JOINT EXAMINATION.

MARKING SCHEME PAPER 2.

1. (a)

- Temperature, when temperature is increased colliding particles gain kinetic energy, this increase collision frequency and hence high rate of chemical reaction.
- Concentration, when concentration is increased number of colliding particles increase, this increase collision frequency hence, high rate of chemical reaction.
- Surface area, This affect only solid particles, surface area of solid particle is increased by converting large particles into small particles by grinding. Small particles provides large surface area for a reaction to take place which increase a chance for effective collision and hence, high rate of chemical reaction.

(03 marks @ 01 mark)

(b) (i) Rate $= \frac{1}{6}\frac{\Delta H2}{\Delta t} = \frac{\Delta[P4]}{\Delta t}$

$\frac{1}{6} \times 0.06 = \frac{\Delta[P4]}{\Delta t} = 0.01$ moldm^{-3} s^{-} **(02 marks)**

(ii) Rate $= \frac{1}{6}\frac{\Delta H2}{\Delta t} = \frac{\Delta[P4]}{\Delta t}$

$\frac{1}{6} \times 0.06 = -\frac{1}{4}\frac{\Delta[PH3]}{\Delta t} = -0.04$ moldm^{-3} s^{-} **(02 marks)**

(c) (i) Overall order is equal to 1

(ii) $[(CH_3)_3CBr\ (aq)]$ is one (1)

$[\ H_2O\ ]$ is zero (0)

(iii) Rate remain constant

(iv) Rate becomes half **(04 marks @ 01 mark)**

(d) Order of reaction with respect to A

$[\frac{0.24}{0.12}]^x = \frac{2}{0.5}$

$2^X = 4$

X= 2, thus order of reaction with respect to A is 2 **(01mark)**

Order of reaction with respect to B

$[\frac{0.12}{0.06}]^y = \frac{2}{1}$

$2^y = 2$

Y = 1, thus order of B is 1 **(01mark)**

Rate law, $R = k\,[A]^2\,[B]$ **(02 marks)**

(e) (i) Since, Cu^{2+} ions being reduced, the object to be connected act as a cathode. Therefore, must be connected to the negative terminal.

(02 marks)

(ii) Molar mass copper = 63.5, I = 0.22 A, t = 1.5 hours = 1.5 x 60 x 60

Valence of Cu = 2 and F = 96500C

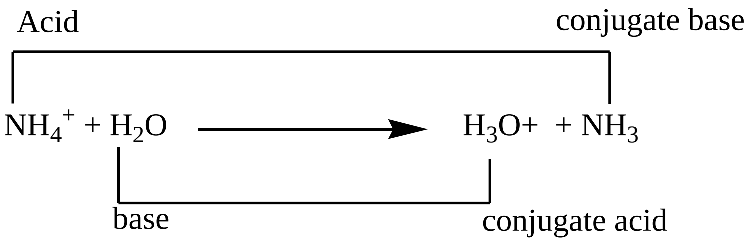
Mass of Cu = $\frac{RAM\ x\ I.x\ t}{Valence\ x\ Faraday}$

Mass of Cu = $\frac{63.5\ x\ 0.22\ X\ 5400}{2\ x\ 96500}$

Mass of copper = 0.39087 g **(03 marks)**

2. (a)

(i)



$NH_4^+ + H_2O \longrightarrow H_3O+ \ + NH_3$

Base conjugate acid

(ii) HSO_4- + $HNO_3 \longrightarrow H_2SO_4 + NO_3^-$

Acid conjugate base

Acid conjugate base

(iii) [Al (H2O) $_6]^{3+}$ + $H_2O \longrightarrow [Al\ (H_2O)_5\ OH]^{2+} + H_3O^+$

Base Conjugate acid

Base conjugate acaid

(iv) $NaNH_2 + NH_4Cl \longrightarrow NaCl + 2NH_3$

acid conjugate base

(04 marks @01mark)

(b) (i) $pH = P_{ka} + \log\left(\frac{[salt]}{Acid}\right)$

$pH = 4.75 + \log\left(\frac{[0.05]}{[0.03]}\right)$

pH= 4.92 **(02 marks)**

(ii) $pH = 4.75 + \log\left(\frac{[0.05-0.01]}{[0.03+0.01]}\right)$

pH = 4.75 **(03 marks)**

(iii) $pH = 4.75 + \log\left(\frac{[0.05+0.01]}{[0.03+0.01]}\right.$

pH = 5.25 **(03 marks)**

(c) Statement meant that the product of Pb^{2+} ions and Cl^- ions in their saturated solution raised to the power of the stochiometry coefficient obtained from balanced chemical equation is equal to 1.6×10^{-5} mol^3dm^{-9} at 298k. **(02 marks)**

(i) $PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$

Let molar solubility of $PbCl_2(s)$ be X

$[Pb^{2+}] = X$

$[Cl^-]=2X$

$K_{sp}\ PbCl_2(s) = [X]\ [2X]^2$

$1.6 \times 10^{-5} = 4X^3$

X = 0.0158 M **(02 marks)**

(ii) $PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$

$NaCl\ (s) \rightarrow Na^+(aq) + Cl^-(aq)$

Let molar solubility of $PbCl_2(s)$ be X

$[Pb^{2+}] = X$

$[Cl^-]=2X + 0.1 = 0.1\ M$

$K_{sp}\ PbCl_2(s) = [X]\ [0.1]^2$

$X = 1.68 \times 10^{-3} M$ **(02 marks)**

(iii) $PbCl_2(s) \rightleftharpoons Pb^{2+}(aq) + 2Cl^-(aq)$

$Pb(NO_3)_2(s) \rightarrow Pb^{2+}(aq) + 2NO_3^-(aq)$

Let molar solubility of $PbCl_2(s)$ be X

$[Pb^{2+}] = X + 0.1 = 0.1M$

$[Cl^-]=2X$

$1.6 \times 10^{-5}) = [0.1]\ [2X]^2$

X = 0.03419M **(02 marks)**

3. (a) (i) This is because transition element can lose electrons both in penultimate shell and in valence shell **(01 mark)**

(ii) This is because transition element has the following features:

- They have variable oxidation state
- They provide large surface area for reactant to react
- They have vacant d-orbitals
- They form reactant intermediate with reactant
- They have irregular arrangement of atoms in their crystal lattice

(any point 01 mark)

(b) (i) $[Ni(NH_3)_6]Cl_2$

(ii) $[Pt(NH_3)_4][PtCl_4]$

(iii) $[Pt(en)_2Cl_2](NO_3)_2$ **(03 marks @ 01 mark)**

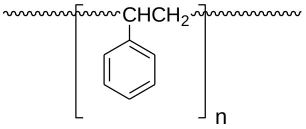
(c) Compounds:

- Compound **A** $[Cr(NH_3)_3(H_2O)_2Cl]Br_2$
- Compound **A** $[Cr(NH_3)_3H_2OClBr]Br.H_2O$ (**04 marks @ 02 marks)**

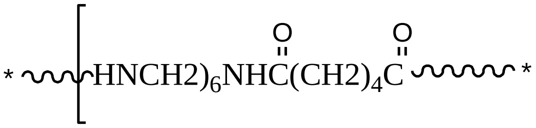
(d) Polymers based on physical properties

- Elastomer
- Fibre
- Thermoplastic
- Thermosetting

(e) (i)



(ii)

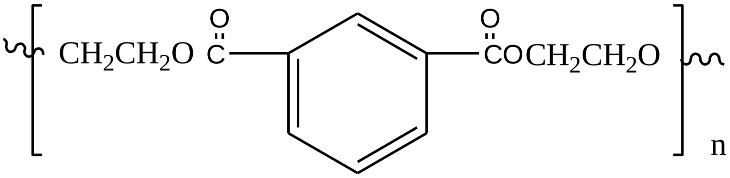


$* \sim\sim [HNCH2)_6NH\overset{O}{\overset{\|}{C}}(CH2)_4\overset{O}{\overset{\|}{C}} \sim\sim *$

(iii)

$\sim\sim[CF_2CF_2]_n\sim\sim$

((iv)



(06marks @ 1.5 mark)

(f) (i) $CH_3CH_2CH_2Br$

(ii) $CH_3CH=CH_2$

(iii) CH_3CH_2COOH

(iv) $CH_3COOCH_2CH_3$ **(04marks @01)**

4\. (a) (i) Azeotropic mixture is a mixture of liquids that boils at constant temperature behave like a pure liquid and whose composition in the liquid phase is the same as in the vapour phase.

(ii) Ideal solution is the solution that is made from completely miscible liquids whose intermolecular forces are the same as the intermolecular forces within the liquids involved in formation the solution.

(iii) Completely miscible liquids are liquids which dissolve completely in one other in all proportions to form a homogeneous solution. **(03 marks)**

(b) (ii) Maximum boiling azeotropic mixture (negative deviation)

(iii) Nitric acid will evaporate less than water so it increase from 20% to 68%

(iii) Yes it is possible because in the distillate nitric acid is obtained only while the residue obtained is azeotropic mixture **(06 marks @ 02 mark)**

(c) Vapour pressure of nitrobenzene (Pn) = 760mmHg−733mmHg = 27mmHg Molecular mass of nitrobenzene ($C_6H_5NO_2$)= 123g/mol Vapour pressure of water (Pw)= 733mmHg Mass of water = unknown Mass of nitrobenzene = unknown From Mass of organic liquid mass of water = Pn ×Mrn Pw ×Mrw

(02 marks)

Mn Mw = 27mmHg 733mmHg × 123g/mol 18g/mol (01 marks) Mn Mw = 0.25(01 marks) The proportional of water and nitrobenzene in distillate is 4 : 1 **(03 marks)**

(d) (i) $Wr = m\left(\frac{V1}{V2 \times Kd + V1}\right)^{n}$

$Wr = 5\left(\frac{500}{90 \times 80 + 500}\right)^{1}$

$Wr = 0.32467$ g

Mass extracted = 5-0.32467 = 4.675g **(02 marks)**

(ii) $Wr = m\left(\frac{V1}{V2 \times Kd + V1}\right)^{n}$

$Wr = 5\left(\frac{500}{45 \times 80 + 500}\right)^{2}$

$Wr = 0.074$g

Mass extracted = 5-0.074 = 4.92 g **(02 marks)**

(iii) Extraction using small portions is more efficient compared to when extractive solvent is used at once. **(02 marks)**

5. (a) (i) Refining of bauxite ore to alumina is done by using the following stages:

The ore is roasted first to convert iron(II) oxide to iron(III) oxide.

Step1

$Al_2O_3\,(s) + 2NaOH \xrightarrow{200^oC\text{-}250^oC} 2NaAlO_2\,(aq) + H_2O\,(l)$

Step2

$2Na[Al(OH)_4](aq) + CO2(g) \xrightarrow{50^oC\text{-}60^oC} 2Al(OH)_3\,(s) + H_2O\,(l)$

Step3

$2Al(OH)_3\,(s) \xrightarrow{1200^oC} Al_2O_3\,(s) + H_2O\,(l)$

(05 marks)

(ii) $Al_2O_3 \rightarrow 2Al^{3+} + 3O^{2-}$

At the cathode $Al^{3+} + 3e^- \rightarrow Al$

At the anode $2O^{2-} \rightarrow O_2 + 4e^-$ **(03 marks)4**

(b) (i) This is because aluminium has large reduction potential indicating that it has large ability to gain electrons than sodium. In the solution aluminium ions gain electrons first to form aluminium solid which is deposited at the cathode.

(ii) This is because carbon reacts with oxygen to form carbon dioxide.

(iii) This is because aluminium form strong protective layer (aluminium oxide) which prevent further reaction between aluminium and nitric acid.

(iv) Aluminium has vacant orbital and small cationic radius which can the lone pair of chlorine atom. **(04 marks @01mark)**

(c) Unique properties of fluorine

(i) Fluorine is the most reactive element of all halogens because of weak F-F bond energy.

(ii) Hydrogen fluoride form strong hydrogen bonds where as other hydrogen halide do not exhibit strong hydrogen bonds.

(iii) Fluoride of silver is soluble in water where as halide of silver chloride and silver bromide are insoluble in water.

(iv) Fluorine react with water to form Hf and O2 where other halogens disproportionate in water.

(d)

(i) Silicon dioxide does not react with water because it is difficult to break up the giant covalent structure $SiO2+H2O \longrightarrow$ No reaction.

(ii) In presence of water AlCl3 form hexaaqualumium (III) Chloride which is a complex compound (01 marks) $AlCl3(s) +6H2O(l) \longrightarrow [Al(H2O)6\ ]Cl3(aq$ Further reaction with water release[H +] ion which turn blue litmus paper red.

(iii) Lithium has small cationic size hence have high polarizing power which tend to decompose the peroxide ion back to normal oxide formed. The sodium cationic size is large enough to accommodate the peroxide ion

$2Na(s)+O_2(g) \rightarrow Na_2O_2(s)$

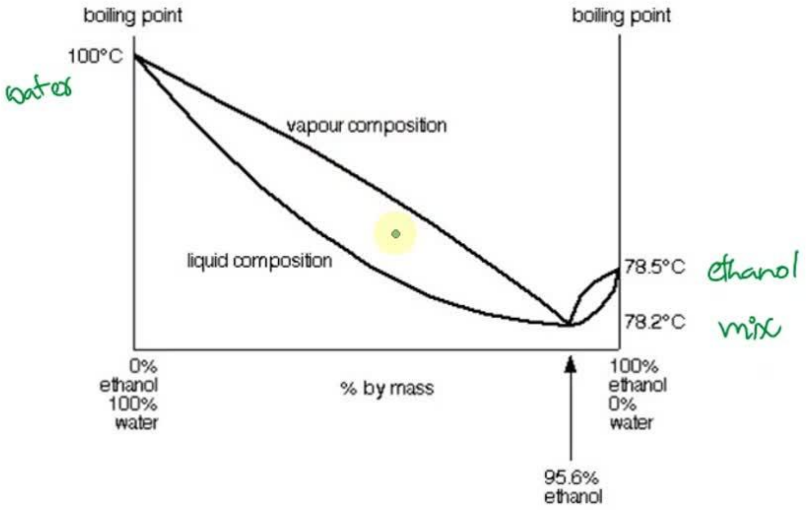
$4Li(s) + O_2(g) \rightarrow 2\ Li_2O(s)$ **(03marks@01 mark)**

5. (a) (i) They form hydrogen bond, thus deviate negatively from Raoult's Law

(ii) They form ion-ion interaction thus, deviate negatively from Raoult's Law

(iii) They form hydrogen bond, thus deviate negatively from Raoult's Law **(03 marks @ 01 mark)**

(b) (i) Temperature versus mole fraction curve of ethanol- water solution



(02 marks)

(ii) The solution will boil in such a way that, ethanol will be richer in vapour until it reaches 95.6%,the residue in flask will be water and the distillate in collector will be ethanol. **(02 marks)**

(iii) This is because the solution boil at constant temperature with constant composition (azeotropic mixture)

The following are the methods which can be used to obtain large quantity:

- Drying agent (CaO)
- Adsorption
- Third distillate
- Solvent extraction **(03 marks @ 01 mark)**

6 (a) IUPAC system

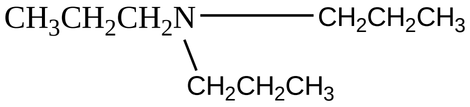
(i) N,N-diphenylamine

(ii) benzyl amine

(iii) N-ethyl-n-methylpropanamine **(03 marks)**

(b)

(i) $CH_3CH_2NH_2CH_3$

(ii) 

$CH_3CH_2CH_2N(CH_2CH_2CH_3)CH_2CH_2CH_3$

(iii) $CH_3CH_2CH_2CH_2CH_2NHCH_2CH_2CH_2CH_2CH_3$

(iv) $(CH_3)_4NCl$ **(04 marks)**

(c) (i) Tertiary amine is less basic than amine due to large steric hindrance

(ii) Methylamine is more basic because it has methyl goup which release electrons towards amino group and make lone pair in nitrogen available for the chemical reaction.

(iii) Benzyl amine has large pKb because is less basic as its lone pair participate in mesomerism.

(iv) Aldehyde is more basic than ketone because its carbonyl carbon is more positive polarized and it experience less steric hindrance.

(08 marks @02 marks)

(d) structure:

- **B** $CH_3CH_2CH_2Cl$

- **C** CH_3CH_2COOH
- **D** $CH_3CH_2CONH_2$
- **E** $CH_3CH_2NH_2$ **(05 marks @01 marks)**