

NAME  
Signature

P52S/I  
Chemistry  
Paper I  
July/August 2019  
2<sup>3/4</sup> Hours

Marking Guide  
Date 18/7/19

Index No.

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Albaan -

# Proposed guide



ACEITEKA JOINT MOCK EXAMINATIONS, 2019  
UGANDA ADVANCED CERTIFICATE OF EDUCATION  
CHEMISTRY

PAPER I

2 HOURS 45 MINUTES

INSTRUCTIONS TO CANDIDATES:

- \* Answer all questions in section A and six questions in section B.
- \* All questions must be answered in the spaces provided.
- \* The periodic Table with relative atomic masses is provided.
- \* Illustrate your answers with equations where applicable.
- \* Molar gas constant =  $8.314 \text{ J mol}^{-1}\text{K}^{-1}$ .
- \* Molar volume of a gas at s.t.p is 22.4 litres.

For examiners use only

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Marks																		

SECTION A: (46 Marks)

Answer all the questions

1. (a) Explain what is meant by the term electron affinity.

*This is the energy released / evolved when an electron is gained by one mole of an isolated neutral gaseous atom to form a unipositively charged gaseous ion. OR is the standard enthalpy change accompanying the addition of one electron to an atom in the gaseous phase.*

(1 mark)

- (b) Calculate the electron affinity of hydrogen using the following data :

Enthalpy of atomization of potassium =  $90 \text{ kJ mol}^{-1}$

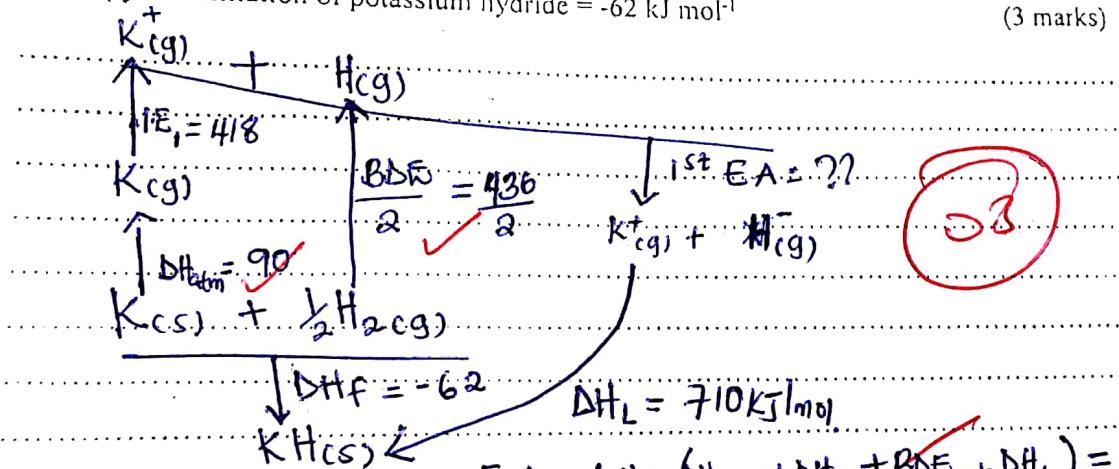
Bond dissociation energy of hydrogen =  $436 \text{ kJ mol}^{-1}$

First ionization energy of potassium =  $418 \text{ kJ mol}^{-1}$

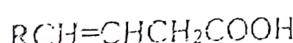
Lattice energy of potassium hydride =  $710 \text{ kJ mol}^{-1}$

Enthalpy of formation of potassium hydride =  $-62 \text{ kJ mol}^{-1}$

(3 marks)



2. An organic compound Z has a structure



~~$$\text{E.A.} = \Delta H_f - (\Delta H_{\text{atom}} + \Delta H_{\text{IE}} + \text{BDE} + \Delta H_L) = -62 - (90 + 418) = -1498 \text{ kJ mol}^{-1}$$~~

Name the functional group which is present in Z and in each case name the reagent that can be used to identify the functional group, state the observation made and write equations for the reaction that takes place when the compound is reacted with the reagent.

(1/2 mark)

- (i) Name of the functional group

*Carbon double bond.*

✓ (5/6)

Reagent:

*K₂Cr₂O₇ Alkaline potassium permanganate.*

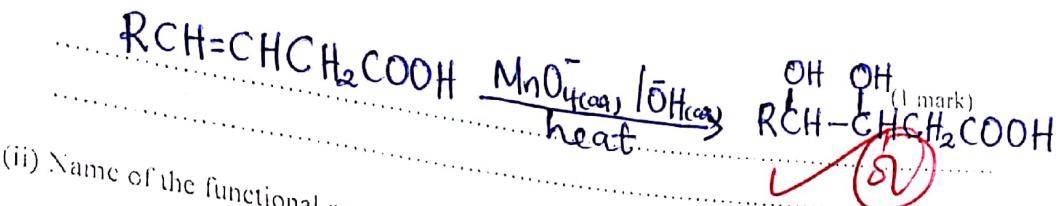
(1/2 mark)

Observation:

*Purple solution turns colourless.*

✓ (5/6)

Equation



(ii) Name of the functional group

Carboxylic acid group. ✓ (1/2 mark)  
(5)

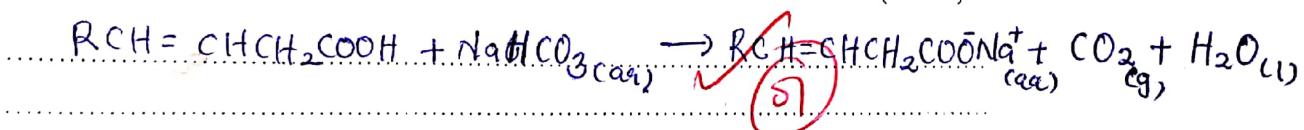
Reagent.

Sodium hydrogen Carbonate solution  
or sodium carbonate. ✓ (1/2 mark)  
(5)

Observation.

R.F. effervescence of a colourless gas. ✓ (1/2 mark)  
(5)

Equation

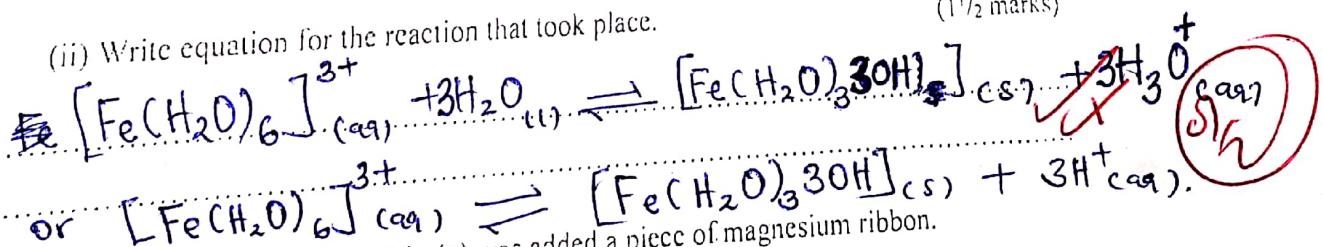


3. (a) Water was added to anhydrous iron(III) chloride drop wise until there was no further change.

(i) State what was observed. (1 mark)

Brown precipitate. ✓ (1 mark)  
(5)

(ii) Write equation for the reaction that took place. (1 1/2 marks)



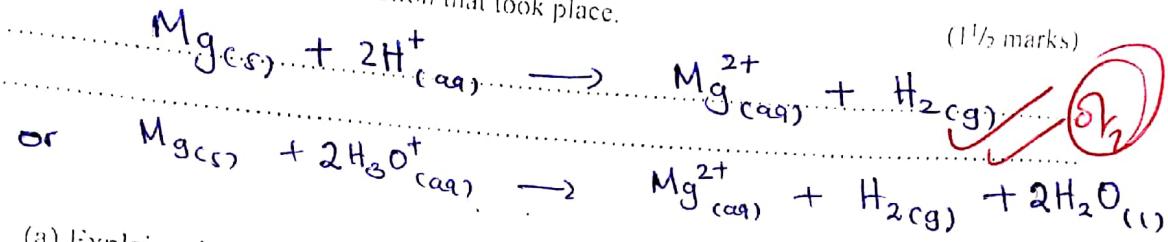
or  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}(aq) \rightleftharpoons [\text{Fe}(\text{H}_2\text{O})_3\text{OH}]^{+}_{cs} + 3\text{H}^+(aq)$ .

(b) To the solution formed in (a) was added a piece of magnesium ribbon. (1 mark)

(i) State what was observed.

Bubbles of a colourless gas. ✓ (1 mark)  
(5)

(ii) Write equation for the reaction that took place.



4. (a) Explain what is meant by the term isotopes. (1 mark)

These are atoms of an element with the same number of protons but with different number of neutrons. (9)

- (b) Bromine has relative atomic mass of 79.9 and consists of two isotopes  $^{79}\text{Br}$  and  $^{81}\text{Br}$ .

Determine which of the two isotopes is the most abundant. (2½ marks)

Let the relative abundance of  $^{79}\text{Br}$  be  $x$ .

Let the relative abundance of  $^{81}\text{Br}$  be  $(100-x)$ .

RAM =  $\sum \% \text{ abundance} \times \text{atomic mass of isotopes}$

$$79.9 = \frac{(79x) + (100-x) \times 81}{100}$$

$$79.9 = 79x + 8100 - 81x$$

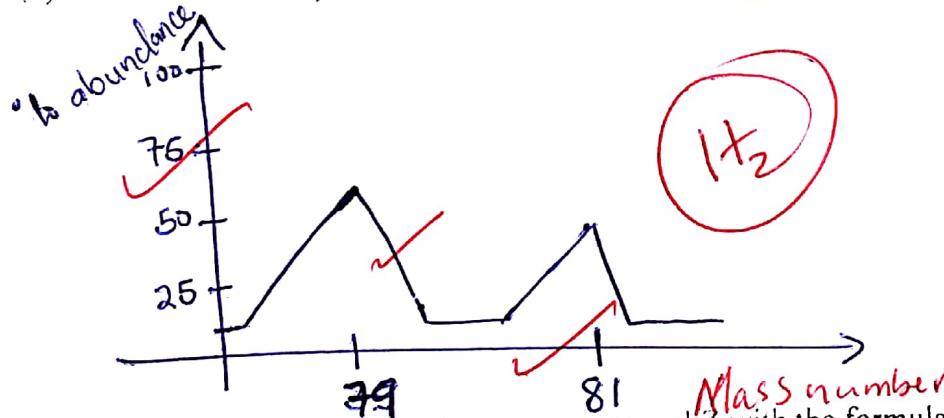
$$\frac{2x}{2} = \frac{110}{2}$$

$$2x = 55$$

$$x = 55\%$$

The most abundant isotope is  $^{79}\text{Br}$ .

- (c) Sketch the mass spectrum for bromine. (1½ marks)



5. (a) Oxygen diffuses 2.31 times as fast as a compound Z with the formula  $\text{Ni}(\text{CO})_n$ .

Determine the molecular formula of Z. (3 marks)

Let the rate of diffusion of Z be X.

$\Rightarrow$  The rate of diffusion of Oxygen be  $2.31X$ .

$$M_{\text{O}_2} = 16 \times 2 = 32, M_Z = ??$$

from Gravie

from Graham's law; Rate of diffusion of Z  
Rate of diffusion of O<sub>2</sub> =  $\sqrt{\frac{M_{O_2}}{M_Z}}$

$$= \left( \frac{x}{2.31x} \right)^2 = \sqrt{\frac{32}{M_Z}}$$

(b) State the:

(i) Co-ordinate number of nickel in compound Z.

4

$$\left( \frac{1}{2.31} \right)^2 = \frac{32}{M_Z}$$

molecular mass of Z is 171

molecular formula of Z is (Ni(CO)<sub>n</sub>) = 171

$$(58 + (12+16)n) = 171$$

$$n = \frac{4}{2} = 2$$

molecular formula is ~~Ni(CO)<sub>4</sub>~~ Ni(CO)<sub>4</sub>

(ii) Oxidation number of nickel in compound Z.

(1/2 mark)

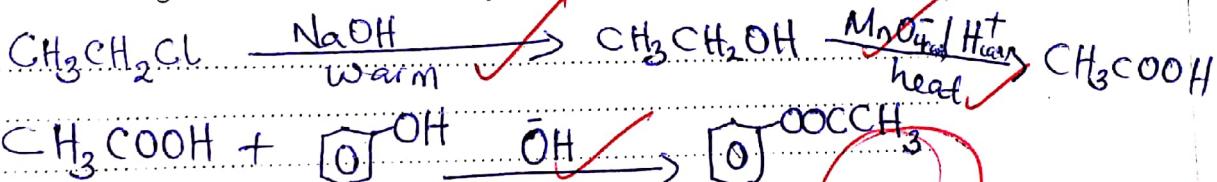
~~X + 0x4 = 0~~ Oxidation number of nickel is 0

~~X + 4x1 = 0~~ Oxidation number of nickel is 0

6. Write equations to show how Phenyl ethanoate can be synthesized from Chloroethane.

Indicate the reagents and conditions necessary.

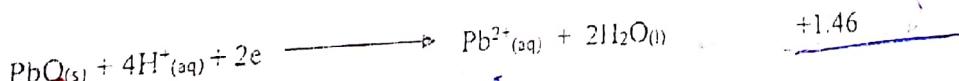
(4 marks)



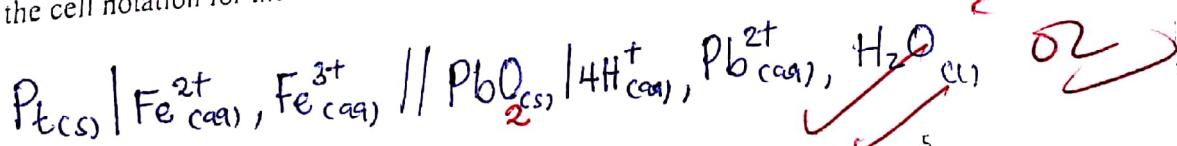
54

7. The following half cell reactions are given;

E/V



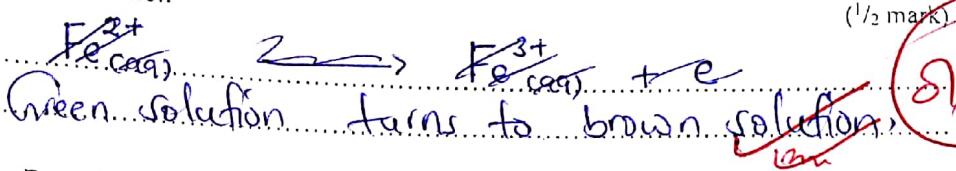
(a) Write the cell notation for the cell formed by combining the two half cells. (2 marks)



(b) State what will be observed and write equations for the reactions that takes place at:

(i) Anode

Observation



(1/2 mark)

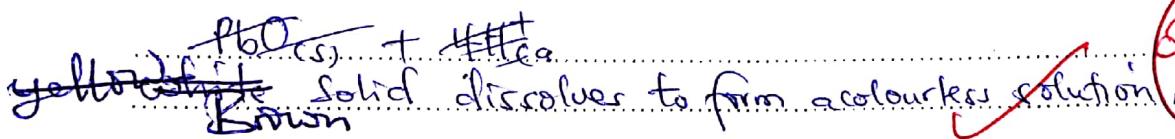
Equation



(1 mark)

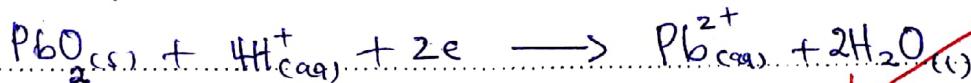
(ii) Cathode

Observation



(1/2 mark)

Equation



(1 mark)

(c) Calculate the e.m.f. of the cell.

(1 mark)

$$\begin{aligned} E_{\text{m.f.}} &= E_{\text{R.H.S.}} - E_{\text{L.H.S.}} \\ &= 1.46 - 0.77 \\ &= +0.69\text{V.} \end{aligned}$$

8. (a) Starting with dodecan-1-ol  $\text{CH}_3(\text{CH}_2)_{10}\text{CH}_2\text{OH}$  describe briefly how a synthetic detergent can be prepared.

(4 1/2 marks)

Dodecanol is heated with concentrated sulphuric acid to form dodecene.  $\text{CH}_3(\text{CH}_2)_{10}\text{CH}_2\text{OH} \xrightarrow{\text{Conc. H}_2\text{SO}_4} \text{CH}_3(\text{CH}_2)_{9}\text{CH}=\text{CH}_2$   
Dodecene is then reacted with benzene to form an alkylated benzene  $\text{CH}_3(\text{CH}_2)_{9}\text{CH}=\text{CH}_2 + \text{C}_6\text{H}_6 \xrightarrow[\text{heat}]{\text{AlCl}_3 / \text{H}^+} \text{C}_6\text{H}_5\text{CH}(\text{CH}_3)_{10}\text{CH}_2\text{CH}_3$

6

The alkylated benzene is then reacted with fuming sulphuric acid which is reacted with sodium hydroxide solution to form the detergent.

(b)

State any two advantages of synthetic detergent over soapy detergents.

- It is not affected by hard water.
- It is fairly soluble with water & form more lather than soap.
- does not form scum with hard water.

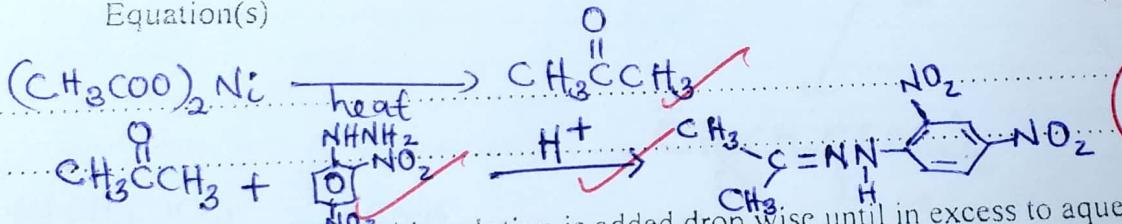
9. State what will be observed and write equations for the reaction that takes place when;

(a) Nickel ethanoate is heated strongly and the gaseous products passed through acidified 2,4-dinitrophenyl hydrazine.

Observation (1 1/2 marks)

Yellow precipitate.

Equation(s) (2 1/2 marks)

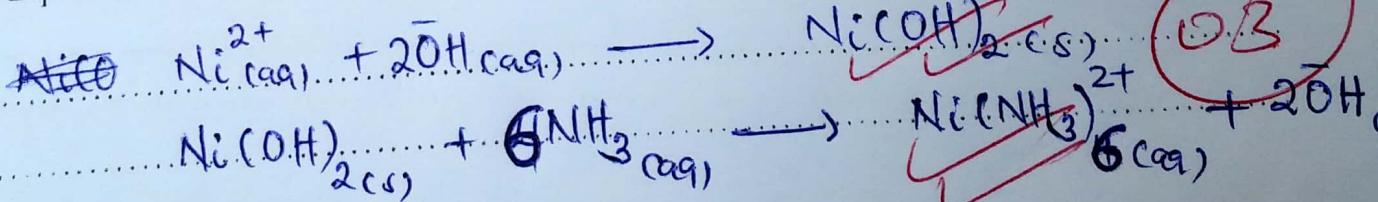


(b) Ammonium hydroxide solution is added drop wise until in excess to aqueous solution of Nickel ethanoate.

Observation (1 1/2 marks)

A green precipitate soluble in excess forming a ~~purple~~ solution.

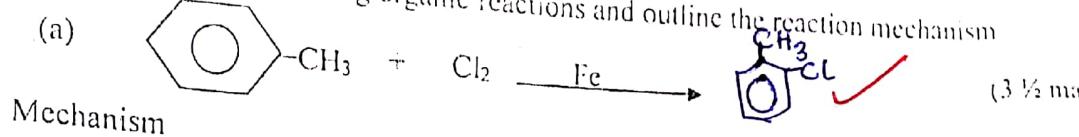
Equation(s) (2 1/2 marks)



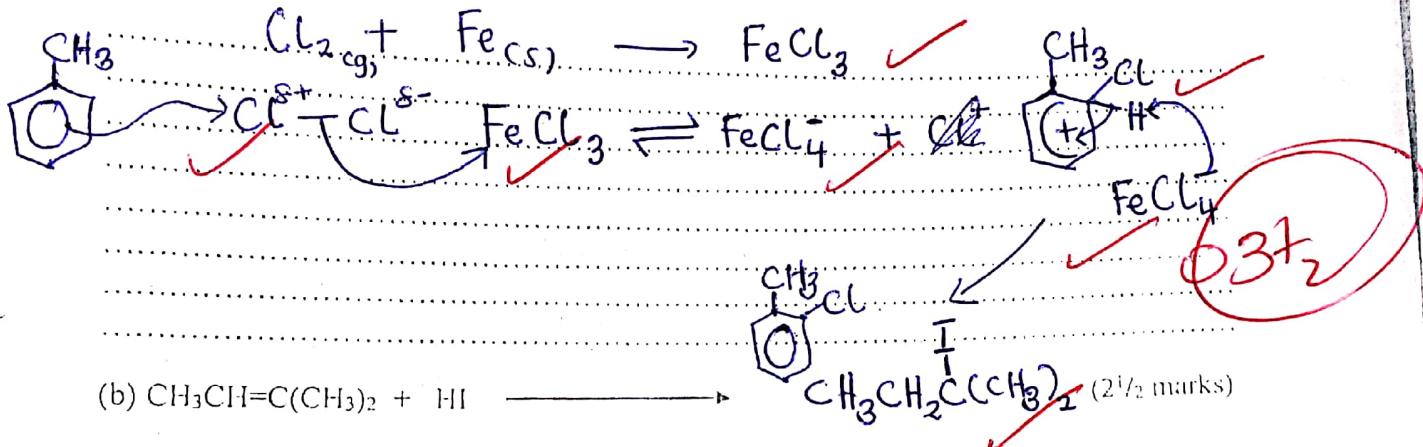
SECTION B: (54 Marks)

Answer six questions ONLY

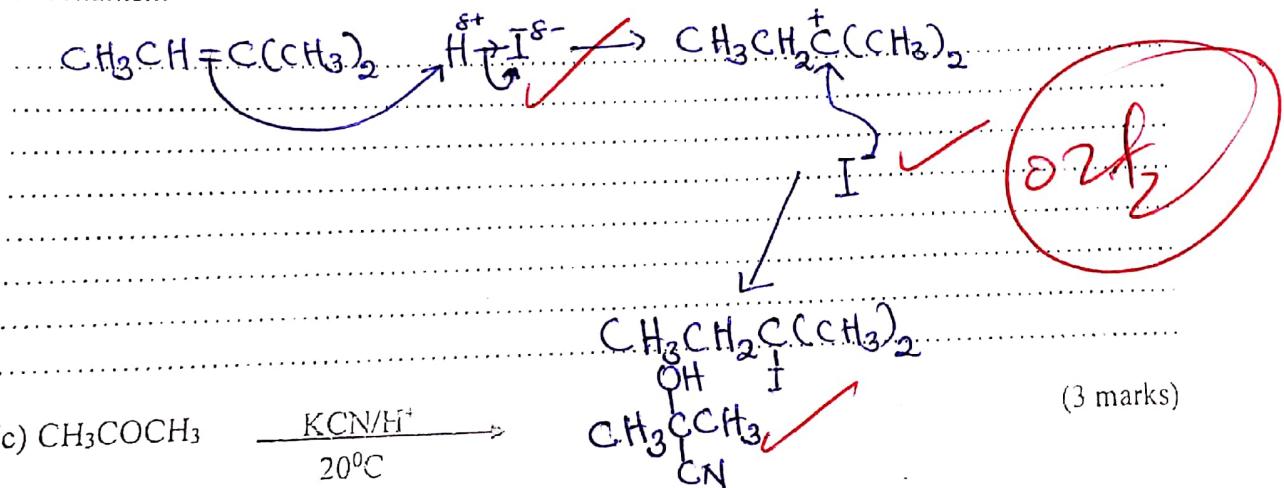
10. Complete the following organic reactions and outline the reaction mechanism



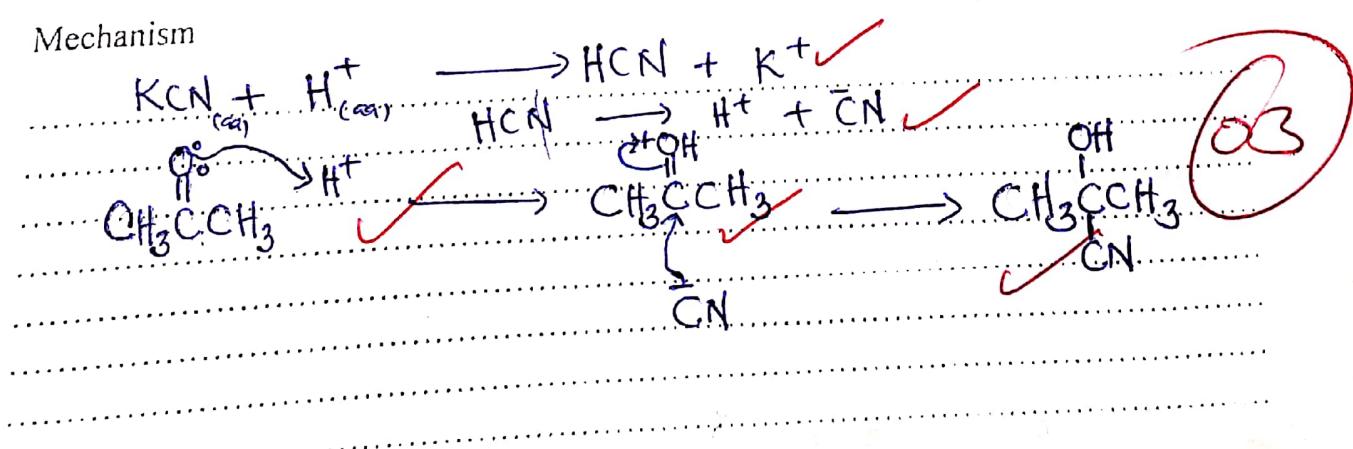
Mechanism



Mechanism



Mechanism



11. (a) Draw the structure and name the shape of the following species. In each case state the oxidation state of the central atom in the structure. (6 marks)

Species	Structure	Shape	Oxidation state
CS <sub>2</sub>		V-Shape or Bent	+4
POBr		Bent or V-Shape	+3
SnO <sub>3</sub> <sup>2-</sup>		Trigonal Planar	+4

(b) Compare the bond angle of POBr and SnO<sub>3</sub><sup>2-</sup>. Give reason for your answer. (3 marks)

POBr has a smaller bond angle compared to SnO<sub>3</sub><sup>2-</sup> because POBr has lone pair which causes repulsion decreasing the bond angle giving it bent shape.

OB

12. (a) The bond dissociation energies of the following compounds are given;

Elements	Fluorine	Chlorine	Bromine	Iodine
Bond dissociation energies/ kJ mol <sup>-1</sup>	33.3	57.8	46.1	36.2

State and explain variation in bond dissociation energies of the above given elements.

(4marks)

The bond dissociation energies of group VII elements decreases from chlorine down the group. This is due to increase in atomic radius which decreases the nuclear attraction for the bond pairs thus increasing the bond length.

However, the bond energy of fluorine is lower than expected due to small atomic radius which makes lone pairs of electrons easily approach other thus the further repulsion.

S4

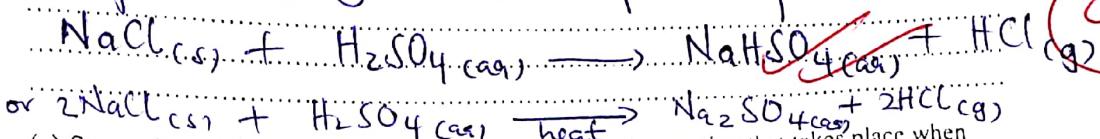
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(b) Bromine and iodine can be prepared by reacting concentrated sulphuric acid with sodium bromide and sodium iodide respectively however chlorine cannot be prepared using the same method. Explain. (3 marks)

~~Chlorine cannot be prepared from Sodium hydrochloride and concentrated sulphuric acid because concentrated sulphuric acid forms hydrogen chloride fumes from metal chlorides~~



(c) State what will be observed and write equation for the reaction that takes place when concentrated sulphuric acid is added to solid sodium bromide.

Observation

(1/2 mark)

~~Red brown liquid or dark red liquid.~~ SK

Equation



(1 1/2 marks)

13. (a) Explain what is meant by the term partition coefficient. (1 1/2 marks)

~~This is the constant ratio of the concentration of solute in one immiscible solvent to its concentration in another immiscible solvent when the two solvents are in contact at equilibrium at constant temperature when the solute is in the same molecular state in both solvents.~~

(b)  $100\text{cm}^3$  of an aqueous solution of X containing 30g per litre of X was shaken with  $100\text{cm}^3$  of trichloromethane. The distribution coefficient of X between trichloromethane and water is 2. Calculate the mass of X which was extracted. (2 1/2 marks)

$$K_D = \frac{[\text{X}]_{\text{CHCl}_3}}{[\text{X}]_{\text{water}}}$$

~~Let  $2x$  g be mass extracted by  $\text{CHCl}_3$ .~~

~~Let  $(30-x)$  g be mass extracted by water.~~

$$2 = \frac{x}{100} : \frac{30-x}{100} = \frac{x}{30-x}$$

$$2(30-x) = x$$

$$60 - 2x = x$$

$$60 = x + 2x = 3x$$

$$\frac{60}{3} = x$$

$$x = 20\text{g}$$

The mass extracted is ~~20g~~

~~1000cm<sup>3</sup> of the solution contains 30g of X  
100cm<sup>3</sup> of solution contains  $\frac{30}{1000} \times 100 = 3\text{g}$  of X.~~

~~Let mass extracted be  $y$  g.  
mass left in water be  $3-y$  g.~~

$$2 = \frac{y}{100} : \frac{3-y}{100} = \frac{y}{3-y}$$

$$6 - 2y = y$$

$$y = 2\text{g}$$

SK

(c) Calculate the mass of X which will be extracted if the solution of X in (b) is shaken with two successive portions of  $50\text{cm}^3$  of trichloromethane. (4 marks)

~~Mass that let the mass extracted by organic bz~~

~~Mass remained in aqueous bz~~

54

$$Z = \frac{z}{3-z} \cdot z = 1.5\text{g}$$

~~50 100 Mass remaining in aqueous~~

$$Z = \frac{z \times 100}{50 \cdot 3-z} \cdot 3-1.5 = 1.5\text{g}$$

$$Z = \frac{2z}{3-z} \cdot \text{let the mass extracted be } w$$

$$6-2z = 2z \quad \text{Mass remained be } 1.5-w$$

$$2 = \frac{w}{1.5-w} \cdot 3-2w = 2w \cdot 3 = 4w \cdot w = 0.75\text{g}$$

(d) Comment on your answer in (b) and (c) Total mass extracted =  $1.5 + 0.75 = 2.25\text{g}$  (1 mark)

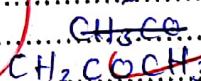
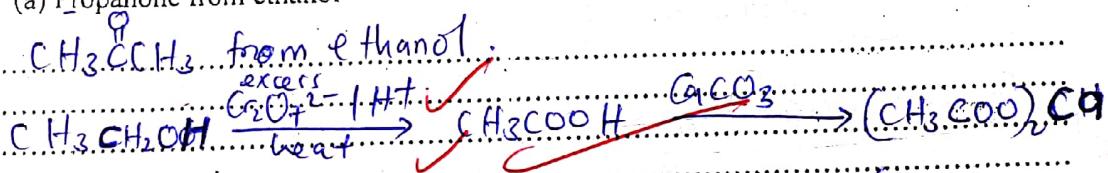
~~Single extract is less than the 2 for two portion al extract~~

(e) State one application of partition coefficient apart from solvent extraction. (1/2 mark)

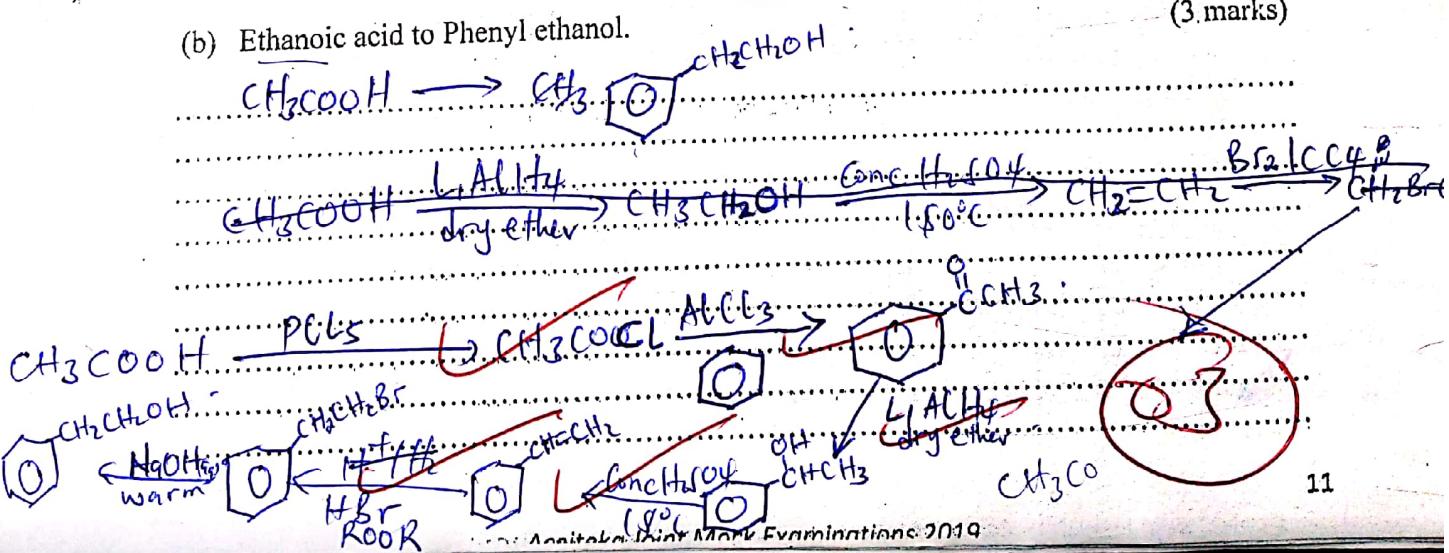
~~In analysis of Complex ion formation~~

14. Write equations to show how the following synthesis can be carried out. In each case indicate the reagents and conditions necessary.

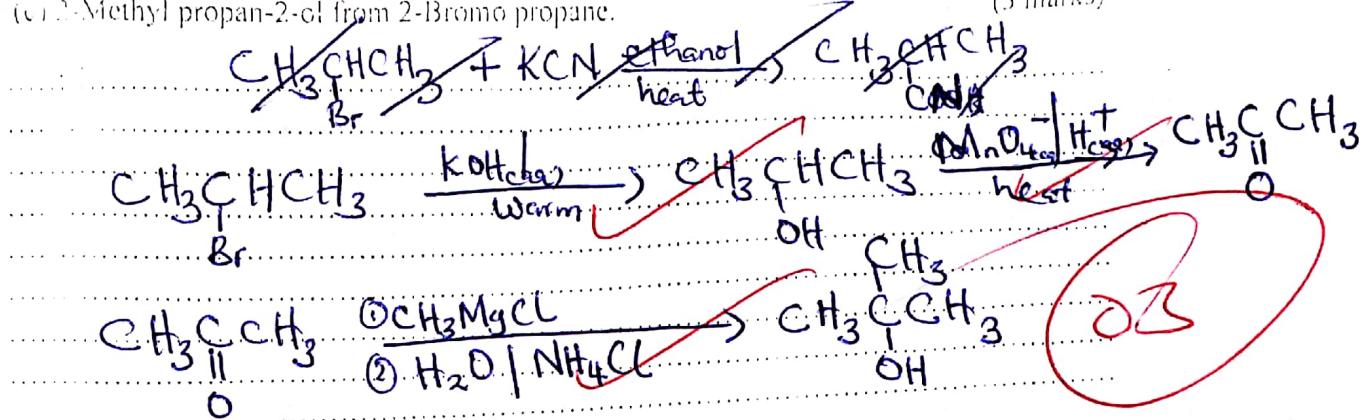
(a) Propanone from ethanol



(b) Ethanoic acid to Phenyl ethanol.



(c) 2-Methyl propan-2-ol from 2-Bromo propane. (3 marks)



15. A compound Y contains by mass 61.02% carbon, 15.25% hydrogen and the rest nitrogen.

(a) Determine the empirical formula of Y.

% mass	C	H	N	$100 - (61.02 + 15.25) = 23.73\%$
% mass	61.02	15.25	23.73	
RAM	12	1	14	
moles ratio	$\frac{5.085}{1.695}$	$\frac{15.250}{1.695}$	$\frac{1.695}{1.695}$	2
	3	9	1	

Empirical formula of Y is  $\text{C}_3\text{H}_9\text{N}$

(b) Compound Y has a density of  $2.63 \text{ gdm}^{-3}$  at s.t.p. Determine the molecular formula of Y.

$$\begin{array}{lll} 1000 \text{ cm}^3 & \text{weigh} & 2.63 \text{ g of Y} \\ 22400 \text{ cm}^3 & \text{weigh} & \frac{2.63 \times 22400}{1000} = 58.9 \approx 59. \end{array}$$

(2 marks)  $\text{O}_2$

$$(\text{C}_3\text{H}_9\text{N})_n = 59$$

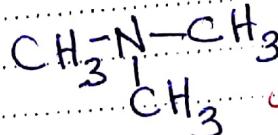
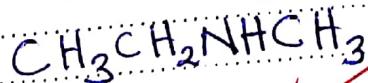
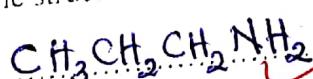
$$(12 \times 3 + 9 \times 1 + 14 \times 1)_n = 59$$

$$59n = 59$$

$$n = 1$$

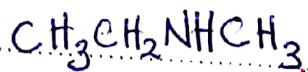
∴ The molecular formula of Y is  $\text{C}_3\text{H}_9\text{N}$ .

(c) Write the structural formula of the possible isomers of Y.



(d) Compound Y forms yellow oils when reacted with cold concentrated hydrochloric acid and sodium nitrite.

(i) Identify Y



(1/2 mark)

(ii) Write equation for the reaction that took place.



(1 mark)

(e) (i) Name the reagent that can be used to confirm the functional group in compound Y.

Sodium metal

(1/2 mark)

(ii) State the observation made.

Bubbles of colourless gas

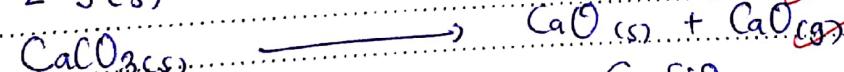
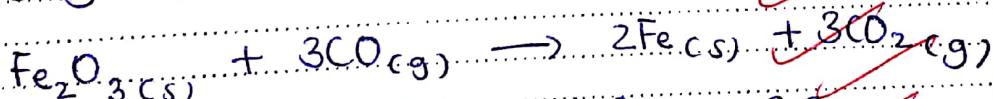
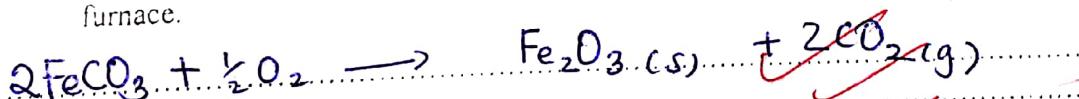
(1/2 mark)

(iii) Write equation for the reaction that takes place when the named reagent in (e) (i) is reacted with compound Y.



51

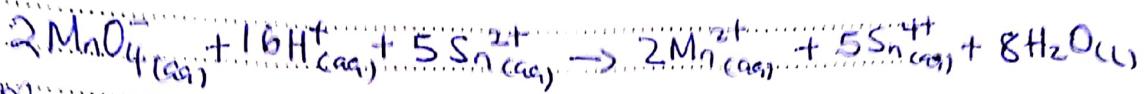
16. (a) Iron metal is extracted from one of its ore siderite. The ore is mixed with coke and lime stone and then heated strongly in a blast furnace.  
Write equations for the reactions that lead towards formation of iron metal in the blast furnace. (4 1/2 marks)



51/2

(b) 1.6g of an impure sample of tin (II) chloride was added to an aqueous solution of iron(III) chloride and the mixture heated until there was no further change. The solution was diluted to 250cm<sup>3</sup> with water. 25cm<sup>3</sup> of the solution was acidified with dilute sulphuric acid and titrated with 0.02M potassium permanganate solution. 16.0cm<sup>3</sup> of oxidant was required to reach the end point. Determine the percentage purity of tin(II) chloride. (4 1/2 marks)

13



Moles of  $\text{MnO}_4^-$  in  $250\text{cm}^3$  of solution contains  $1.6\text{g}$  of  $\text{SnCl}_4$   
 $1000 \text{ cm}^3$  of solution contains  $\frac{1.6 \times 1000}{250} = 6.4\text{g}$

$$\text{Moles of } \text{MnO}_4^- = \frac{1.6 \times 0.02}{1000} = 0.00032 \text{ moles}$$

$$2 \text{ moles of } \text{MnO}_4^- \text{ react with } 5 \text{ moles of Sn}^{2+}$$

$$0.00032 \text{ moles of } \text{MnO}_4^- \text{ react with } \frac{5 \times 0.00032}{2} = 0.0008 \text{ moles}$$

$$\text{mass of } \text{SnCl}_4 = 0.0008 \times (119 + 35.5 \times 4) = 0.2 \text{ g}$$

$$25 \text{ cm}^3 \text{ of solution contain } 0.0008 \text{ moles of Sn}^{2+}$$

$$1000 \text{ cm}^3 \text{ of solution contain } \frac{0.0008 \times 1000}{25} = 0.032 \text{ g}$$

$$\text{mass of } \text{SnCl}_4 = 0.032 \times (119 + 35.5 \times 4) = 8.352 \text{ g}$$

to purity =  $\frac{\text{mass sample}}{\text{mass impure sample}} \times 100$   
 $= \frac{8.352}{6.4} \times 100$

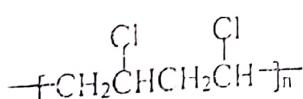
17. (a) Distinguish between terms thermosetting plastics and thermosoftening plastics.

Name one example in each case.

Thermosetting plastics are plastics which harden on heating and cannot be remoulded e.g. melamine while thermosoftening plastics are plastics which become soft when heated and can be remoulded e.g. polyethene.

Q3

- (b) A polymer Q has a structural formula of



- (i) Write the name and structural formula of the monomer of the above given polymer (1½ marks)

chloro ethene  
 $\text{CH}_2=\text{CHCl}$

CH<sub>2</sub>

- (ii) Name the type of polymerization by which the above given polymer is formed. (½ marks)

Addition polymerisation

DP

(c) When 71.76g of the monomer in (a) was polymerized  $2.67 \times 10^{-2}$  moles of the polymer was formed.

Determine the;

(i) Molecular mass of the polymer.

(1 1/2 marks)

$$2.67 \times 10^{-2} \text{ moles weigh } 71.76 \text{ g}$$
$$\text{1 mole weighs } \frac{71.76}{2.67 \times 10^{-2}} = 2687.64$$



(2 marks)

(ii) Number of monomers in the polymer.

$$\text{mass of } \text{CH}_2=\text{CHCl} = 62.5 \text{ g}$$

$$\text{number of monomers} = \frac{2687.64}{62.5} = 43$$

43 monomers

(1/2 mark)

(d) State one use of the polymer Q.

- An insulator for cables
- making artificial leather
- making water pipes.

END

15