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Answer Sheet No.____________

Sign. of Candidate ___________

Sign. of Invigilator ___________

CHEMISTRY HSSC–I

SECTION – A (Marks 17)

Time allowed: 25 Minutes

Section – A is compulsory. All parts of this section are to be answered on this page and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. **Do not use lead pencil.**

Q.1 Fill the relevant bubble for each part. Each part carries one mark.

1. Plasma is the mixture of:
   A. Electrons and protons only. ○
   B. Electrons and positive ions. ○
   C. Electrons and beta two particles. ○
   D. Neutrons and protons. ○

2. The electrode potential of metals are:
   $Mg^{2+} + 2e^- \longrightarrow Mg$ E° = - 2.71 v
   $Ag \longrightarrow Ag^+ + 1e^-$ E° = - 0.8 v
   Cell potential (emf) of the cell formed by these two will be:
   A. + 3.51 v ○ B. -3.51 v ○
   C. + 1.91 v ○ D. – 1.91 v ○

3. At constant Pressure what will be the change in temperature when the volume of a gas will become twice of what it is at 0°C?
   A. 546°C ○ B. 200°C ○
   C. 546 K ○ D. 273 K ○

4. Rate equation for a reaction $2A \longrightarrow$ product is Rate = K $[A]^2$. Unit of specific rate constant for this reaction is:
   A. $mol^2dm^{-6}\ S^{-1}$ ○ B. $mol^{-1}dm^3\ S^{-1}$ ○
   C. $moldm^{-3}$ ○ D. S^{-1} ○

5. A substance which itself is not a catalyst but increases the activity of a catalyst is called:
   A. Enzyme ○ B. inhibitor ○
   C. Promoter ○ D. Poisoner ○

6. Diamond is a bad conductor of electricity because:

A. It has a tight structure ◯ B. It has a high density ◯

C. It has no free electrons ◯ D. It is transparent to light ◯

7. Mixture containing 0.01 mole/300cm^3 of NH_4Cl and 0.1 mole/400cm^3 of NH_4OH having pKb = 5 has pH of:

A. 4.00 ◯ B. 4.12 ◯

C. 9.88 ◯ D. 10.00 ◯

8. 5g of urea (M.wt = 60) is dissolved in 250 cm^3 of its solution. Concentration of solution will be:

A. 5 % w/w ◯ B. 5 % v/w ◯

C. 0.34 M ◯ D. 0.34m ◯

9. The gaseous element X exists in diatomic form. One volume of the element X combines with two volume of hydrogen to form two volume of gaseous hydride. What is the formula of hydride of X.?

A. HX_2 ◯ B. HX_3 ◯

C. H_2X ◯ D. HX ◯

10. The number of bonds in one molecule of Nitrogen is:

A. one σ and one π ◯ B. one σ and two π ◯

C. three σ only ◯ D. two σ and one π ◯

11. Splitting of spectral lines by placing the excited atom in electric field is called:

A. Zeeman effect ◯ B. Stark effect ◯

C. Photoelectric effect ◯ D. Compton effect ◯

12. In the ground state of an atom, the electron is present:

A. in the valence shell ◯ B. in the second shell ◯

C. nearest to the nucleus ◯ D. farthest from the nucleus ◯

13. Which one of the following exists in the solid state as a giant covalent lattice?

A. ice ◯ B. iodine ◯

C. silicon (IV) oxide ◯ D. dry ice ◯

14. pH of 1×10^{-4} M solution of Phosphoric acid is:

A. 1.10 ◯ B. 2.02 ◯

C. 3.52 ◯ D. 4.13 ◯

15. In which substance does nitrogen exhibit the highest oxidation state?

A. NO ◯ B. N_2O ◯

C. N_2O_4 ◯ D. $NaNO_2$ ◯

16. The heat of neutralization of the given reaction is -57.3 kJ

$NaOH + HCl \longrightarrow NaCl + H_2O$

What is the heat of neutralization of the following reaction?

$Fe(OH)_2 + 2HCl \longrightarrow FeCl_2 + 2H_2O$

A. -57.3kJ ◯ B. -114.6kJ ◯

C. -228kJ ◯ D. -28.6kJ ◯

17. Which of these samples of gas contains the same number of atoms as 1g of hydrogen molecule? (At. Mass C = 12, O = 16, H = 1, Ne = 20)

A. 22 g of CO_2 ◯ B. 8 g of CH_4 ◯

C. 20 g of Ne ◯ D. 8 g of O_3 ◯

Federal Board HSSC-I Examination
Chemistry Model Question Paper
(Curriculum 2006)

MCQ'S KEY

i B	**ii A**	**iii C**	**iv B**	**v C**	**vi C**	**vii C**	**viii C**	**ix C**	**x B**
xi B	**xii C**	**xiii C**	**xiv C**	**xv C**	**xvii B**	**xvii C**			

Q. No. 2(i): The bond angles of H_2O and NH_3 are not 109.5° like that of CH_4. Although O and N atoms are SP^3hybridized like C. Give reason.

Ans: Bond angle in NH_3 is 107.5°. This is due to lone pair, bond pair repulsion is greater than bond pair, bond pair repulsion. So bond angle is reduced to 107.5° although there is sp^3 hybridization in N. Bond angle in H_20 is 104.5°. This is due to lone pair, lone pair repulsion is greater than lone pair, bond pair repulsion. So bond angle is reduced to 104.5° although there is sp^3 hybridization in oxygen. CH4 has no lone pair. So bond angle is 109.5° and C is sp3 hybridized.

Q. No. 2(ii) As both NF_3 and BF_3 are tetra atomic molecules but have different shape and geometry. Explain according to VSEPR theory.

Ans: NF_3, N $1s^2$, Valence Shell

[↑↓] [↑ | ↑ | ↑] [$2s^2$, $2p^3$]

2s 2px 2py 2pz

Total electron pair Lone pair Bond pair

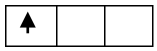
4 1 3

Shape of NF3 is trigonal pyramidal with angle 107.5°. This is due to one lone pair and three bond pair while in BF_3

${}_5B$ $1S^2$, $2s^2$, $2p^1$ Valence Shell

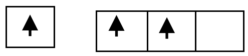
Ground state

[↑↓]



2s 2px 2py 2pz

Excited state



Total electron pair	Lone pair	Bond pair
3	0	3

Shape is trigonal due to three bond pair and no lone pair. Bond angle is 120°.

Q. No. 2(iii) Ionic Crystals are brittle in nature but metals are malleable in nature. Give reason of your answer.

Ans: It is because ionic solid consist of parallel layers in which cations and anions are present in alternate positions. Thus, when a stress is applied on crystal one layer of ions slides a little bit over the other layer. In this way like ions come in front of each other, which repel each other and thus a crystal is broken and show brittleness. When stress is applied on metal then layer slip over each other and their shape is changed. Hence they can be changed into sheets malleable or were ductile without breaking.

Q. No. 2(iv) Derive the units for general gas constant 'R' in general gas equation.

a. **When the pressure is in Nm^{-2} and volume in m^3.**

b. **When energy is expressed in ergs.**

Ans: PV= nRT

$$\frac{PV}{nT} = R$$

$$R = \frac{1.01 \times 10^5 N/m^2 \times 0.022414 m^3}{1\ mole \times 273\ K}$$

R = 8.314Nm $mol^{-1}k^{-1}$

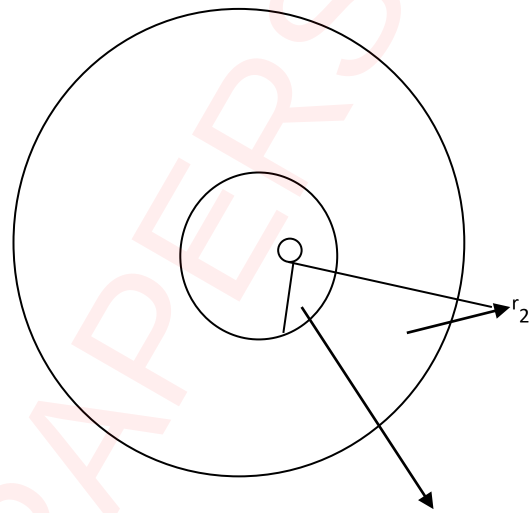
R = 8.314 J $mole^{-1}k^{-1}$

I J = 10^7 erg

8.314 J = 8.314 × 10^7 erg $mol^{-1}k^{-1}$

$R = 8.314 \times 10^7$ erg $mol^{-1}k^{-1}$

Q. No. 2(v) Justify that the distance gaps between different orbits of an atom go on increasing from the lower to the higher orbits



Ans: For H

Z=1

If n=1 ⟹ K shell

$r_1 = 0.529$ A°$\times n^2$

$r_1 = 0.529$ A°

If n=2 ⟹ L shell

$r_2 = 0.529$ A°$(2)^2 = 0.529 \times 4$

$r_2 = 2.116$ A°

If n=3 ⟹ M shell

$r_3 = 0.529\ (3)^2$

$r_3 = 0.529 \times 9$

$r_3 = 4.761$ A°

This shows that as n is increased gap between the orbits is also increased.

Q. No. 2(vi) Describe hybridization in acetylene (C_2H_2) molecule. Also draw diagram of hybridized orbitals in this molecule.

Ans: C_2H_2

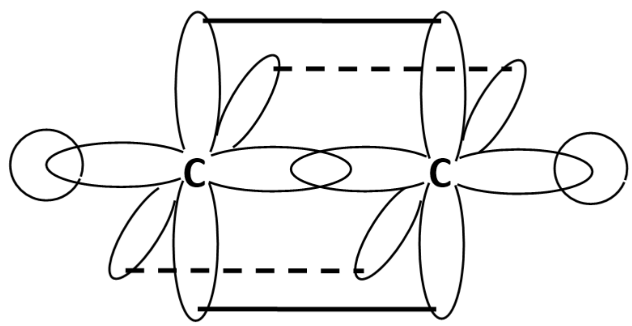
$_6C$ $1s^2, 2s^2, 2p^2$

Ground State

Excited State

2ps 2px 2py 2pz non hybridization orbital's

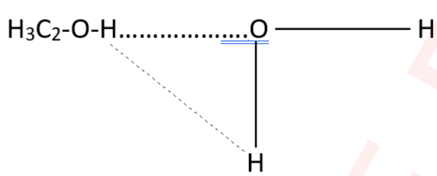
Sp hybridization



These are four hybrid orbital's. One δ bond is formed due to sp-sp end to end overlap. Two δ bonds are formed due to sp-1s end to end overlap. One π bond is formed due to 2py-2py lateral overlap. One π bond is formed due to 2pz-2pz lateral overlap.

Q. No. 2(vii) Interpret why water and ethanol can mix easily in all proportions.

Ans: Water and ethanol are mixed in all proportion. This is due to the hydrogen bonding this between water and ethanol. Oxygen attains partial negative charge (-δ) and hydrogen attain partial positive charge (+δ). Hence H-bonding is formed in between ethanol and water. Secondly both exist in liquid state



Q. No. 2(viii) Justify that Bohr's equation for the wave number can explain the spectral lines of Lyman, Balmer and Paschen series.

Ans: From Bohr's wave number equation

$$\bar{\gamma} = 1.0967 \times 10^{7} m^{-1}\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

For Lyman's series $n_1 = 1$

$$\bar{\gamma} = 1.0967 \times 10^{7} m^{-1}\left[\frac{1}{1^2} - \frac{1}{n_2^2}\right]$$

Where $n_2 = 2, 3, 4.....$

For Bulmer's series

$\bar{\gamma} = 1.0967 \times 10^7 m^{-1}\left[\frac{1}{2^2} - \frac{1}{n_2^2}\right]$

Where $n_2 = 3, 4, 5.....$

For Paschalis Series

$\bar{\gamma} = 1.0967 \times 10^7 m^{-1}\left[\frac{1}{3^2} - \frac{1}{n_2^2}\right]$

Where $n_2 = 4, 5, 6.....$

Hence Bohr's equations justify the Lyman's, Bulmer's and Paschen's series.

Q. No. 2(ix) State Dalton's law. Also write its two applications.

Ans: Sum of the partial pressure of the non-reacting gases is equal to the total pressure of the gases

$P_t = P_1 + P_2 + P_3 + ...$

Where P_1, P_2 and P_3 are the partial pressure of the gases and pt is the total pressure of the gases.

Applications:

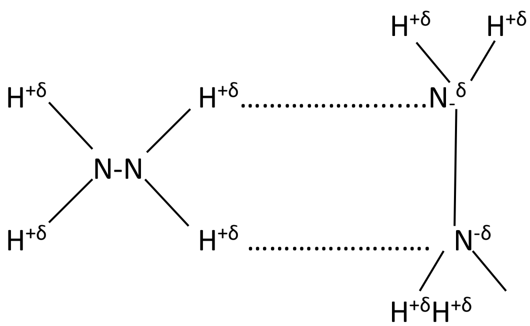
1. When gas is collected over vapors of water then

   $P_{gas} = P_{total} - P_{H2O}$

Where P_{H2O} is called aqueous tension. The respiration in living things depends upon the difference in partial pressure. Partial pressure of O_2 outside is 159g/cm^2 than in lungs, where the pressure is 116 g/cm^{2}at higher altitudes becomes 150g/cm^{2}so pilot may have uncomfortable breathing.

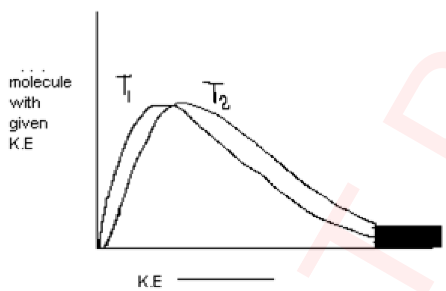
Q. No. 2(x)The melting and boiling points of hydrazine (N_2H_4) are much higher than those of ethane (C_2H_4). Suggest reasons for these differences in terms of the intermolecular forces each compound possesses.

Ans: N_2H_4 has lone pair and H- bonding. So M.P and B.P of N_2H_4 is much greater while in ethane C_2H_6 there is weak London dispersion force. So B.P is very low. B.P of C_2H_6 is -88.6°C



H-bonding

Q. No. 2(xi) Consider this graph and explain on the basis of Maxwell Boltzmann curve of kinetic energy why does rate of reaction increase with the increase in temperature.



Ans: Effective collisions bring about the reaction. For a collision to be effective molecules must posses the activation energy and must be properly oriented. At ordinary temperature very few molecules possess this energy of activation. All the molecules of a reactant do not possess the same energy at a particular temperature. Most of them possess average energy. A fraction of molecules has kinetic energy more than the average energy. The number of molecules having at least kinetic energy equal to Ea at temperature T in proportional to the shaded area under the Maxwell Boltzmann curve of kinetic energy. As the temp is increased the area of the shaded region increases and more molecules have kinetic energy greater than Ea. An increase in temp increase the number of reactant molecules that have enough energy for effective collision.

Q. No. 2(xii)An aqueous solution of ammonium Chloride is acidic and that of sodium acetate is basic in nature. Give reason with the help of equations.

Ans: $NH_4Cl + H\text{-}OH \longrightarrow HCl + NH_4OH$

Strong acid   weak base

On hydrolysis of NH4Cl, strong acid HCl is produced. Hence ammonium chloride aqueous solutions is acid PH<7

$CH_3COONa + H\text{-}OH \longrightarrow CH3COOH + NaOH$

CH3COOH: Weakened NaOH: Strong base

On hydrolysis of CH_3COONa, strong base NaOH is produced. Hence sodium acetate aqueous solution is basic in nature PH>7

Q. No. 2(xiii)Calculate molarity of aqueous solution of sulfuric acid from the following data.

Molar mass	Molarity	Density in g/Cm^3
98	**18**	**1.84**

Ans: Molarity = 18 mol/dm^3= 18 mol/ 1000cm^3

Density = 1.84 cm^{-3}

d = $\frac{m}{v}$

m = d × v

m = 1.84 × 1000

m = 1840 g H_2SO_4

Mass of H_2SO_4 = Mole × Molar mass

Mass of H_2SO_4 = 18 × 98 = 176 g H_2SO_4

Mass of water = 1840 – 1764 = 76 g H_2O

Molarity = $\frac{Mole \times 1000}{Mass\ of\ H2O}$

Molarity = $\frac{18 \times 1000}{76}$

Molarity = 236.84m

Q. No. 2(xiv)Lattice energies of LiCl and KCl are 833 kJ/mol and 690 kJ/mol, respectively. Discuss why is lattice energy of LiCl greater than KCl?

Ans: Size of Li^+ is smaller than size of K^+ hence force of attraction between Li^+ and Cl^{-1} is much greater as compare to force of attraction between K^+ and Cl^{-1}. These force lattice energy of LiCl is Q33kJ/mol while that of KCl is 690kJ/mol

$LiCl(s) \longrightarrow Li^+ + Q^- (g)$

$KCl(s) \longrightarrow K^+ + Q^-(g)$

Size of Li^+< size of K^+

Q. No. 2(xv)Benzene (C_6H_6) is an aromatic hydrocarbon which exists as a liquid at room temperature.

Using the following standard enthalpy changes:

Heat of formation of CO_2 = -393 KJ / mol

Heat of formation of H_2O = -286 KJ / mol

Heat of combustion of C_6H_6 = -3268 KJ / mol

Calculate the enthalpy change of formation of C_6H_6.

Ans:

$C_6H_6 + \frac{15}{2} O_2 \longrightarrow 6CO_2 + 3H_2O$ $\Delta H1 = -3268$ kJ/mol

For formation reverse the equation

(i) $6CO_2 + 3H_2O \longrightarrow C_6H_6 + \frac{15}{2} O_2$ $\Delta H_1 = +3268$ kJ/mol

(ii) $6C + 6O_2 \longrightarrow 6CO_2$ $\Delta H_2 = -393 \times 6$

(iii) $3H_2 + \frac{3}{2} O_2 \longrightarrow 3H_2O \Delta H_3 = -286 \times 3$

Adding above equation

$6C + 3H_2 \longrightarrow C_6H_6$

From Hisses Law

$\Delta H_f = \Delta H_1 + \Delta H_2 + \Delta H_3$

$\Delta H_f = +3258 - 2358 - 858$

$\Delta H_f = 52$kJ/mol

Q. No. 2(xvi)Consider the Standard electrode potentials

$Ag^+ / Ag = 0.7994V$, $Fe^{3+} / Fe = 0.771V$

Write the half-cell reactions at each electrode. Also write overall reaction

Ans: $E_{cell} = E_{cahode} - E_{anode}$

$E_{cell} = 0.7994 - 0.771$

E_{cell} = +0.02Q4

At cathode Reduction

$(Ag^+ + e^- \longrightarrow Ag) \times 3$

At Anode Oxidation

$Fe \longrightarrow Fe^{+3} + 3e^-$

$3Ag^+ + Fe \longrightarrow 3Ag + Fe^{+3}$

Overall reaction

Q. No. 2(xvii) Chemical kinetics is concerned with rates of chemical reactions and factors that affects the rates of chemical reactions. Consider the following steps of reactions:

$FeCl_3 (aq) + 2KI (aq) \longrightarrow FeI_2 (aq) + 2KCl (aq) + Cl^- (aq)$ (slow)

$2KI(aq) + 2Cl^- (aq) \longrightarrow 2KCl(aq) + I_2(S)$ (fast)

a. Write the rate expression for the above reaction.

b. Give the order of reaction for the above reaction.

Ans:

a. Rate Law expression
   Rate = K $[FeCl_3][KI]^2$
b. Order of reaction = 1 + 2

   Order of reaction = 3rd order reaction

Q. No. 2(xviii) What is reverse osmosis? Give its daily life applications.

Ans: If a solution in contact with pure solvent across a semi permeable membrane is subjected to an external pressure equal to osmotic pressure, it stops osmosis. If external pressure is greater than solutions osmotic pressure, it will force solvent to flow from solution to solvent. This process is called reverse osmosis.

Daily life application of reverse osmosis:

Sea water is highly hypertonic to body fluids and this is not drinkable. By reverse osmosis it is subjected to desalination i.e remove large amounts dissolve salts from sea water. The sea water is pumped under high pressure 20 atm through the semi permeable membrane, which allow water molecules to pass and stop ions.

Q. No. 2(xix)How to calculate the molecular mass of the solute by using $\Delta P/P^0 = X_2$?

Ans: From Roult's Law

$\frac{\Delta P}{P^\circ} = X_2$ ⟶ Eq (1)

Since $X_2 = \frac{n_2}{n_1+n_2}$

Where n_2 is the mole of solute. Neglect the n_2 from denominator for dilute solution.

$X_2 = \frac{n_2}{n_1}$

$n_1 = \frac{W_1}{M_1}$

$n_2 = \frac{W_2}{M_2}$

Put in above equation

$X_2 = \frac{W_2}{M_2} \times \frac{M_1}{W_1}$

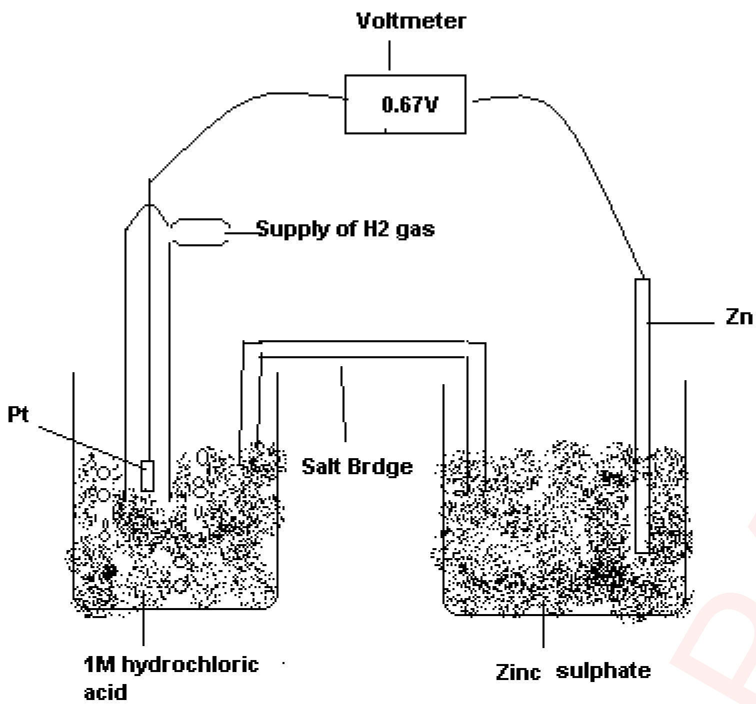
Put in eq 1

$\frac{\Delta P}{P^\circ} = \frac{W_2 \times M_1}{M_2 \times W_1}$

$M_2 = \frac{P^\circ}{\Delta P} \times \frac{W_2 M_1}{W_1}$

Q. No. 2(xx)How to calculate standard electrode potential? Explain briefly.

Ans: Standard hydrogen electrode is used to know the electrode potential. It is made up of platinum wire, which is sealed in glass tube. It is dipped in 1MHCl solution. H_2 gas is introduced from the top. Oxidation as well as reduction potential of hydrogen is zero. So voltmeter shows the electrode potential of the required element.



At anode Zn $\longrightarrow$ $Zn^{+2} + 2e^-$ $E^\circ_{oxi} = ?$

At cathode $2H^+ + 2e^-$ $\longrightarrow$ H_2 $E^\circ_{Red} = 0.00V$

$Zn + 2H^+ \longrightarrow Zn^{+2} + H_2$ $E^\circ_{cell} = 0.76V$

$E^\circ_{cell} = E^\circ_{oxi} + E^\circ_{Red}$ from voltmeter

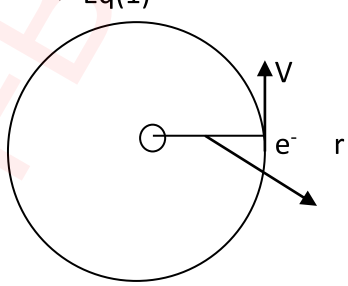
$0.76V = E^\circ_{oxi} + 0.00$

$E^\circ_{oxi} = 0.76V$

Q. No. 3 (a)Derive the equation for the radius of nth orbit of hydrogen atom using Bohr's model.

Ans: Electrons revolve around the nucleus in circular path. So centrifugal force is given by

$F = \frac{mv^2}{r}$ $\longrightarrow$ Eq(1)



Coulomb’s force of attraction between electron and proton in given by

$$F = \frac{Kq_1q_2}{r^2}$$

Where r_1= ƶe and $q_2 = e^-$ $K = \frac{1}{4\pi €_\circ}$

$€_\circ$ is the primitivity constant of the vacuum

$€_\circ = 8.85 \times 14^{-12}\ C^2\ N^{-1}\ m^{-2}$

Put in above eq

$$F = \frac{Zee}{4\pi €_\circ r^2}$$

$$F = \frac{Ze^2}{4\pi €_\circ r^2} \longrightarrow \text{Eq(2)}$$

Where Z is the atomic number

These two forces are equal. So by comparing Eq(1) and Eq(2)

$$\frac{mv^2}{r} = \frac{Ze^2}{4\pi €_\circ r^2}$$

$$V^2 = \frac{Ze^2}{4\pi €_\circ rm} \longrightarrow \text{Eq(3)}$$

From Bohr’s postulate angular momentum is given by

$$mvr = \frac{nh}{2\pi}$$

Where n is the principal quantum number

n = 1, 2, 3……..

Shell K L M

h = plank’s constant

$h = 6.625 \times 10^{-34}$

m is the mass of electron

v is the velocity of electron

r is the radius

$v = \frac{nh}{2\pi mr}$

Squaring both sides

$v^2 = \frac{n^2h^2}{4\pi^2m^2r^2}$ ⟶ Eq(4)

By comparing Eq(3) and Eq(4)

$\frac{Ze^2}{4\pi\epsilon_\circ rm} = \frac{n^2h^2}{4\pi^2m^2r^2}$

$\frac{Ze^2}{\epsilon_\circ} = \frac{n^2h^2}{\pi mr}$

$r = \frac{n^2h^2\epsilon_\circ}{\pi mZe^2}$

$r = \frac{h^2\epsilon_\circ}{\pi mZe^2} \times \frac{n^2}{Z}$ ⟶ Eq(5)

Let $a° = \frac{h^2\epsilon_\circ}{\pi me^2}$

$a° = \frac{(6.625 \times 10^{-34})^2(8.85 \times 10^{-12})}{3.14 \times 9.1 \times 10^{-31} \times (1.6 \times 10^{-19})^2}$

$a_\circ = 0.529 \times 10^{-10}$

$a_\circ = 0.529$ A°

Put in Eq(5)

$r = a° \times \frac{n^2}{z}$

$r = 0.529$ A° $\times \frac{n^2}{z}$

For hydrogen $z = 1$

$r = 0.529$ A° $\times n^2$

(b)Ammonia Solvay process is used to manufacture sodium carbonate. During this process ammonia is recovered by the following reaction.

$2NH_4Cl + Ca(OH)_2 \longrightarrow CaCl_2 + 2H_2O + 2NH_3$

When 100 g of ammonium chloride and 150 g calcium hydroxide are used then

(At. Mass N=14 H=1 Cl= 35.5 Ca=40)

i. **Calculate the mass in kg of ammonia produce during chemical reaction.**

ii. **Calculate the excess mass in gram of one of the reactant left unreacted.**

Ans:

Mass of NH_4Cl = 100g

Molar mass of NH_4Cl = 14+1×4+35.5

Molar mass of NH_4Cl =53.5g/mol

Molar of NH_4Cl = $\frac{Mass\ in\ gram}{Molar\ mass}$

Molar of NH_4Cl = $\frac{100}{53.5}$

Molar of NH_4Cl =1.87 mole of NH_4Cl

From equation

2moles of NH_4Cl = 2 moles of NH_3

1.87 moles of NH_4Cl = x

$= \frac{2}{2} \times 1.87$

= 1.87 moles of NH_3

Mass of $Ca(OH)_2$ = 150g

Molar mass of $Ca(OH)_2$ = 40+16×2+1×2

Molar mass of $Ca(OH)_2$ = 74 g/mol

Molar of $Ca(OH)_2$=$\frac{Mass\ in\ gram}{Molar\ mass}$

Molar of $Ca(OH)_2$=$\frac{150}{74}$

Molar of $Ca(OH)_2$= 2.03 moles of $Ca(OH)_2$

From equation

1 mole of $Ca(OH)_2$= 2 moles of NH_3

2.03 moles of $Ca(OH)_2$= x

x = 2 × 203

x = 4.06 moles of NH_3

Since NH_4Cl produces the least amount of NH_3. So NH_4Cl is the limiting reactant.

Mass of NH_3 = mole × molar mass of NH_3

Mass of NH_3 = 1.87 × 17

Mass of NH_3 = 31.97 g NH_3

Mass of NH_3 = $\frac{31.97}{1000}$

Mass of NH_3 = 0.03197 Kg of NH_3

(ii) From equation

2 moles of NH_4Cl = 1 mole of $Ca(OH)_2$

1.87 moles of NH_4Cl = x

x = $\frac{1.87 \times 1}{2}$

x = 0.935 moles of $Ca(OH)_2$used

$Ca(OH)_2$left = 2.03 – 0.935

$Ca(OH)_2$ = 1.095 moles of $Ca(OH)_2$left

Mass of $Ca(OH)_2$left = mole × molar mass

Mass of $Ca(OH)_2$left = 1.095 × 74

Mass of $Ca(OH)_2$left = Q1.03 g $Ca(OH)_2$left

Q. No. 4Consider the following reaction:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) Derive expression of Kc for the above reaction and calculate equilibrium concentration of N_2. The equilibrium concentration of H_2 and NH_3 are 1.0 moldm^3 and 0.5 moldm^{-3} respectively. Kc of above reaction at 25℃ is 1.85 ×10^3.

Ans:

$N_2 + 3H_2 \rightleftharpoons NH_3$

At t = 0

a/v mol/dm^3 b/v mol/dm^3

$$\frac{a-x}{v}\frac{b-3x}{v}\frac{2x}{v}$$

K_c is written as

$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$

By putting respective values.

$K_c = \frac{\left[\frac{2x}{v}\right]^2}{\left[\frac{a-x}{v}\right]\left[\frac{b-x}{v}\right]^3}$

$K_c = \frac{4x^2}{(a-x)\frac{(b-3x)^3}{v^4}}$

$K_c = \frac{4x^2v^2}{(a-x)(b-3x)^3}$

K_c = 1.85 ×10^3 V = 1dm^3

Equilibrium concentration

$[H_2]$ = 1.0 mole/dm^3

$[NH_3]$= 0.5 mole/dm^3

$[NH_3]$= 2x = 0.5

x = $\frac{0.5}{2}$

x = 0.25 mole/dm^3

$[N_2]$ = a-x

$K_c = \frac{4x^2v^2}{(a-x)(b-3x)^3}$

1.85 ×10^3= $\frac{4(0.25)^2 \times 1}{(a-x)\times(1)^3}$

$(a - x)$ = $[N_2]$ = $\frac{4(0.25)^2}{1.85 \times 10^3}$

$[N_2]$ = 1.35×10^{-4}mole/dm^3

Equilibrium concentration of N_2

Q. No. 4 (b)Balance the following chemical equation in an acidic medium

$$Cr^{3+} + BiO_3^{1-} \longrightarrow Cr_2O_7^{2-} + Bi^{3+}$$

Ans:

Cr^{+3} + BiO_3^{-1} ~~$Cr_2O_7^{2-}$~~ $\rightarrow$ + BC^{3+}

Step 1 write Oxidation number

Cr^{+3} + $[Bi^{+5}O_3^{-2\times3}]^{-1} \longrightarrow [Cr_2^{+6\times2}O_7^{-2\times7}]^{2-}$+ BiC^{3+}

Steps 2 write half oxidation reaction. Balance e$^-$

$2Cr^{+3} \longrightarrow [Cr_2^{+6\times2}O_7^{-2\times7}]^{2-}$ + 6e$^-$

Step 3 Balance oxygen by adding 7$H_2$0 on LHS

$2Cr^{+3} + 7H_20 \longrightarrow Cr_2O_7^{2-} + 6e^- + 14H^+$ **Eq(1)** ⟶

Steps 4 write half reduction reaction. Balance the e^-

$[Bi^{+5}O_3^{-2\times3}]^{-1} + 2e^- \; Bi^{3+} \longrightarrow$

Step 5 Balance oxygen by adding $3H_20$ on RHS

$BiO_3^{-1} + 3e^- + 6H^+ \longrightarrow Bi^{3+} + 3H_20$ **Eq(2)** ⟶

Step 6 Balance the electrons by Xing Eq(2) by '2' and then add in Eq (1)

$2Cr^{+3} + 7H_20 \longrightarrow Cr_2O_7^{2-} + 6e^- + 14H^+$

$2BiO_3^{-1} + 6e^- + 12H^+ \longrightarrow 2Bi^{3+} + 6H_20$

$2Cr^{+3} + 7H_20 + 2BiO_3^{-1} \longrightarrow Cr_2O_7^{2-} + 14H^+ + 2Bi^{3+}$

Balanced equation.

Q. No. 5 (a)Phosgene ($COCl_2$) is a toxic gas. This gas is prepared by the reaction of carbon monoxide with chlorine.

$CO\ (g) \; + \; Cl_2\ (g) \longrightarrow COCl_2\ (g)$

The following data were obtained for kinetic study of this reaction.

Experiment	**Initial [CO]**	**Initial [Cl_2]**	**Initial rate (moles $dm^{-3}\,s^{-1}$)**
1	**1.000**	**0.100**	**1.29×10^{-29}**
2	**0.100**	**0.100**	**1.30×10^{-30}**
3	**0.100**	**1.000**	**1.30×10^{-30}**

Use the data in the table to deduce the order of the reaction with respect to CO and Cl_2.Hence write a rate law/equation for this reaction.

Ans:

Exp	Initial conc [CO]	Initial con $[Cl_2]$	Initial rate
1	1.0	0.1	1.29×10^{-29}
2	0.1	0.1	1.30×10^{-30}
3	0.1	1.0	1.31×10^{-30}

In experiment 1 and conc of Cl_2 is constant and conc of CO vary. Ratio of conc is

Exp. 1 : Exp. 2

$$\frac{1.0}{0.1} \quad \frac{0.1}{0.1}$$

10 : 1

Ratio of rate of reaction is exp 1 and 2

Exp. 1 : Exp. 2

$$\frac{1.29\times10^{-29}}{1.30\times10^{-30}} \quad \frac{1.30\times10^{-30}}{1.30\times10^{-30}}$$

10 : 1

Hence it is 1st order W.r.t $[CO]$

Rate = K $[CO]^1$

1st order W.r.t CO

Conc of CO in experiment 2 and 3 is constant but conc of Cl_2 vary. Conc ratio is

Exp. 2 : Exp. 3

$$\frac{0.1}{0.1} \quad \frac{1.0}{0.1}$$

1 : 10

Rate ratio of Exp 2 and 3

Exp.2 : Exp. 3

$$\frac{1.3\times10^{-30}}{1.3\times10^{-30}} \quad \frac{1.3\times10^{-30}}{1.3\times10^{30}}$$

1 : 1

As the conc is increased to 10 times but rate is constant. So Cl_2 is zero order W.r.t Cl_2

Rate = K$[Cl_2]^0$

Zero order of reaction W.r.t Cl_2

Overall rate Law

Rate = K$[CO]^1[Cl_2]^0$

Overall order of reaction = 1 + 0

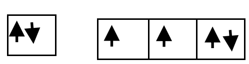
Overall order of reaction = 1st order

(B)Show the diamagnetic/paramagnetic nature of O_2, O_2^{2+} and O_2^{2-} with the help of molecular orbital theory.

Ans:

O_2

$_8O$ $1s^2, 2s^2, 2p^4$ Valence Shell



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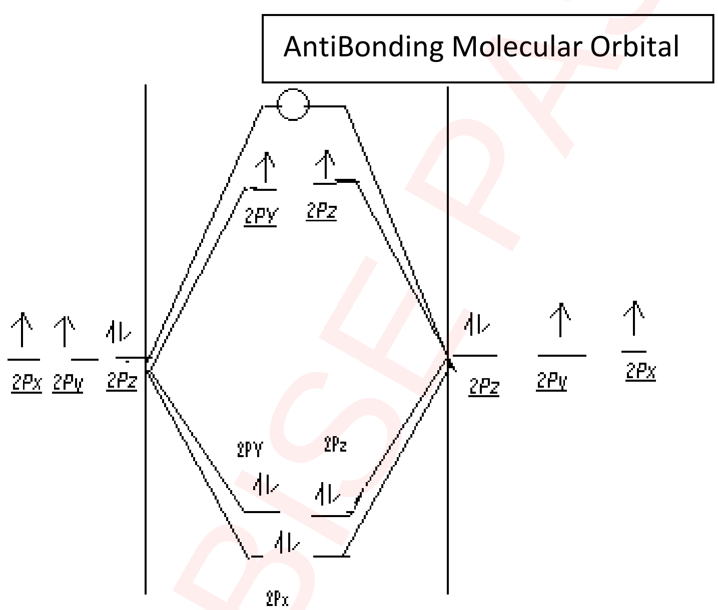
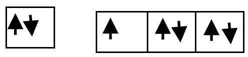


Paramagnetic behaviour:

There are two compare electron in antibonding. So oxygen shows paramagnetic behaviour i.e attract towards magnet.

O_2^{-2}

O^- $1s^2, 2s^2, 2p^5$



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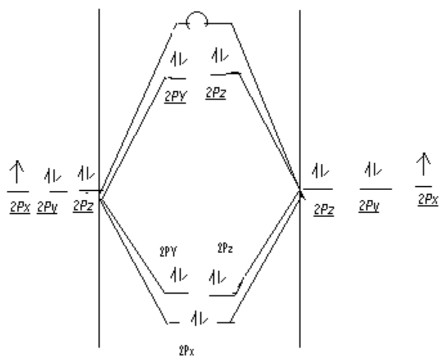
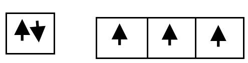


O_2^{+2}

O^+ $1s^2, 2s^2, 2p^5$



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