579\ ms^{-1}$

Substituting the value in the expression of λ:

$\lambda = \frac{6.626 \times 10^{34} Js}{(9.10939 \times 10^{31}\ kg)(811.579\ ms^{-1})}$

$\lambda = 8.9625 \times 10^{-7}\ m$

Hence, the wavelength of the electron is 8.9625×10^{-7} m.

Q14. On the basis of quantum numbers, justify that the sixth period of the periodic table should have 32 elements?

Sol. The sixth period of the periodic table must have elements whose electronic configuration starts from 6s and continue filling 4f, 5d, and 6p orbitals. As the electron enters 7s orbital such element with come under 7th period. The no. of electrons that can be accommodated in 6s, 4f, 5d and 6p orbitals are 2,14,10 and 6 respectively whose total is 32.

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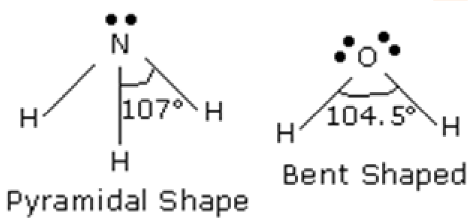
Hence the sixth period of the periodic table should have 32 elements.

Q15. Although geometries of NH_3 and H_2O molecules are distorted tetrahedral, bond angle in water is less than that of ammonia. Discuss.

Sol. If an atom is surrounded by four bonded pairs of electrons, it must assume a tetrahedral shape due to electron repulsion. But in the case of ammonia, N is surrounded by one lone pair and three bonded pairs of electrons. The lp-bp repulsion makes the molecule to assume a pyramidal shape whose HNH angle gets reduced from 109° 28' to 107°. In the case of water molecule the molecule contains 2lps and 2 bps of electrons. The lp-bp and lp-bp repulsion together exists and makes the molecule to assume a bent shape and the HOH angle is reduced from 109°28' to 104.5°. Since the lp-lp repulsions are much greater than the lp-bp repulsion the HOH bond angle in water is smaller than HNH bond angle in NH_3.



Q16. At 0°C, the density of a certain oxide of a gas at 2 bar is same as that of dinitrogen at 5 bar. What is the molecular mass of the oxide?

Sol. Density (d) of the substance at temperature (T) can be given by the expression,

$d = \frac{Mp}{RT}$

Now, density of oxide (d_1) is given by,

$d_1 = \frac{M_1 p_1}{RT}$

Where, M_1 and p_1 are the mass and pressure of the oxide respectively.

Density of dinitrogen gas (d_2) is given by,

$d_2 = \frac{M_2 p_2}{RT}$

Where, M_2 and p_2 are the mass and pressure of the oxide respectively.

According to the given question,

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$d_1 = d_2$

$\therefore M_1 p_1 = M_2 p_2$

Given,

$p_1 = 2\ bar$

$p_2 = 5\ bar$

Molecular mass of nitrogen, $M_2 = 25\ g/mol$

Now, $M_1 = \frac{M_2 p_2}{p_1}$

$= \frac{28 \times 5}{2}$

$= 70\ g/mol$

Hence, the molecular mass of the oxide is 70 g/mol.

Q17. Calculate the standard enthalpy of formation of $CH_3OH_{(l)}$ from the following data:

$CH_3OH_{(l)} + \frac{3}{2} O_{2(g)} \longrightarrow CO_{2(g)} + 2H\_2\ O_{(l)}\ ;\ \Delta_r H^\theta = -726\ kJ\ mol^{-1}$

$C_{(g)} + O_{2(g)} \longrightarrow CO_{2(g)}\ ;\ \Delta_c H^\theta = -393\ kJ\ mol^{-1}$

$H_{2(g)} + \frac{1}{2} O_{2(g)} \longrightarrow H\_2\ O_{(l)}\ ;\ \Delta_f H^\theta = -286\ kJ\ mol^{-1}$

Sol. The reaction that takes place during the formation of $CH_3OH_{(I)}$ can be written as:

$C_{(s)} + 2H_2O_{(g)} + \frac{1}{2} O_{2(g) \rightarrow\ CH_3OH_{(I)}}$ (1)

The reaction (1) can be obtain from the given reactions by following the algebraic calculation as:

Equation (ii) $+2 \times equation$ (iii) – equation (i)

$\Delta_f H^\theta [CH_3OH_{(I)}] = \Delta_c H^\theta [H_2O_{(I)}] - \Delta_r H^\theta$

The given reaction represents the formation of chlorine molecule from chlorine atoms. Here, bond formation is taking place. Therefore, energy is being released. Hence, ΔH is negative.

Also, two moles of atoms have more randomness than one mole of a molecule. Since spontaneity is decreased, ΔS is negative for the given reaction.

Q18. Write the expression for the equilibrium constant, K_c for each of the following reaction:

$$2NOCl(g) \leftrightarrow 2NO(g) + Cl_2(g)$$

Sol. $K_c = \frac{[NO_{(g)}]^2[Cl_{2(g)}]}{[NOCl_{(g)}]}$

Q19. Use the periodic table to answer the following questions.

(a) Identify an element with five electrons in the outer subshell.
(b) Identify an element that would tend to lose two electrons.
(c) Identify an element that would tend to gain tow electrons.
(d) Identify the group having metal, non-metal, liquid as well as gas at the room temperature.

Sol.

(a) The electronic configuration of an element having 5 electrons in its outermost subshell should be $ns^2 \ np^5$. This is the electronic configuration of the halogen group. Thus, the element can be F, CL, Br, I, or At.
(b) An element having two valence electrons will lose two electrons easily to attain the stable noble gas configuration. The general electronic configuration of such an element present in group 2 are Be, Mg, Ca, Sr, Ba.
(c) An element is likely to gain two electrons if it needs only two electrons to attain the stable noble gas configuration. Thus, the general electronic of the oxygen family.
(d) Group 17 has metal, non-metal, liquid as well as gas at room temperature.

Q20. One mole of an non linear triatomic ideal gas is expanded adiabatically at 300 K from 16 atm to 1 atm. Find the values of $\Delta S_{sys}, \Delta S_{surr}$ & ΔS_{total} under the following conditions.

(a) Expansion is carried out reversibly
(b) Expansion is carried out irreversibly
(c) Expansion is free.

Sol.

(a) $\Delta S_{sys} = nC_v ln\frac{T_2}{T_1} + nRln\frac{V_2}{V_1} = 0, q = 0, \Delta_{surr} = -\Delta S_{sys} = \Delta S_{total} = 0$
(b) $\Delta S_{sys} = 1.702\ R, \Delta S_{surr} = 0, \Delta S_{total} = \Delta S_{sys} = 1.702\ R$
(c) $\Delta S_{sys} = nRln\frac{P_1}{P_2} = 2.77\ R, \Delta S_{surr} = \frac{-q_{irr}}{T} = 0, \Delta S_{sys} = 2.77\ R$

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Q21. The standard enthalpy of atomization of PCl_3 (g) is 195 Kcal/mol. What will be the standard enthalpy of atomization of PCl_5 (g), if the bond dissociation energies of axial P–Cl bonds in PCl_5 (g) are 10% lesser and the bond dissociation energies of equatorial P–Cl_5 (g) are 10% higher than the bond dissociation energies of P–Cl_3 (g).

Sol. $PCl_2(g) \rightarrow P(g) + 3Cl(g)$

$3BE_{p-cl} = 195\ kcal/mol$

$BE_{p-cl} = 65\ kcal/mol$ equitorial

$in\ PCl_5$ $3P - Cl$ bonds are equatorial

$BE_{p-Cl}(eq) = 65 \times 1.1 = 71.5\ kcal$

$BE_{P-Cl}(axial) = 65 \times 0.9 = 58.5\ kcal$

$PCl_5(g) \rightarrow P(g) + 5Cl(g)$

$3BE_{P-Cl} + 3BEP - Cl(axial) = 3 \times 71.5 + 2 \times 58.5 = 331.5\ kcal$

(equatorial)

$\Delta H = 331.5\ kcal.$

Q22. 0.10 mol sample of $AgNO_3$. Is dissolved in one litre of 1.00 M NH_3. If 0.010 mol of NaCl is added to this solution will $AgCl_{(s)}$ Preceipitate?

Sol. $K_{sp(AgCl)} = 1.8 \times 10^{-10}, K_{f[Ag(NH3)2]+} = 1.6 \times 10^7$

Ag^+ + $2NH_3$ $\leftrightharpoons$ $[Ag(NH_3)_2^+]$

$0.10\ M$ 1.00

x $(1 - 0.20)M$

It is assumed than all Ag^+ ion has been complexed and only its part x is left

$K_f = \frac{[Ag(NH_3)_2^+]}{[Ag^+][NH_3]} \Rightarrow 1.6X10^7 = \frac{0.10}{X(0.80)^2}$

$\therefore X = 9.8\ X\ 10^{-9}M = [Ag^+]$ undissolved

$[CL^-] = 1.0\ X\ 10^{-2}\ M$

$\therefore [Ag^+][Cl^-] = 9.8\ \ X\ 10^{-9}\ X1.0\ X10^{-2} = 9.8\ X\ 10^{-11} < 1.8\ X\ 10^{-10}\ (K_{sp}(AgCl))$

Hence $AgCl(s)$ will not precipitate.

Q23. Wavelength of the Balmer H_α line is 6565 Å. Calculate the wavelength of H_β, line of same hydrogen like atom.

Sol. For α-line of Balmer Series

$$\frac{1}{\lambda_\alpha} = RZ^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$

For β-line of Balmer series

$$\frac{1}{\lambda_\beta} = RZ^2\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$\frac{\lambda_\beta}{\lambda_\alpha} = \frac{\left[\frac{1}{2^2}-\frac{1}{4^2}\right]}{\left[\frac{1}{2^2}-\frac{1}{3^2}\right]}$$

$$\lambda_\beta = 4.863 \times 10^{-7}\ m$$

Q24. What is the equilibrium concentration of each of the substances in the equilibrium when the initial concentration of ICl was 0.78 M?

$2ICl_{(g)} \leftrightarrow I_{2(g)} + Cl_{2(g)};\ K_c = 0.14$

Sol. The given reaction is:

	$2ICl_{(x)}$	$\leftrightarrow$	$I_{2(x)}$	$Cl_{2(x)}$
Initial conc.	$0.78\ M$		0	0
At equilibrium	$(0.78 - 2x)\ M$		xM	xM

Now, we can write, $\frac{[I_2][Cl_2]}{[Cl]^2} = K_c$

$$\Rightarrow \frac{x \times x}{(0.78 - 2x)} = 0.14$$

$$\Rightarrow \frac{x^2}{(0.78 - 2x)^2} = 0.14$$

$$\Rightarrow \frac{x}{0.78 - 2x} = 0.374$$

$$\Rightarrow \frac{x}{0.78 - 2x} = 0.374$$

$\Rightarrow x = 0.292 - 0.748x$

$\Rightarrow 1.748x = 0.292$

$\Rightarrow x = 0.167$

Hence, at equilibrium,

$[H_2] = [I_2] = 0.167\ M$

$[H] = (0.78 - 2 \times 0.167)M$

$= 0.446\ M$

Q25. Show that the circumference of the Bohr orbit for the hydrogen atom is an integral multiple of the de Broglie wavelength associated with the electron revolving around the orbit.

Sol. Since a hydrogen atom has only one electron, according to Bohr's postulate, the angular momentum of the electron is given by:

$mvr = n\frac{h}{2\pi}$ ....(1)

Where,

$n = 1, 2, 3, ...$

According to de Broglie's equation:

$\lambda = \frac{h}{mv}$

$or\ \ mv = \frac{h}{\lambda}$ ....(2)

Substituting the value of $'mv'$ from expression (2) in expression (1):

$\frac{hr}{\lambda} = n\frac{h}{2\pi}$

$or\ \ 2\pi r = n\lambda$ ....(3)

Since '2nr' represents the circumference of the Bohr orbit (r), it is proved by equation(3) that the circumference of the Bohr orbit of the hydrogen atom is an integral multiple of de Broglie's wavelength associated with the electron revolving around the orbit.

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Q26. Vapour pressure of C_6H_6 and C_7H_8 mixture at 50°C is given by **P (mm Hg)**

$= \mathbf{180\ X_B + 90}$, Where X_B is the mole fraction of C_6H_6. A solution is prepared by mixing 936 g benzene and 736 g toluene and if the vapours over this solution are removed and condensed into liquid and

again brought to the temperature of 50°C, what would be the new mole fraction of C_6H_6 in the vapour state?

Sol. $C_6H_6 - B,\qquad C_7H_8 - T$

$n_B = \frac{936}{78},\qquad n_r = \frac{736}{92} = 8$

$$X_B = \frac{n_B}{n_B+n_r} = \frac{12}{12+8} = 0.6$$

$P = 180\ X_B + 90$

Now $P = (P_B^0 - P_T^0)X_B + P_T^0$

$P_A^0 = 90\ mm,\qquad P_T^0 = 270\ mm$

$P_T = 0.6 \times 270,\qquad P = 180 \times 0.6 + 90$

$= 162\ mm\qquad = 198\ mm$

$$Y_B = \frac{P_B}{P} = \frac{162}{198} = \frac{9}{11}$$

Mole fraction of benzene in vapour

Now on condensation

$$X_B = Y_B\qquad X_B = \frac{9}{11}$$

$$P_B = \frac{9}{11} \times 270\ mm,\qquad P = 180 \times \frac{9}{11} + 90 = 90\left(\frac{29}{11}\right) mm$$

$X_B = \frac{P_B}{P} = \frac{\frac{9}{11}\times 270}{9\times\frac{29}{11}} = \frac{27}{29} = 0.93$

Q27. Light of frequency 7.5×10^{14} Hz is incident on a metal surface. A curve between $KE_{max}\ v/s$ incident frequency is plotted as shown. Find

(a) The stopping potential
(b) Magnitude of the slope of curve given.
(c) Intercept on x-axis

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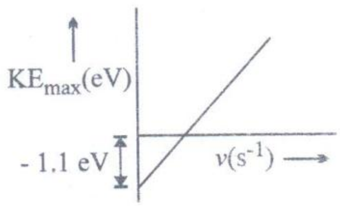

Sol. $KE_{max} = hv - hv_0$ ....(1)

$hv_0 = 1.1\ eV$ (from the given curve)

Incident energy = hv

$= 6.62 \times 10^{-34} \times 7.5 \times 10^{-14}$ J $\Longrightarrow \frac{6.62\times10^{-20}\times7.5}{1.6\times10^{-19}}\ eV \Longrightarrow 3.1\ eV$

$KE_{max} = 3.1 - 1.1 = 2\ eV$

We know that

(a) Stopping that $= KE_{max}/e$
(b) Magnitude of slope of curve $= h$

$= \frac{6.62\times10^{-34}\ JS}{1.6\times10^{-19}} \Longrightarrow 4.14510^{-15}$

(c) Intercept on x-axis = Threshold frequency

$= V_0 = \frac{1.1eV}{heV-s} = \frac{1.1}{4.14\times10^{-15}} = 2.66 \times 10^{14} Hz$

Q28. A gaseous mixture containing 49.5 ml of hydrogen chloride and H_2 gases was kept in contact with Na/Hg. The volume of mixture decreased to 42 ml. If 99.5 ml of the same mixture is mixed 49.5 ml of gaseous ammonia and then exposed to water, calculate the final volume. All measurements of volume being done under same conditions of temperature and pressure.

Sol. Volume of H_2 gas + $HCl(g) = 49.5\ mL$. When kept in contact with Na/Hg only HCl will react with Na as follows:

$$2Na \ + \ HCl \ \rightarrow \ 2NaCl9 + \ H_2$$

$$2Vol \qquad\qquad 1\,Vol$$

Reduction in volume $= 2\ Vol - 1\ Vol = 1$ Vol for 2 Vol of HCl

Actual reduction in volume $= 49.5 - 42 = 7.5\ ml$

∴ Volume of HCl present in 4935 ml mixure $= 7.5 \times 2 = 15\ ml$

Volume of $H_2 = 49.5 - 15 = 34.5\ ml$

∴ 99.5 mL of mixture would contain HCl(g) $= 15 \times \frac{99.5}{49.5} = 30\ ml$

And

When mixed with NH_3, the reaction will be:

$NH_3(g) + \ HCl(g) \rightarrow NH_4Cl(s)$

$1\ Vol$ $\quad 1\ Vol$

$30\ ml$ $\quad 30\ ml$

Residual $NH_3 = 49.5 - 30 = 19.2\ ml$

It will also dissolve in $H_2O.So$, only gas left behind is H_2 gas. Hence:

Residual $H_2 = 99.5 - 30 = 69.5\ mL$ or final volume = 69.5 ml

Q29. A mixture of ethyne (C_2H_2) and $H_2$was mixed with 65 ml of O_2 and exploded in a eudiometer tube. On cooling, it was found to have undergone a contraction of 35 ml. When treated with KOH solution, a further contraction of 34 ml took place and 15 ml of O_2 alone was left behind. Find the percentage composition of ethyne and H_2 in the mixture.

Sol. Let mixture contains $H_2 = x\ ml\ and\ C_2H_2 = y\ ml$

Reaction (i) $\quad 2H_2 \quad + \quad O_2 \quad \rightarrow \quad 2H_2O$

$2\ Vol \quad 1\ Vol \quad 2\ Vol$

Or $\quad 2C_2H_2 + 5O_2 \rightarrow \quad 4CO_2 \ + \ 2H_2O$

(ii) $\quad 2\ Vol \quad 5\ Vol \quad 4\ Vol \quad 2\ Vol$

Or $\quad yml \quad \frac{5y}{2}\ ml \quad 2yml$

From question

$2y = 34 \Longrightarrow y = 17$

And, $\frac{x}{2} + \frac{5y}{2} = 65 - 17$

$\therefore x = 15$

∴ $\quad x = 2 \times 7.5 = 15.0\ ml$

Thus, volume of $H_2 = 15.0\ mL$; volume of $C_2H_2 = 17\ ml$

∴ % age of $H_2 = \frac{Vol.of\ H_2}{Vol.of\ H_2 + Vol.of\ C_2H_2} \times 100$

$= \frac{15}{15+17} \times 100 = 46.8$

∴ % age of $C_2H_2 = 100 - 46.88 = 53.2$

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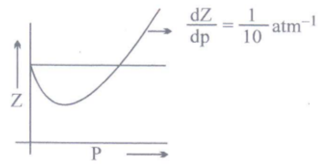
Q30. The graph of compressibility factor (Z) vs P for one mole of a real gas is shown in following diagram. The graph is plotted at constant temperature 273 K. If the slope of graph at very high pressure $\left(\frac{dZ}{dp}\right)$ is $\frac{1}{10}\ atm^{-1}$, the volume of one molecule of real gas in cm^3 is

$$\left[Given: R = \frac{22.4}{273}\ L\ atm\ K^{-1}\ mol^{-1}\ and\ N_A = 6 \times 10^{23}\right]$$



Sol. At very high pressure

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

$$\frac{dZ}{dp} = \frac{b}{RT} = \frac{1}{10} atm^{-1}$$

$$b = \frac{22.4}{273} \times \frac{273}{10} = 2.24\ litre/mole$$

$$b = 4 \times V \times N_A$$

$$V = \frac{2.24 \times 10^3}{4 \times 6 \times 10^{23}} \implies 9.3 \times 10^{-27}\ cc$$