Final Examination - Grade 13 - 2016

Index No. ..... Chemistry II Three hours only

Instructions

- Periodic Table is provided.
- Use of calculations is not allowed.

❖ Part A - Structures Essay

- Answer all the questions on the question paper itself.
- Write your answer in the space provided for each question. Please note that the space provided is sufficient for the answer and that extensive are not expected.

❖ Part B and Part C - Essay

- Answer four questions selecting two questions from each part. Use the paper supplied for this purpose.

Part A - Structured Essay

Answer all the four questions on this paper itself each question carries 10 marks.

Universal gas constant. $R = 8.314\ JK^{-1}\ mol^{-1}$

Avagardro Constant $N_A = 6.022 \times 10^{23}\ mol^{-1}$

01. (a) Consider the following Chemical species.

SO_2F_2, SF_6, IOF_2, CNO^-, ClF_2^+

(i) Species with number of lone pairs of the central atom equals to the number of double bonds to the central atom is .....

(ii) Equals to the shape of $^-NH_2$ .....

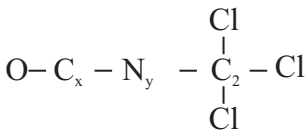
(iii) Molecule without dipole moment .....

(iv) Total number of lone pairs in the molecule is three times of the bonds. .....

(v) Has the shape of trigonal bipyramidal .....

(vi) Which species is isoelectronic with $^+NO_2$ .....

(b) The skeleton of trichloromethyl isocyanate which is a very poisonous compound, is given below.



i. Draw the most acceptable lewis structure for this compound.

ii. Draw the resonance structures possible for the above molecule. Giving reasons comment on the stability of those structures.

iii. State the following.

(a) electrone pair geometry around the atoms.

(b) Shape around the atom.

(c) Hybridization of the atoms given in the table below.

	C_x	N_y	C_z
(a) Electrone pair geometry			
(b) Shape around the atom.			
(c) Hybridization			

iv. Identyfy the atomaic / hybrid orbitals involved in the formation of the following bonds in the lewis structure drawn in part (b) i above Atoms are labelled as x,y and z.

(A) C_x and N_y ..... + ...

(B) N_y and C_z ..... + ...

(C) (i) Arrange the following in decreasing order of the radius and mention the reasons. Li, Be, O^{-2}, Na^{+}

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(ii) Mention which is larger among first ionization energy of As and second ionization energy of Se, giving reasons.

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02. a. A_1 is di atomic gaseous element belongs to first 20 elements of the periodic table. It reacts with gaseous element under vigorous conditions and form gaseous A_2, Gaseous A_3 is obtained by oxidizing it with a catalyst while it reacts with air and form gaseous A_4. Aqueous compound A_5 is obtained by reacting A_4 with air, water while small amount of aqueous solution of that reacts with Al under alkaline Conditions A_2 is obtained again.

i) Identify A_1 and write the ground state electronic configurations.

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ii) Write possible oxidation states for A_1. Write one example for each oxidation state.

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iii) Write the Chemical formula of following compounds.

A_2 .....

A_3 .....

A_4 .....

A_5 .....

iv) Write balanced chemical equations for following.

A_2 A_3

..... ⟶ .....

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A_5 A_2

..... ⟶ .....

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b) Chemical compounds P to T are contains in test tubes while description about the products obtained by heating them is given below. (They are not in order from P to T)

$NaNO_3$, $Mg(HCO_3)_2$, $(NH_4)_2Cr_2O_7$, NH_4Cl, $LiNO_3$

Chemical Compound	Description abou the products obtained.
P	Two gaseous products with solid residue.
Q	Does not remains any residue after heating the solid compound.
R	Colourless gas which turns lime water to milky colour and white solid residue.
S	Reddish brown gas with a solid residue.
T	Remain a white solid residue.

i) Identify solid substances from P to T.

P ..... S .....

Q ..... T .....

R .....

ii) Write balanced Chemical wquations for heating of the above chemical substances P to T.

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03. a) i. I write the balanced Chemical equation for the equilibrium of weak acid HA in aqucous solution.

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ii. Apply equilibrium law for the equation you have written above and obtain

$$[H_3O^+(aq)] = ka \frac{[HA(aq)]}{[A^-(aq)]}$$

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iii. $25cm^3$ of the aqueous solution of $0.1moldm^{-3}$ HA is in a titration flask. Obtained the pH value of this solution using the above expression. ($ka\,[HA] = 1 \times 10^{-5}\ moldm^{-3}$)

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iv. $12.5cm^3$ of $0.1\ moldm^{-3}$ NaOH solutions is added to the above solutions. Solution obtained as as the product shows a special characteristic. Explain it briefly.

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v. Calculate the pH value of the solution obtained in iv above using the expression obtained in ii. Mention your assumptions.

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vi) $24.5cm^3$ of NaOH solutions is added to the titration flask containing the aqueous solution of weak acid above. Obtain the pH value of that solution using the expression in ii above.

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b) i) Consider the aqueous solution of the salt NaA formed by the weak acid HA. Write the balanced chemical equation for the equilibrium occurs in this solution. (Neglect the equilibrium of water.)

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ii) Apply equilibrium law to the above equilibrium and get the equation.

$$[OH^-(aq)] = K_b \frac{[A^-(aq)]}{[HA(aq)]}$$

(K_b is the constant relevant to the above equilibrium)

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iii) Write expression for Kw of water and Ka of HA and get the expression $K_b = \frac{kw}{ka}$ from them.

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iv) Calculate pH of the solution when $25cm^3$ of $0.1moldm^{-3}$ NaOH is added to $25cm^3$ of $0.1moldm^{-3}$ HA considering the above information. ($kw = 1x10^{-14} mol^2dm^{-6}$)

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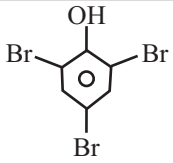
v) Draw the pH curve for the titration between $25cm^3$ of $0.1moldm^{-3}$ HA and $25cm^3$ of $0.1moldm^{-3}$ NaOH using the pH values obtained by you in parts (a) and (b) above.

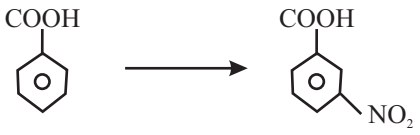
04. a) i. Complete the following able using given symbols for 'type of the mechanism'

Electrophilic substitution - S_E Electrophilic addition - A_E

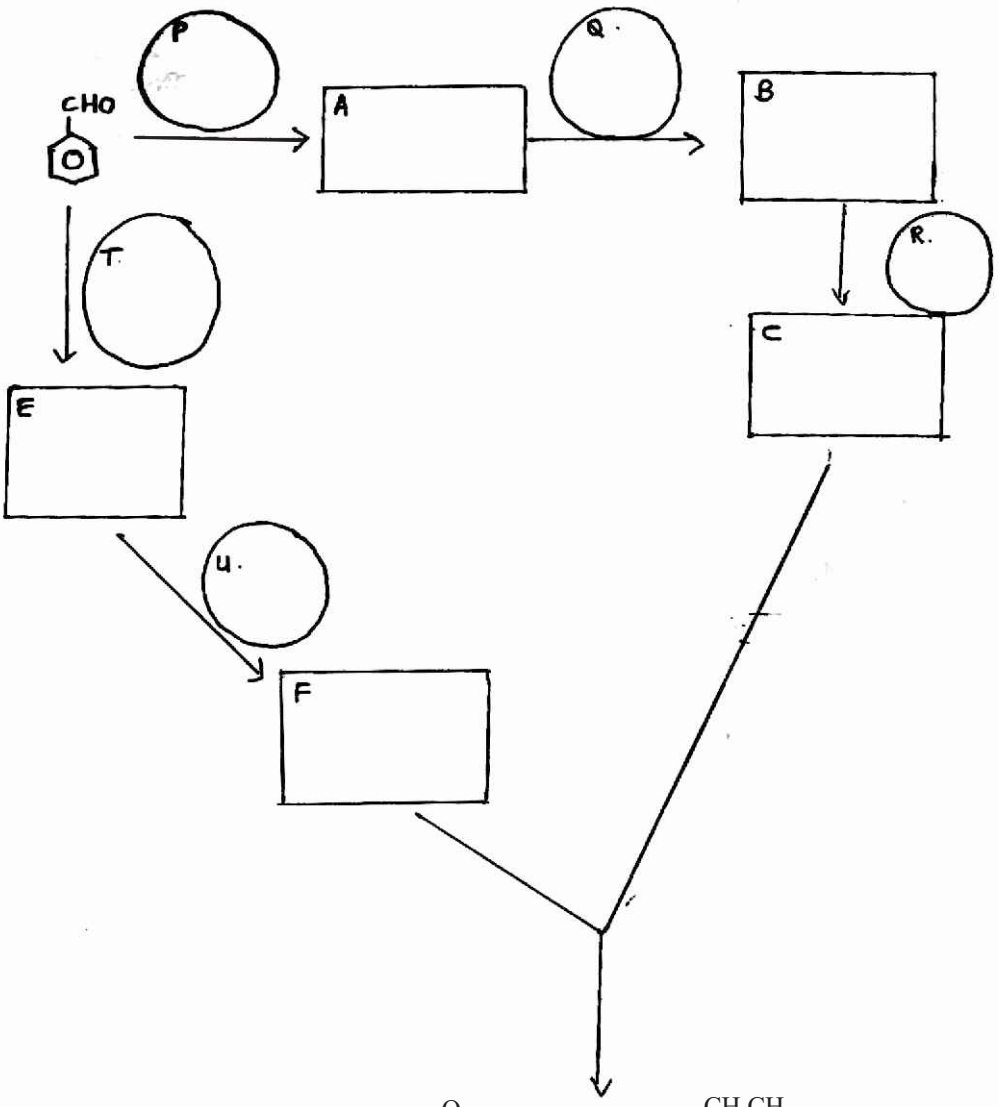
Neucleophilic substitution - S_N Neucleophilic addition - A_N

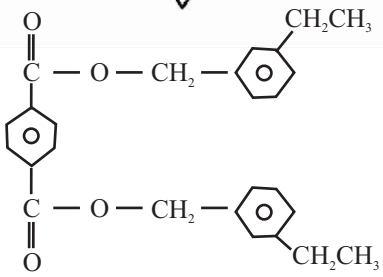
Acid - Base - A_B

Reactant	Reagent	Main product obtained	Observable\changes in the medium	Type of the mechanism
$CH_3 - C \equiv C - H$	Bromine water			
$HC \equiv CH$	NH_3 / CuCl			
CH_3CHO	Bready's reagent			
	Br_2 water			
CH_3CH_3Cl		$CH_3CH_2NH_2$		

b)  Write the mechanism the given reaction.

c) Complete the following order of reactions writing structures of relevant compounds in the boxes given and writing relevant regents and reaction condition in the circles.





Reagents:-

Conc. HCl

Conc. H_2SO_4

anhydrous $AlCl_3$

PCl_3

C_2H_5Cl

$LiAlH_4$

$Zn(Hg)_2$

CH_3Cl

$KMnO_4$

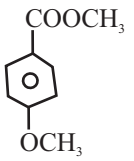
H_2O

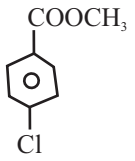
d) Arrange the given organic compounds in ascending order according to the given property and write inside the box using the letters given.

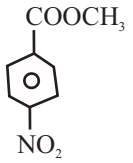
1. Acidity

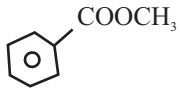
a) CH_3COOH a) CH_3CH_2COOH c) HCOOH d) $(CH_3)_2CHCOOH$

2. Ability of hydrolysis

a) 

b) 

c) 

d) 

3. Water Solubility

a) 

b) 

c) CH_3CHO d) CH_3CH_2OH

4. Strength of basicity

a) P - nitroaniline b) metanitroaniline c) $C_2H_5NH_2$ d) Anilinc

Final Examination - Grade 13 - 2016

Part B - Essay

- **Answer two questioì only. (Each question carries 15 marks.)**

05. a) Standard Lattice enthalpy of NaCl(s) is -793 $KJmol^{-1}$ while the standard lattice enthalpy of AgCl(s) is -918$Kjmol^{-1}$. Explain reasons for the above difference using necessary factors.

b) Sodium reacts with excess oxygen and form sodium peroxide.

i. Draw a Born Haber cycle to obtain the lattice enthalpy of sodium peroxide. $Na_2O_2(s)$

ii. Using suitable date calculate lattice enthalpy of $Na_2O_2(s)$

Standard bond dissociation enthalpy of oxygen	$\Delta H^{\theta}_{D(0=0)}$	=	498 $kJmol^{-1}$
Standard optimization enthalpy of sodium	ΔH^{θ}_{at}	=	108 $kJmol^{-1}$
Standard enthalpy of first electron affinity of oxygen	$\Delta H^{\theta}_{E.A_1}$	=	-320 $kJmol^{-1}$
Standard enthalpy of second electron affinity of oxygen	$\Delta H^{\theta}_{E.A_2}$	=	790 $kJmol^{-1}$
Standard enthalpy of first ionization of sodium	$\Delta H^{\theta}_{I.E_1}$	=	502 $kJmol^{-1}$
Standard enthalpy of second ionization of sodium	$\Delta H^{\theta}_{I.E_2}$	=	4533 $kJmol^{-1}$
Standard enthalpy of formation of Na_2O_2	ΔH^{θ}_{f}	=	-382 $kJmol^{-1}$

c) At 500k gas A dissociated to gases B and C while gas B dissociated to gasses D and C at the same temperature. Stoichiometric and equilibrium reactions relevant to them and their equilibrium constants are given below.

$$A(g) \rightleftharpoons B(g) + C(g)\ ,\ K_c = 6.75\ moldm^{-3}$$

$$B(g) \rightleftharpoons D(g) + C(g)\ ,\ K_c = 4.5\ moldm^{-3}$$

At 298 K A(g) was in a rigid vessel of $1dm^3$ and it is reach heated to 500K and let it to reach the equilibrium. At the equilibrium, concentration of C(g) in the vessel is 4.5 $moldm^{-3}$.

i. Find concentrations of A(g), B(g) and D(g) at the equilibrium in the vessel.

ii. Find the pressure inside the vessel at 500^0C.

06. a. i. Consider the following gaseous reaction.

$$NO_2(g) + CO(g) \longrightarrow NO(g) + CO_2(g)$$

For this reaction overall order is 2. Write three rate equations possible for that reaction.

ii. At T,K reactions rates for the different concentrations of NO_2 and CO for above reactions a(i) is given below.

	Concentration of $NO_{2(g)}$ / ($moldm^{-3}$)	Concentration of $CO_{(g)}$ / ($moldm^{-3}$)	Rate of reaction ($moldm^{-3}$)
1.	1.20×10^{-2}	1.20×10^{-2}	2.00×10^{-3}
2.	1.19×10^{-2}	2.40×10^{-2}	1.98×10^{-3}
3.	3.60×10^{-2}	1.18×10^{-2}	1.80×10^{-2}

i) Find, order of reaction with respect to $NO_2(g)$.

ii) Order of reaction with respect to CO(g).

iii) Rate expression for the reaction in above a(i).

iv) If rate constant is K, units of K.

iii. If he above a(i) reaction takes place in two steps, propose two suitable reactions (balanced equation should be written) according to a(ii) above.

iv. According to the a(iii) above draw rough sketch of a graoh for the reaction between $NO_2(g)$ and $O_2(g)$.

b. i. $500cm_3$ of a solution where $[NH_3(aq)] = 2.412\ moldm^{-3}$ is taken and $50.0cm^3$ of $CHCl_3$ is added to it and shake it well, to seperate into layers. $30.00cm^3$ of $2.0\ moldm^{-3}$ HCl was required to titrate $25.00cm^3$ of aqueous layer in the presence of phenolpthalene. Calculate the distribution coefficient of NH_3 between $CHCl_3$ and NH_3.

ii. $50cm^3$ of NH_3 solution in above (i) is mixed and shake well with $50cm^3$ of $0.18moldm^{-3}$ $CuSO_4$ and $50cm^3$ of $CHCl_3$. After layers were separated, $8.0cm^3$ of $0.04\ moldm^{-3}$ HCl was required to titrate $25cm^3$ of $CHCl_3$ layer and $41.0cm^3$ of $0.4\ moldm^{-3}$ HCl solution was required to titrate $25cm^3$ of the aqueous layer.

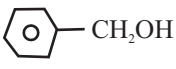
Find the formula of the complex formed between $Cu^{2+}(aq)$ and $NH_3(aq)$.

07. a. Explain reasons.

i. Whether the alcohols subjected to neucleophilic substitution reactions, phenols does not.

ii. Wether phenols react with NaOH but alcohols are not.

b. Using the only organic substance as , show how would you synthesis.

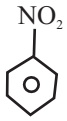
i. 

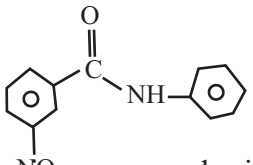
ii. Show how you would synthesize the following compound using $CH_3C^{14}H_2OH$ as the only organic starting, material.

$CH_3{}^{14}CH_2{}^{14}CH_2CH_3$

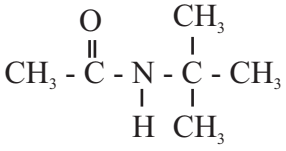
c. I. Mixture of 1 - butyne and 2 - butyne is provided. Mention how you would obtain a pure sample of

1 - butyne.

II. Show how you would synthesize (A) using the only organic substance as, 

(A) - 

d. Show how you would synthesize compound using ethyl amine ($CH_3CH_2NH_2$) and methyl iodide (CH_3I) as only organic materials.

M – 

Part C - Essay

Answer two questions only. (Each question carries 15 marks.)

08. a) Following question is based on the elements of S and P block of the periodic table and organic compounds. Identify Chemical species A,B,C,D,E,F,G,H,I,J,K,L,M,N,O of following reactions given below.

A (White Solid) $\xrightarrow{\Delta}$ B (White Solid) + C (Colourless gas)

B + HCl + D $\xrightarrow[\text{tempetature}]{\text{room}}$ F + G (Colourless gas) + E (Compound) + Other Products

E (Compound) $\xrightarrow{\text{Flame Test}}$ Purple colour Flame

F $\xrightarrow[\text{Water}]{\text{Bromine}}$ H (White precipitate)

Mg + G $\longrightarrow$ I

I + H_2O $\longrightarrow$ J (White Precipitate) + K (gas)

K + C $\xrightarrow[\Delta]{\text{Catalyst}}$ L (gas) + Water Vapour

L + C $\longrightarrow$ M (Brown colour gas)

M + C + H_2O $\longrightarrow$ N

N + K $\longrightarrow$ O

b) Following tests were carried out with an aqueous solution containing inorganic ionic salt X.

	Test	Observation
1.	HCl is added to the aqueous solution of the compound.	The gas Y was evolved while giving a clear solution.
2.	The gas Y released was passed to water and $BaCl_2$ is added to that solution.	A white precipitate Z formed. It dissolves in acids.
3.	H_2O_2 is added to the aqueous solution in (2) above. Then $BaCl_2$ is added to that solution.	A white precipitate K was formed. It is not dissolved in acids.
4.	NaOH is added drop wise to the aqueous solution of X.	A White precipitate formed by the drops added initially. The precipitate dissolves by adding NaOH further.
5.	Aqueous NH_3 is added dropwise to aqueous solution of X	A white precipitate formed by the drops added initially. It dissolved on further addition of the NH_3(aq)

i. What is the gas X?

ii. What is the white precipitate Y.

iii. What is the white precipitate K.

iv. Write the reaction between aqueous solution Y and H_2O_2.

v. What is the white precipitate formed in (4), why it dissolves further addition of NaOH (aq).

vi. What is the white precipitate formed in (5). Why is dissolves on further addition of NH_3.

(C) The following order experiments was carried out to determine the amount of Mn coated on a sheet made by an innert substance with rectangular shape.

Rectangular sheet of 10cm x 4cm is taken form the given sheet and dilute acid is used to remove the coated Mn. Mn^{2+} formed is oxidized as follows to $S_2O_8^{-2}$ (peroxi di sulphate ion) in the neutral medium.

$$S_2O_8^{-2}(aq) + Mn^{2+}(aq) + H_2O(l) \longrightarrow MnO^-_{4\,(aq)} + H^+(aq) + SO_4^{2-}(aq)$$

2.94g of excess ferrous ammonium sulphate ($FeSO_4(NH_4)_2SO_4.6H_2O$) is added to the acidified solution after removing excess $S_2O_8^{2-}$ 20 cm^3 of 0.025moldm^{-3} $KMnO_4$ solution was required to react with Fe^{2+} remains as unreacted. Represent reactions between following as balanced chemical equations.

i. Mn^{2+} and $S_2O_8^{-2}$

ii. Fe^{2+} and MnO_4^-

iii. Calculate the thickness of Mn layer coated on the sheet. (Density of Mn = 13.75 g cm^{-3})

(Fe = 56, Mn = 55, S = 32, O=16, N=14).

09. a. Answer the following questions considering the given polymers below.

Polyisoprene, Teflon, Nylon -6, 6, Polyethene, Polyvinyl Chloride, Polystyrene, Terylene, Proteins, Bakelite.

i. Classify the above polymers, as natural polymers and synthetic.

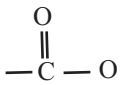
ii. Write the natural addition polymers and the natural condensation polymers separately.

iii. Write the synthetic addition polymers and the synthetic condensation polymers separately.

iv. What is the thermoplastic, linear and addition polymers which bears the high temperature.

v. During the first stage of manufacture once moulded this polymers sets and then cannot be re-softened by heating. It is a three dimensional condemnation polymer. Identify that polymer.

vi. Considering the polymers given as the answers in iv and v above suggest a simple test can be carried out in the laboratory or home to distinguish between.

vii. Write the chemical formula of the polymer linked through the repeating unit of  group.

viii. What is known as the natural rubber ? Draw the structure of it. Write the structure of the monomer and the repeating unit.

ix. What is known as the 'Vulcanization of rubber' what are the special Chemical and Physical properties gained by the Vulcanized rubber than the natural rubber.

The above polymer P, is decided to produce for a special task, by a certain chemist.

i. In polymenzation of above P, what is the chemical bond type involved in linking repeating units together ?

ii. Give the monomer, which is relevant to produce P.

iii. The Polymer P belongs to certain common set. Identify that common set of polymers. According to the identify of that set give the suitable name for P.

b. The existance of the constant composition of atmosphere favours in long term existance in life. The changes occurred in the composition of the atmosphere affects more for the existance of life and chemical and physical conditions of the surroundings.

i. Arrange in the order of decreasing composition by volume for the man gaseous components of unpolluted dry air at the sea level.

ii. Write separately three inorganic gases and three organic gases which cause in changing the composition of the atmosphere.

iii Explain briefly how to release the gases mentioned in above (ii) to the atmosphere.

iv Mention the green house gasses from the above list in (ii). Explain briefly and completely the way of that gas causes in green house effect.

v. What is known as the 'global warming'? Give the bad effects occurred to the environment because of the global warming.

vi. The air polution results in global warming acid rains and photo chemical smog. Although the content of CO_2 in air is high, most of the people do not like to accept that Co_2 gas affects for the acids rains.

I. The gas CO_2 causes in acid rains. What are the reasons for that?

II. Mention the gases affect for the acid rains. Select a favoured gas and explain the acting of it towards the farming acid rains, with the chemical equations.

10. I. A is a salt formed by a metal, belongs to S block of the periodic table and it gives a light green colour flame in the flame test. When the salt A is heated with a powder of the metal B and solution C, it gives the colourless gas D and the colourless solution E. When the solution F is added to the solution E the white geletineous precipitate G is formed. G is dissolved in excess F to give the colourless solution H. When the solution F is mixed with a Cu^{2+} solution, the yellow colour complex ion I with the co ordination number of 4 is formed.

When solution A is mixed with the solution J the precipitate K is formed which is insoluble in dil HNO_3. When the gas D is passed through the solution J, the light green colour precipitate L is formed L formes a solution of the blue violet colour, with the excess D gas.

i. Identify A to M.

ii. Write the IUPAC names of I,M and L.

iii. Write the balance chemical equations.

a. $Cu^{2+} + F \longrightarrow I$ b. $A + J \longrightarrow K$ c. $J + D \longrightarrow L$ d. $L \longrightarrow + D$ M

(ii) Hals boil reactions occurred in a certain electrochemical cell are given below.

$A^{3+}(aq) + 3e \rightleftharpoons A(s)$, $E^{\theta}_{A^{+3}(aq)\,/\,A(s)} = -1.66\ V$

$2\,H_2O(l) + O_2(g) + 4e \rightleftharpoons 4OH^-$, $E^{\theta}_{O_2(g)\,/\,OH^-(aq)} = -0.40\ V$

i. Which electrode acts as the anode.

ii. How to prepare the cathode to exist under standard states.

iii. Mention the cell reaction, occurred here.

iv. Calculate the clectromative force of the cell.

v. The above cell is prepared with a salt bridge. When the current is produced, changing of volume of the anodic solution is negligible. But the volume of the cathodic solution is decreasing gradually. Explain it.

vi. A cell is prepared using 1.0 dm^3 of the cathodic solution and 1.0 dm^3 of the anodic solutions. The initial ionic concentration of both cathodic and anodic solution is 0.01 $moldm^{-3}$ each. After producing a current the volume of the cathodic solution is again brought to 1.0 dm^3 and measure the pH. pH is changed by one unit. At that moment calculate the concentration of $OH^-(aq)$ of the cathodic solution and A^{+3} concentration of the anodic solution.

v. The cell prepared using the electrodes under standard states is conducted in series to the following cell. B (s) | B^{2+}(aq, 1.0 $moldm^{-3}$) || H^+ (aq, 1.0 $moldm^{-3}$) | H2 (g, 1.0 bar), Pt(s)

The electromotive force of the connective cell is 2.29V. Calculate the standard electrode potential of $B^{2+}(aq)$ / B (s) clectrode.