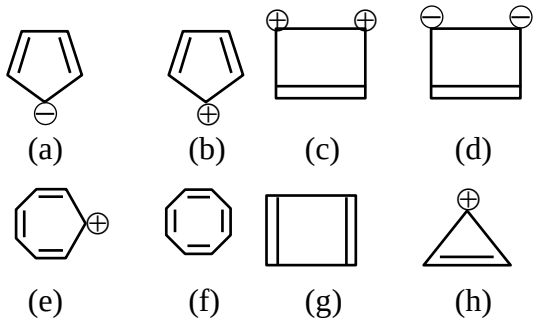
JEE–MAIN EXAMINATION – APRIL 2025

(HELD ON WEDNESDAY 2nd APRIL 2025) **TIME : 9:00 AM TO 12:00 NOON**

CHEMISTRY | TEST PAPER WITH SOLUTION

SECTION-A

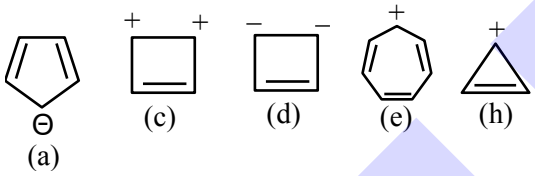
51. Designate whether each of the following compounds is aromatic or not aromatic.



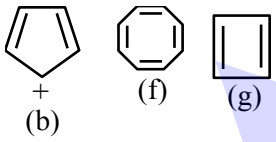
(1) e, g aromatic and a, b, c, d, f, h not aromatic
(2) b, e, f, g aromatic and a, c, d, h not aromatic
(3) a, b, c, d aromatic and e, f, g, h not aromatic
(4) a, c, d, e, h aromatic and b, f, g not aromatic

Ans. (4)

Sol. Aromatic compounds



a, c, d, e, h follow Huckel's rule



(Not Aromatic)

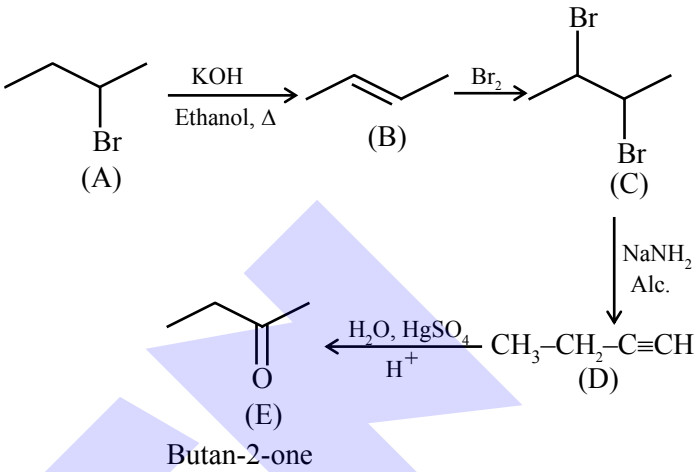
b, f, g, are not aromatic, these compounds do not follow Huckel's rule

52. An optically active alkyl halide C_4H_9Br [A] reacts with hot KOH dissolved in ethanol and forms alkene [B] as major product which reacts with bromine to give dibromide [C]. The compound [C] is converted into a gas [D] upon reacting with alcoholic $NaNH_2$. During hydration 18 gram of water is added to 1 mole of gas [D] on warming with mercuric sulphate and dilute acid at 333 K to form compound [E]. The IUPAC name of compound [E] is :

(1) But-2-yne (2) Butan-2-ol
(3) Butan-2-one (4) Butan-1-al

Ans. (3)

Sol.



Butan-2-one

53. The property/properties that show irregularity in first four elements of group-17 is/are :

(A) Covalent radius
(B) Electron affinity
(C) Ionic radius
(D) First ionization energy

Choose the **correct** answer from the options given below:

(1) B and D only (2) A and C only
(3) B only (4) A, B, C and D

Ans. (3)

Sol. The order of first four elements of group-17 are as follows.

F < Cl < Br < I (Covalent radius)

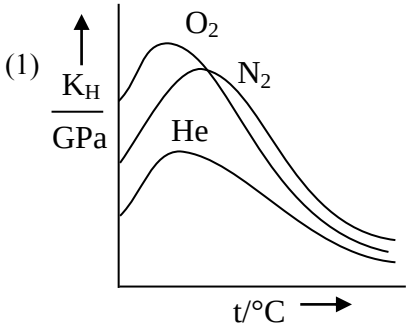
Cl > F > Br > I (Electron affinity)

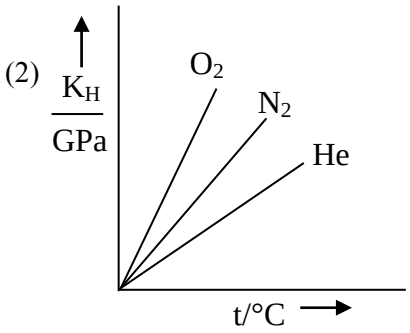
$F^- < Cl^- < Br^- < I^-$ (Ionic radius)

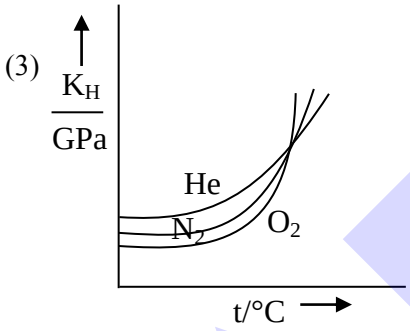
F > Cl > Br > I (I^{st} ionization energy)

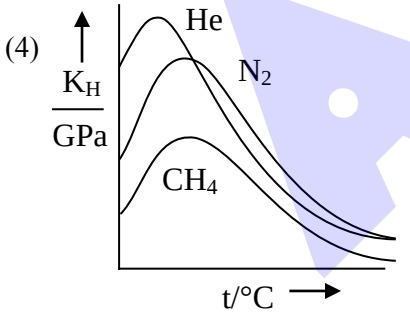
Electron affinity order is irregular.

54. Which of the following graph correctly represents the plots of K_H at 1 bar gases in water versus temperature ?

(1) 

(2) 

(3) 

(4) 

Ans. **(4)**

Sol. As temperature increases solubility first decrease then increase hence K_H first increase than decrease also at moderate temperature K_H value He > N_2 > CH_4.

55. According to Bohr's model of hydrogen atom, which of the following statement is **incorrect**?

(1) Radius of 3rd orbit is nine times larger than that of 1st orbit.

(2) Radius of 8th orbit is four times larger than that of 4th orbit.

(3) Radius of 6th orbit is three time larger than that of 4th orbit.

(4) Radius of 4th orbit is four times larger than that of 2nd orbit.

Ans. **(3)**

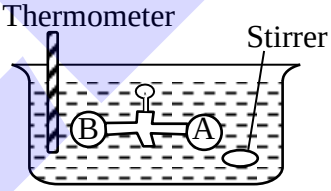
Sol. $r \propto n^2$

(1) $\frac{r_3}{r_1} = \frac{9}{1}$

(2) $\frac{r_8}{r_4} = \frac{64}{16} = 4$

(3) $\frac{r_6}{r_4} = \left(\frac{6}{4}\right)^2 = \frac{9}{4}$

(4) $\frac{r_4}{r_2} = \left(\frac{4}{2}\right)^2 = 4$

56. 

Two vessels A and B are connected via stopcock. The vessel A is filled with a gas at a certain pressure. The entire assembly is immersed in water and is allowed to come to thermal equilibrium with water. After opening the stopcock the gas from vessel A expands into vessel B and no change in temperature is observed in the thermometer. Which of the following statement is **true**?

(1) $dw \neq 0$

(2) $dq \neq 0$

(3) $dU \neq 0$

(4) The pressure in the vessel B before opening the stopcock is zero.

Ans. **(4)**

Sol. It is free expansion of gas $\Rightarrow P_{ext} = 0$

Where $w = 0$, $q = 0$ and $\Delta U = 0$

57. A solution is made by mixing one mole of volatile liquid A with 3 moles of volatile liquid B. The vapour pressure of pure A is 200 mm Hg and that of the solution is 500 mm Hg. The vapour pressure of pure B and the least volatile component of the solution, respectively, are :

(1) 1400 mm Hg, A (2) 1400 mm Hg, B

(3) 600 mm Hg, B (4) 600 mm Hg, A

Ans. **(4)**

Sol. $P_S = P_A^o.X_A + P_B^o.X_B$

$500 = 200 \times \frac{1}{4} + P_B^o.\frac{3}{4}$

$P_B^o = 600$ mm Hg

As $P_A^o < P_B^o \Rightarrow$ A is least volatile.

58. $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g)\ H_2O(l)$

Consider the above reaction, what mass of $CaCl_2$ will be formed if 250 mL of 0.76 M HCl reacts with 1000 g of $CaCO_3$?

(Given : Molar mass of Ca, C, O, H and Cl are 40, 12, 16, 1 and 35.5 g mol^{-1}, respectively)

(1) 3.908 g

(2) 2.636 g

(3) 10.545 g

(4) 5.272 g

Ans. **(3)**

Sol. $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

Moles of $CaCO_3 = \frac{1000}{100} = 10$

Moles of $HCl = 0.76 \times \frac{250}{1000} = 0.19$ (L.R.)

Moles of $CaCl_2$ formed $= \frac{0.19}{2}$

Mass of $CaCl_2 = \frac{0.19}{2} \times 111 = 10.545$ gm

59. If equal volumes of AB_2 and XY (both are salts) aqueous solutions are mixed, which of the following combination will give a precipitate of AY_2 at 300 K?

(Given K_{sp} (at 300 K) for $AY_2 = 5.2 \times 10^{-7}$)

(1) 3.6×10^{-3} M AB_2, 5.0×10^{-4} M XY

(2) 2.0×10^{-4} M AB_2, 0.8×10^{-3} M XY

(3) 2.0×10^{-2} M AB_2, 2.0×10^{-2} M XY

(4) 1.5×10^{-4} M AB_2, 1.5×10^{-3} M XY

Ans. **(3)**

Sol. When equal volumes are mixed molarity reduce to half.

For precipitation $Q_{SP} = [A^{+2}]\ [Y^-]^2 > K_{SP}$

(1) $Q_{SP} = (1.8 \times 10^{-3}) \left(\frac{5}{2} \times 10^{-4}\right)^2 < K_{SP}$

(2) $Q_{SP} = (10^{-4})\ (0.4 \times 10^{-3})^2 < K_{SP}$

(3) $Q_{SP} = (10^{-2})\ (10^{-2})^2 > K_{SP}$

(4) $Q_{SP} = \left(\frac{1.5}{2} \times 10^{-4}\right) \left(\frac{1.5}{2} \times 10^{-3}\right)^2 < K_{SP}$

60. Among SO_2, NF_3, NH_3, XeF_2, ClF_3 and SF_4, the hybridization of the molecule with non-zero dipole moment and highest number of lone-pairs of electrons on the central atom is

(1) sp^3 (2) dsp^2

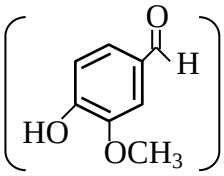
(3) sp^3d^2 (4) sp^3d

Ans. **(4)**

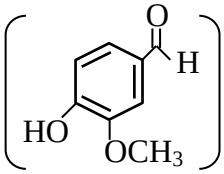
Sol.

Molecule	Hybridisation	Dipole Moment	Lone pair on the central atom
SO_2	sp^2	Non-zero	**1**
NF_3	sp^3	Non-zero	**1**
NH_3	sp^3	Non-zero	**1**
XeF_2	sp^3d	zero	**3**
$C\ell F_3$	sp^3d	Non-zero	**2**
SF_4	sp^3d	Non-zero	**1**

61. Given below are two statements :

Statement (I) : Vanillin 

will react with NaOH and also with Tollen's reagent.

Statement (II) : Vanillin 

will undergo self aldol condensation very easily.

In the light of the above statements, choose the **most appropriate answer** from the options given below :

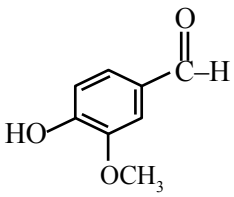
(1) **Statement I** is incorrect but **Statement II** is correct

(2) **Statement I** is correct but **Statement II** is incorrect

(3) Both **Statement I** and **Statement II** are incorrect

(4) Both **Statement I** and **Statement II** are correct

Ans. (2)

Sol. 

Phenolic group soluble in NaOH

Benzaldehyde derivative react with Tollen's reagent.

Vanillin does not give self-aldol reaction due to lack of acidic H for condensation.

62. Identify the correct statement among the following:

(1) All naturally occurring amino acids except glycine contain one chiral centre.

(2) All naturally occurring amino acids are optically active.

(3) Glutamic acid is the only amino acid that contains a –COOH group at the side chain.

(4) Amino acid, cysteine easily undergo dimerization due to the presence of free SH group.

Ans. (4)

Sol. * Isoleucine has 2 chiral centre

* Glycine is optically inactive

* Aspartic acid also contain COOH group at the side chain.

* Cysteine easily dimmerise due to free SH group

63. The correct order of basic nature on aqueous solution for the bases NH_3, $H_2N–NH_2$, $CH_3CH_2NH_2$, $(CH_3CH_2)_2NH$ and $(CH_3CH_2)_3N$ is :

(1) $NH_3 < H_2N–NH_2 < (CH_3CH_2)_3N < CH_3CH_2NH_2 < (CH_3CH_2)_2NH$

(2) $NH_3 < H_2N–NH_2 < CH_3CH_2NH_2 < (CH_3CH_2)_2NH < (CH_3CH_2)_3N$

(3) $H_2N–NH_2 < NH_3 < (CH_3CH_2)_3N < CH_3CH_2NH_2 < (CH_3CH_2)_2NH$

(4) $NH_2–NH_2 < NH_3 < CH_3CH_2NH_2 < (CH_3CH_2)_3N < (CH_3CH_2)_2NH$

Ans. (4)

Sol. Basic strength of amine depends on hydrogen bonding and electronic inductive effect.

$$NH(Et)_2 > N(Et)_3 > NH_2Et > \ddot{N}H_3 > NH_2 - NH_2$$

64. Given below are two statements :

Statement (I) : The metallic radius of Al is less than that of Ga.

Statement (II) : The ionic radius of Al^{3+} is less than that of Ga^{3+}.

In the light of the above statements, choose the **most appropriate answer** from the options given below :

(1) Both **Statement I** and **Statement II** are incorrect

(2) **Statement I** is incorrect but **Statement II** is correct

(3) **Statement I** is correct but **Statement II** is incorrect

(4) Both **Statement I** and **Statement II** are correct

Ans. **(2)**

Sol. $\Rightarrow$ The metallic radius order of Al & Ga is

$$B < \underset{\downarrow}{Ga < Al} < In < T\ell$$

(due to poor shielding of d-subshell electrons)

$\Rightarrow$ The ionic radius order of Al^{+3} & Ga^{+3} is

$B^{+3} < Al^{+3} < Ga^{+3} < In^{+3} < T\ell^{+3}$

65. Given below are two statements :

Statement (I) : In octahedral complexes, when $\Delta_o < P$ high spin complexes are formed. When $\Delta_o > P$ low spin complexes are formed.

Statement (II) : In tetrahedral complexes because of $\Delta_t < P$, low spin complexes are rarely formed.

In the light of the above statements, choose the **most appropriate answer** from the options given below :

(1) **Statement I** is correct but **Statement II** is incorrect.

(2) Both **Statement I** and **Statement II** are incorrect

(3) **Statement I** is incorrect but **Statement II** is correct

(4) Both **Statement I** and **Statement II** are correct

Ans. **(4)**

Sol. In octahedral complex (CN = 6)

If $\Delta_0 <$ P.E. , then high spin complexes are formed

If $\Delta_0 >$ P.E. , then low spin complexes are formed

But in tetrahedral complex (CN = 4)

$\Delta_t <$ P.E. , then mainly high spin complexes are formed and rarely low spin complexes are formed.

66. Choose the correct tests with respective observations.

(A) $CuSO_4$ (acidified with acetic acid) + $K_4[Fe(CN)_6] \rightarrow$ Chocolate brown precipitate.

(B) $FeCl_3 + K_4[Fe(CN)_6] \rightarrow$ Prussian blue precipitate.

(C) $ZnCl_2 + K_4[Fe(CN)_6]$, neutralised with $NH_4OH \rightarrow$ White or bluish white precipitate.

(D) $MgCl_2 + K_4[Fe(CN)_6] \rightarrow$ Blue precipitate.

(E) $BaCl_2 + K_4[Fe(CN)_6]$, neutralised with NaOH $\rightarrow$ White precipitate.

Choose the **correct** answer from the options given below :

(1) A, D and E only (2) B, D and E only

(3) A, B and C only (4) C, D and E only

Ans. **(3)**

Sol.

$$2CuSO_4 + K_4[Fe(CN)_6] \xrightarrow{CH_3COOH} \underset{\text{(Chocolate brown ppt.)}}{Cu_2[Fe(CN)_6]} + 2K_2SO_4$$

$$4FeCl_3 + 3K_4[Fe(CN)_6] \longrightarrow \underset{\text{(Prussian Blue ppt.)}}{Fe_4[Fe(CN)_6]_3} + 12KCl$$

$$3ZnCl_4 + 2K_4[Fe(CN)_6] \xrightarrow{NH_4OH} \underset{\text{(White or bluish white ppt.)}}{K_2Zn_3[Fe(CN)_6]_2} + 6KCl$$

67. On complete combustion 1.0 g of an organic compound (X) gave 1.46 g of CO_2 and 0.567 g of H_2O. The empirical formula mass of compound (X) is _____ g.

(Given molar mass in g mol^{-1} C : 12, H : 1, O : 16)

(1) 30 (2) 45 (3) 60 (4) 15

Ans. **(1)**

Sol. Moles of 'C' = $n_{CO_2} = \frac{1.46}{44} = 0.033$

Moles of 'C' = $W_C = 0.033 \times 12$

Moles of 'H' = $2 \times n_{H_2O} = 2 \times \frac{0.567}{18} = 0.063$

Mass of 'H' = 0.0063

Mass of Oxygen (O) = $1 - (W_C + W_H)$

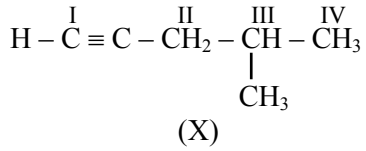
$= 1 - (0.033 \times 12 + 0.063 \times 1) = 0.541$ gm

Moles of 'O' = $\frac{0.541}{16} = 0.033$

Empirical formula = CH_2O

Empirical formula mass = 30.

68. Consider the following compound (X)



(X)

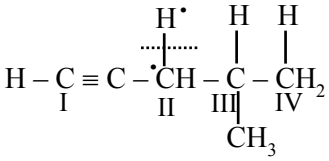
The most stable and least stable carbon radicals, respectively, produced by homolytic cleavage of corresponding C – H bond are :

(1) II, IV (2) III, II

(3) I, IV (4) II, I

Ans. (4)

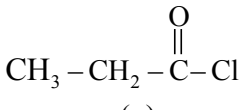
Sol.



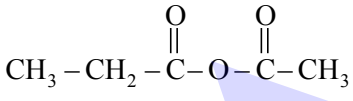
II most stable carbon radical due to resonance stablise

I least stable carbon radical due to no stabilising factor.

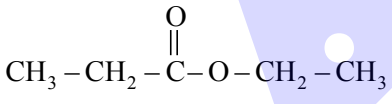
69. Consider the following molecules :



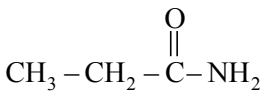
(p)



(q)



(r)



(s)

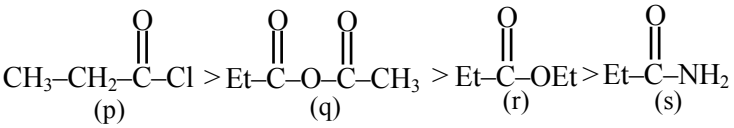
The correct order of rate of hydrolysis is :

(1) r > q > p > s (2) q > p > r > s

(3) p > r > q > s (4) p > q > r > s

Ans. (4)

Sol. Rate of hydrolysis ∝ Leaving group ability



(p) (q) (r) (s)

70. A molecule with the formula AX_4Y has all it's elements from p-block. Element A is rarest, monoatomic, non-radioactive from its group and has the lowest ionization enthalpy value among A, X and Y. Elements X and Y have first and second highest electronegativity values respectively among all the known elements. The shape of the molecule is :

(1) Square pyramidal

(2) Octahedral

(3) Pentagonal planar

(4) Trigonal bipyramidal

Ans. (1)

Sol. Given A is rarest, monoatomic, non-radioactive p-block element and form AX_4Y type of molecule.

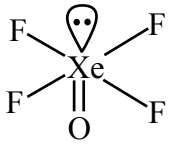
$\therefore$ It is concluded that it is Xe

It is given the electronegativity of A is less than X & Y

It is given the electronegativity of X & Y is highest and second highest respectively among all element.

$\therefore$ X & Y are F & O

$\therefore$ Compound is consider as $XeOF_4$ with square pyramidal shape.



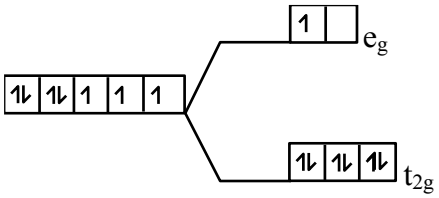
SECTION-B

71. A transition metal (M) among Mn, Cr, Co and Fe has the highest standard electrode potential (M^{3+}/M^{2+}). It forms a metal complex of the type $[M(CN)_6]^{4-}$. The number of electrons present in the e_g orbital of the complex is _____.

Ans. **(1)**

Sol. Co has highest standard electrode potential (M^{+3}/M^{+2}) among Mn, Cr, Co, Fe

$\therefore$ Complex is $[Co(CN)_6]^{4-}$ and its splitting is as follows.



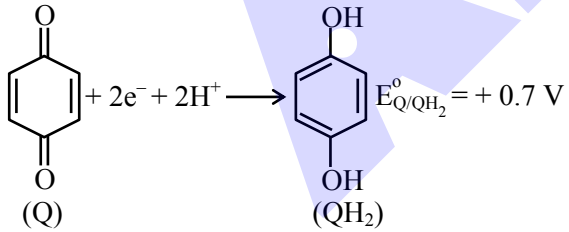
$\therefore$ electron in e_g orbital is one.

72. Consider the following electrochemical cell at standard condition.

$Au(s)|QH_2,Q|NH_4X(0.01M)||Ag^+(1M)|Ag(s)$

$E_{cell} = +0.4V$

The couple QH_2/Q represents quinhydrone electrode, the half cell reaction is given below



$$\left[\text{Given : } E^{o}_{Ag^+/Ag} = +0.8V \text{ and } \frac{2.303RT}{F} = 0.06V\right]$$

The pK_b value of the ammonium halide salt (NH_4X) used here is _____. (nearest integer)

Ans. **(6)**

Sol. $QH_2 + 2Ag^+ \rightarrow 2Ag + Q + 2H^+$

$$E = E° - \frac{0.06}{2}\log[H^+]^2$$

$$E = E° - 0.06 \times \log[H^+]$$

$$pH = -\log(H^+) = \frac{E - E^o}{0.06} = \frac{0.4 - 0.1}{0.06}$$

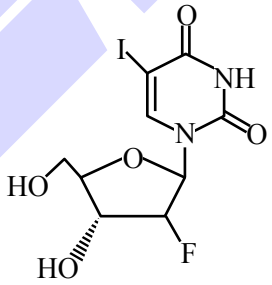
$$= \frac{0.3}{0.06} = 5$$

$$pH + NH_4X = 7 - \frac{1}{2}pK_b - \frac{1}{2}\log C$$

$$5 = 7 - \frac{1}{2} \times pK_b - \frac{1}{2}\log(10^{-2})$$

$pK_b = 6.$

73. 0.1 mol of the following given antiviral compound (P) will weigh _____ $\times 10^{-1}$ g

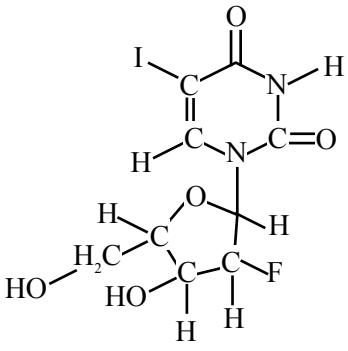


(P)

(Given : molar mass in g mol^{-1} H: 1, C : 12, N : 14, O : 16, F : 19, I : 127)

Ans. **(372)**

Sol.



Molar mass = 372 gm

$\therefore$ 0.1 mole has = 372 $\times 10^{-1}$ gm

74. Consider the following equilibrium,

$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

0.1 mol of CO along with a catalyst is present in a 2 dm^3 flask maintained at 500 K. Hydrogen is introduced into the flask until the pressure is 5 bar and 0.04 mol of CH_3OH is formed. The K_p^0 is _____ $\times 10^{-3}$ (nearest integer).

Given : R = 0.08 dm^3 bar K^{-1} mol^{-1}

Assume only methanol is formed as the product and the system follows ideal gas behaviour.

Ans. (74)

Sol.

	$CO(g)$	$+ 2H_2(g)$	$\rightleftharpoons CH_3OH(g)$
t = 0	0.1 mol	a mol	–
t_{eq}	0.1 – x	a – 2x	x = 0.04
	= 0.06	= a – 0.08	
		= 0.23 – 0.08	
		= 0.15 mole	

V = 2L

T = 500 K

P_{total} = 5 bar

$n_{Total} = 0.25 = \frac{1}{4}$ mol.

$P_{total} = n_{total} \times \frac{RT}{V}$

$\Rightarrow 5 = (0.06 + a - 0.08 + 0.04) \times \frac{0.08 \times 500}{2}$

$\Rightarrow 10 = (0.02 + a) \times 0.08 \times 500$

$\Rightarrow a = 0.25 - 0.02 = 0.23$ mol.

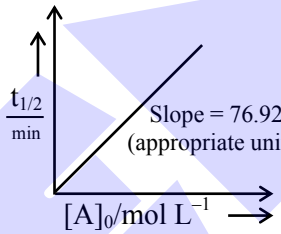
$$K_P = \frac{X_{CH_3OH}}{X_{CO} \times X_{H_2}^2} \times \frac{1}{(P_T)^2} = \frac{0.04}{0.06 \times (0.15)^2} \times \left[\frac{1/4}{5}\right]^2$$

$$= \frac{4}{6 \times (0.15)^2 \times 16} \times \frac{1}{25}$$

$$= \frac{100 \times 100}{24 \times 225 \times 25} = \frac{100 \times 100}{135000}$$

$= 0.074 = 74 \times 10^{-3}$

75. For the reaction A $\rightarrow$ products.



The concentration of A at 10 minutes is _____ $\times 10^{-3}$ mol L^{-1} (nearest integer).

The reaction was started with 2.5 mol L^{-1} of A.

Ans. (2435)

Sol. $t_{1/2} \propto [A]_0 \Rightarrow$ Order = zero

$t_{1/2} = \frac{A_0}{2K} \Rightarrow$ Slope $= \frac{1}{2K} = 76.92$

$K = \frac{1}{2 \times 76.92}$

$[A]_{10} = -Kt + A_0 = -\frac{1}{2 \times 76.92} \times 10 + 2.5 = 2.435$

$= 2435 \times 10^{-3}$ mol/L

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