KIBUGO DENNIS

Candidates Name:

.....

Signature: .....

Centre No.					Personal No.		

0750-732031
0760-954033

P525/1
CHEMISTRY
PAPER 1
JULY/AUGUST 2022
2 ¾ Hours

TORORO ARCHDIOCESE EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS – AUGUST 2022

CHEMISTRY

Paper 1

3 hours 45 minutes

INSTRUCTIONS TO CANDIDATES

Answer all questions in Section A and only six questions in Section B.

All questions must be answered in the spaces provided.

The Periodic table, with relative atomic masses is attached at the end of the paper.

Mathematical tables (3 – figure tables) and non-programmable scientific electronic calculators may be used.

Molar gas constant, $R = 8.314 JK^{-1}mol^{-1}$

Molar volume of gas at s.t.p is $22.4 dm^3$

For Examiner's Use Only																	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total

Turnover

SECTION A: (46 MARKS)

Answer **all** *questions from this section.*

1. (a) Define:

(i) Bond energy. (1 mark)

The energy required to break one mole of a covalent compound into its constituent gaseous atoms. ✓ 01

(ii) Heat of formation. (1 mark)

The heat change that occurs when one mole of a compound is formed from its constituent elements in their normal physical states. ✓ 01

(b) Given the following bond energies.

Bond	Bond Energy (Kj/mole)
C—C	337
C—H	414
C—O	360
O—H	123

Calculate the heat of conversion of gaseous methoxymethane to gaseous ethanol.

$CH_3OCH_3 \longrightarrow CH_3CH_2OH$ (2 marks)

ΔH^{θ} = Σ bonds broken — Σ bonds formed ✓ 02

= $(6(C-H) + 2(C-O)) - (5(C-H) + (C-C) + (O-H) + (C-O))$ ✓

= $((6\times414) + (2\times360)) - ((5\times414) + 337 + 123 + 360)$ ✓

= $+314\ KJmol^{-1}$ ✓

2. (a) An alkyne Q has molecular formula C_4H_6. Write the names and structural formulae of all possible isomers of Q. (2 marks)

$CH_3C\equiv CCH_3$ ✓ But-2-yne ✓ 02

$CH_3CH_2C\equiv CH$ ✓ But-1-yne ✓

(b) Q reacts with an ammoniacal solution of silver nitrate.

(i) State what is observed. (½ marks)

white precipitate ✓ Reject; white solid

(ii) Write the equation for the reaction in b (i) above. (1 ½ marks)

$CH_3CH_2C{\equiv}CH_{(g)} + Ag(NH_3)_2^+{}_{(aq)} \rightarrow CH_3CH_2C{\equiv}CAg_{(s)} + 2NH_4^+{}_{(aq)}$ ✓✓

Accept;

$CH_3CH_2C{\equiv}CH_{(g)} + AgNO_{3(aq)} + NH_{3(aq)} \rightarrow CH_3CH_2C{\equiv}CAg_{(s)} + NH_4NO_{3(aq)}$

(c) Write equations to show how Q can be synthesized from ethane. (4 marks)

$CH_3CH_3 \xrightarrow[\text{excess ✓ Reject; if not excess}]{Cl_2(g)\,/\,U.V\ light} CH_3CH_2Cl \xrightarrow[\text{heat}]{NaOH_{(aq)}\ \text{Rej; if not (aq)}} CH_3CH_2OH$ ✓✓

Accept

$CH_3CH_3 \xrightarrow[\text{Dibenzoyl peroxide, 40-80°C}]{SO_2Cl_2} CH_3CH_2Cl$ ✓

$CH_3CH_2OH \xrightarrow[180°C]{\text{Conc. } H_2SO_4}$ ✓

$CH_3CH_2C{\equiv}CH \xrightarrow[2)\ CH_3CH_2Br]{1)\ Na_{(s)}\,/\,liq.NH_3} HC{\equiv}CH \xrightarrow[\text{heat}]{\text{Excess } KOH_{(aq)}\,/\,CH_3CH_2OH} CH_2CH_2 \xrightarrow{Br_2/CCl_4} H_2C{=}CH_2$ ✓✓✓

Br Br

3. (a) Explain briefly why chlorine is a stronger oxidizing agent than bromine. (2 marks) 04

Oxidising power of halogens depend on their electron affinity, bond dissociation energy and hydration energy. ✓

02

Chlorine has a lower bond dissociation energy ✓ due to a weaker chlorine–chlorine bond. Consequently, the chloride ion has a higher hydration energy ✓ due to its smaller ionic radius. Both effects make chlorine to have a larger negative enthalpy ✓ of formation of chloride ions hence chlorine is ~~more~~ stronger oxidising agent.

(b) Write equation (s) for the reactions of:

(i) Bromine with cold dilute sodium hydroxide. (1 ½ marks)

$Br_{2(g)} + 2\bar{O}H_{(aq)} \rightarrow Br^-_{(aq)} + \bar{O}Br^-_{(aq)} + H_2O_{(l)}$ ✓✓

(ii) Chlorine with hot concentrated sodium hydroxide. (1 ½ marks)

$2Cl_{2(g)} + 6\bar{O}H_{(aq)} \rightarrow 5Cl^-_{(aq)} + ClO_3^-{}_{(aq)} + 3H_2O_{(l)}$ ✓✓

Accept molecular equation.

- No mark for unbalanced equation
- Deduct ½ for wrong or missing state symbol (s)

4. The standard electrode potentials for some half-cell reactions are given below.

Half-cell reaction	E^{θ}/V
$MnO_4^-(aq) + e \longrightarrow MnO_4^{2-}(aq)$	+0.56
$MnO_4^{2-}(aq) + 2H_2O(l) + 2e \longrightarrow MnO_2(s) + 4OH^-(aq)$	+0.60
$MnO_4^-(aq) + 8H^+(aq) + 5e \longrightarrow Mn^{2+}(aq) + 4H_2O(l)$	+1.52
$Br_2(aq) + 2e \longrightarrow 2Br^-(aq)$	-1.06

(a) Write the:

(i) Cell convention of the cell formed when bromine half-cell is combined with the half-cell of acidified potassium manganate (VII). (1 mark)

$Pt(s)/2Br^-_{(aq)}, Br_{2(aq)} // MnO^-_{4(aq)}, H^+_{(aq)}, Mn^{2+}_{(aq)}/Pt(s)$ ✓ 01

(ii) Overall cell reaction in a (i). (1 ½ marks)

$10Br^-_{(aq)} + 2MnO^-_{4(aq)} + 16H^+_{(aq)} \xrightarrow{\checkmark\checkmark\ 01½} 5Br_{2(aq)} + 2Mn^{2+}_{(aq)} + 8H_2O_{(l)}$

(b) Calculate the electromotive force of the cell in (a). (1 ½ marks)

$E^{\theta}_{cell} = E^{\theta}_{right} - E^{\theta}_{left}$ 01½

$= 1.52 - (-1.06)$ ✓

$= +2.58V$ ✓

Accept OR $E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{Anode}$ OR $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxid}$

(c) State whether the reaction in (b) above is feasible or not. Give a reason for your answer. (1 marks)

It is feasible. This is because the emf of the cell is positive. ✓ (01)

(d) State what would happen when a solution of potassium manganate (VI) is exposed to air and write equation for the reaction that took place. (2 marks)

Observation

Green solution turns to purple solution with black particle 01½

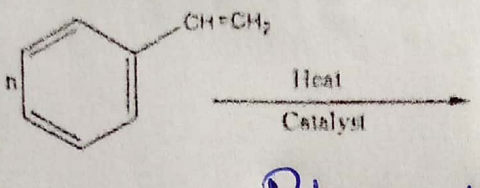
Equation

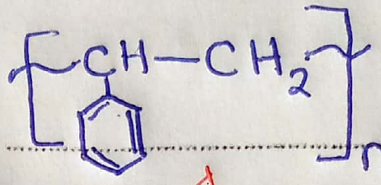
$3MnO^{2-}_{4(aq)} + 2CO_{2(g)} \longrightarrow 2MnO^-_{4(aq)} + MnO_{2(s)} + 3CO^{2-}_{3(aq)}$ ✓✓ 01½

5. Complete the following equations and write the IUPAC name of the major product.

(a) $(CH_3COO)_2Ca \xrightarrow{\text{Heat}} CH_3COCH_3 + CaCO_3(s)$ (1½ marks) 0½

Name of product: Propanone ✓

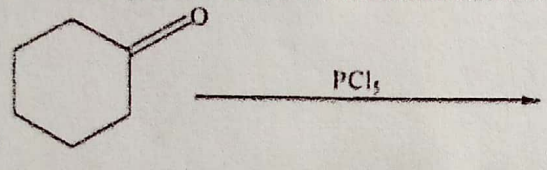
(b) 


(1½ marks) 0½

Name of product: Polyphenylethene ✓ Accept; Polystyrene

(c) $HOCH_2CH_2CH_2CH_2OH \xrightarrow[\text{Heat}]{\text{Excess } Cr_2O_7^{2-}/H^+} HOOCCH_2CH_2COOH$ (1½ marks) 0½

Name of product: Butane-1,2-dioic acid. ✓

(d) 

(1½ marks)

Name of product: 1,1- dichlorocyclohexane ✓ 0½

6. (a) Write the:

(i) Equation for the ionization of ethylamine in water. (1½ marks) 0½

$CH_3CH_2NH_2(aq) + H_2O(l) \rightleftharpoons CH_3CH_2\overset{+}{N}H_3(aq) + \overline{O}H(aq)$

Reject; If ⇌ not used.

(ii) Expression for the ionization constant, K_b, of ethylamine. (1 mark)

Reject if a (i) is wrong

$$K_b = \frac{[CH_3CH_2\overset{+}{N}H_3][\overline{O}H]}{[CH_3CH_2NH_2]}$$ ✓ 01

(b) A solution containing 0.1 moles of ethylamine per litre of solution at 25°C.

(i) Calculate the pH of the solution.
(the ionization constant of ethylamine is 5.4×10^{-4} moldm^{-3} at 25°C, Kw = 1.0 $\times 10^{-14}$ mol^{2}dm^{-3}) (2 ½ marks)

From $K_b = \frac{[CH_3CH_2\overset{+}{N}H_3][\bar{O}H]}{[CH_3CH_2NH_2]}$

At equilibrium, $[CH_3CH_2\overset{+}{N}H_3] = [\bar{O}H]$

$K_b = \frac{[\bar{O}H]^2}{[CH_3CH_2NH_2]}$ ✓

$5.4 \times 10^{-4} = \frac{[\bar{O}H]^2}{0.1}$ ✓

$[\bar{O}H] = 7.348 \times 10^{-3}$ M ✓

But (02½)

$K_w = [H^+][\bar{O}H]$

$1 \times 10^{-14} = 7.348 \times 10^{-3}[H^+]$ ✓

$[H^+] = 1.3608 \times 10^{-12}$ M ✓

$pH = -\log_{10}[H^+]$ ✓

$= -\log 1.3608 \times 10^{-12}$

$pH = 11.87$ ✓

Alternatively

$K_b = C\alpha^2$

Accept $\alpha = \sqrt{\frac{5.4 \times 10^{-4}}{0.1}}$

$\alpha = 0.07348$

$[\bar{O}H] = C\alpha = 0.1 \times 0.7348$

$= 7.348 \times 10^{-3}$M

$K_w = [H^+][\bar{O}H]$

$[H^+] = 1.3608 \times 10^{-12}$M

$pH = -\log[H^+]$

$= -\log 1.3608 \times 10^{-12}$

$pH = 11.87$.

(ii) State the assumptions made in b (i) above. (1 mark)

At Equilibrium, $[CH_3CH_2\overset{+}{N}H_3] = [\bar{O}H]$ (01)

7. (a) State what would be observed and write equation for the reaction that would take place if potassium iodide was added to acidified potassium dichromate (VI) solution.

Observation

Orange solution turns to green solution. (01) (1 marks)

Equation

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6I^-(aq) \rightarrow 2Cr^{3+}(aq) + 7H_2O(l) + 3I_2(aq)$ (01½) (1 ½ marks)

(b) Sodium thiosulphate solution was added to the mixture in (a), state what was observed and write equation for the reaction that took place.

Observation

Brown solution turns to a colourless solution (01) (1 mark)

Equation

$2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow S_4O_6^{2-}(aq) + 2I^-(aq)$ (01½) (1 ½ marks)

8. (a) Define a 'complex ion' (1 mark)

An ion consisting of a central metal ion which is datively bonded to ligands. 01

~~A lone pair~~ Accept any other correct alternative definition.

OR An ion positive or negative in which atoms or groups of atoms with a negative charge or lone pair of electrons form co-ordinate bonds with central metal ion.

(b) Complete the following table about complexes of chromium and cobalt. (2 marks)

Complex	Oxidation state of metal ion	Coordination number
$[Co(NH_3)_4(H_2O)_2]Cl_2$	+2	6
$[Cr(NH_3)_6]^{3+}$	+3	6

02

9. Name the reagent that can be used to distinguish between the following pairs of compounds. In each case state what you would observe when the reagent is treated with each member of the pair.

(a) CH_3CH_2OH and CH_3OH (2 marks)

Reagent

Hot iodine solution and sodium hydroxide solution 02

Observation

With CH_3CH_2OH, A yellow precipitate Reject; orange precipitate

With CH_3OH, No observable change.

(b) HCOOH and CH_3COOH (2 marks)

Reagent

Ammoniacal silver nitrate solution Reject; solution missing

Observation

With HCOOH, A silver mirror. 02

With CH_3COOH, No observable change.

Accept

Fehling's solution

With HCOOH, A reddish brown precipitate.

With CH_3COOH, No observable change.

SECTION B: (54 MARKS)

Answer any **six** *questions from this section.*

Any additional question(s) answered will **not** *be marked.*

10. An organic compound T consists of 48.6% carbon, 8.1% hydrogen and the rest oxygen.

(a) Determine the empirical formula of T. (2 ½ marks)

% of O = 100 − (8.1 + 48.6) = 43.3%

Elements	C	H	O
Composition	48.6	8.1	43.3
Moles	$\frac{48.6}{12}$	$\frac{8.1}{1}$	$\frac{43.3}{16}$
	4.05	8.10	2.71
Mole ratio	$\frac{4.05}{2.71}$	$\frac{8.10}{2.71}$	$\frac{2.71}{2.71}$
Simplest ratio:	2 × (1.49	3	1)

02½

Empirical formula of T is $C_3H_6O_2$

(b) 0.453g of a vaporized sample of T occupied 200cm^3 at 100°C and 95.0kPa pressure.

(i) Calculate the molecular mass of T. (2 ½ marks)

From $PV = nRT$

$PV = \frac{m}{Mr}RT$

$95.0 \times 10^3 \times 200 \times 10^{-6} = \frac{0.453}{Mr} \times 8.314 \times 373$

$Mr = 74g$

02½

∴ Molecular mass of T is 74g

(ii) Determine the molecular formula of T. (1 ½ marks)

$(C_3H_6O_2)_n = 74$

$(12 \times 3)n + (1 \times 6)n + (16 \times 2)n = 74$

$n = 1$

01½

$\therefore (C_3H_6O_2)_1 = C_3H_6O_2$

∴ Molecular formula of T is $C_3H_6O_2$

(c) T reacts with magnesium metal with evolution of a gas. Write:

(i) The structural formula of T. (1 mark)

CH_3CH_2COOH 01

(ii) The equation for the reaction between T and magnesium metal. (1 ½ marks)

$CH_3CH_2COOH_{(aq)} + Mg_{(s)} \rightarrow Mg(CH_3CH_2COO)_{2(aq)} + \frac{1}{2}H_{2(g)}$ 01½

11. During manufacture of sulphuric acid by contact process, Sulphur dioxide is catalytically oxidized to Sulphur trioxide according to the following equation:

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \Delta H^{\theta} = -97kJmol^{-1}$

(a) Name one source of dioxide and one source of oxygen used in the contact process. (1 mark)

Source of Oxygen
- Fractional distillation of liquid air

Sources of SO_2
- Burning sulphur in air
- Roasting iron pyrites / Copper pyrites
- Oxidation of zinc blende.
- Burning Hydrogen sulphide in air (from crude oil)

any one or alternative 01

(b) State the industrial conditions used to obtain the maximum yield of Sulphur ~~dioxide~~ trioxide. (1 ½ marks)

- Temperature of 450°C Accept; Low temperature
- Pressure of 1–3 atm
- Catalyst; Vanadium(V) oxide

01½

(c) State the conditions under which sulphuric acid reacts with tin and copper and in each case write equation for the reaction that takes place.

(i) Tin (2 marks)

Cold dilute sulphuric acid.

$Sn_{(s)} + 2H^+_{(aq)} \rightarrow Sn^{2+}_{(aq)} + H_{2(g)}$ 02

Accept

Hot Concentrated sulphuric acid

$Sn_{(s)} + 4H_2SO_{4(l)} \rightarrow Sn(SO_4)_{2(aq)} + 2SO_{2(g)} + 4H_2O$

(ii) Copper (2 marks)

Hot concentrated sulphuric acid 02

$Cu_{(s)} + 2H_2SO_{4(l)} \longrightarrow CuSO_{4(aq)} + SO_{2(g)} + 2H_2O_{(l)}$

(d) Concentrated sulphuric acid is 98% w/w and has a density of $1.84gcm^{-3}$. Calculate the molarity of the concentrated sulphuric acid. (2 ½ marks)

$1cm^3$ of solution contain 1.84g of H_2SO_4

$1000cm^3$ of solution contain $\left(\frac{1.84 \times 1000}{1}\right)g$

$= 1840g$ of H_2SO_4

$\frac{98}{100} \times 1840 = 1803.2g$

Molar mass of $H_2SO_4 = (2\times1) + 32 + (16\times4)$

$= 98g$

98g of H_2SO_4 contain 1mole

1803.2g of H_2SO_4 contain $\frac{1803.2 \times 1}{98}$

$= 18.4M$

02½

12. (a) State three properties exhibited by chromium as a transition metal. (3 marks)

- Has variable oxidation states
- Forms coloured compounds
- Forms complexes.
- It is paramagnetic
- Acts as a catalyst
- Forms interstitial compound

03 (any 3)

(c) An aqueous solution of iron (II) salt was added to an acidified solution of chromium in the oxidation state of +6.

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

Orange solution turns to green solution 01

(ii) Write half equations and the overall equation for the reaction that took place. (3 ½ marks)

$Fe^{2+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)} + e$ 01

$Cr_2O_7^{2-}{}_{(aq)} + 14H^+_{(aq)} + 6e \longrightarrow 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$ 01

Overall

$Cr_2O_7^{2-}{}_{(aq)} + 14H^+_{(aq)} + 6Fe^{2+}_{(aq)} \longrightarrow 2Cr^{3+}_{(aq)} + 7H_2O_{(l)} + 6Fe^{3+}_{(aq)}$

01½

10

(d) (i) State one application of chromium in the oxidation state of +6 in organic synthesis. (½ mark)

Oxidation of primary alcohol / secondary alcohol / Aldehydes OR OR

Accept; oxidising agent

01

(iii) Write the equation to illustrate your answer. (1 mark)

Accept unbalanced equation

$$CH_3CH_2OH \xrightarrow[\text{heat}]{Cr_2O_7^{2-}(aq) \mid H^+(aq)} CH_3CHO + 2Cr^{3+}(aq) + H_2O(l)$$

01

Accept; $CH_3CH_2OH + Cr_2O_7^{2-}(aq) + H^+(aq) \xrightarrow{heat} CH_3CHO + 2Cr^{3+}(aq) + H_2O(l)$

13. (a) What is meant by the term **common ion effect**? (2 marks)

The precipitation of a sparingly soluble ionic compound from a saturated solution by addition of another soluble compound containing a similar ion.

02

Accept alternative definitions or derivations

(b) Magnesium hydroxide is sparingly soluble in water.

Write:

(i) The equation for the solubility of magnesium hydroxide in water. (1 ½ marks)

$$Mg(OH)_2(s) + aq \rightleftharpoons Mg^{2+}(aq) + 2\bar{O}H(aq)$$

01½

(ii) The expression for the solubility product, *Ksp*, of magnesium hydroxide.

$$K_{sp} = [Mg^{2+}][\bar{O}H]^2$$ (1 mark)

01

(d) If the solubility product of magnesium hydroxide at 25°C is 4.2×10^{-12} mol^3dm^{-9}. Calculate the solubility in mole per litre at 25°C of magnesium hydroxide in:

(i) Water (1 ½ marks)

Let the solubility of $Mg(OH)_2$ be S

$$Mg(OH)_2(s) + aq \rightleftharpoons Mg^{2+}(aq) + 2\bar{O}H(aq)$$

S S 2S

$$K_{sp} = [Mg^{2+}][\bar{O}H]^2$$

$$= (S)(2S)^2$$

$$K_{sp} = 4S^3$$

01½

$$4.2 \times 10^{-12} = 4S^3$$

$$S = 1.0164 \times 10^{-4}\ mol\,l^{-1}$$

(ii) 0.01M sodium hydroxide. (2 marks)

let the solubility of $Mg(OH)_2$ be S

$Mg(OH)_{2(s)} + aq \rightleftharpoons Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$

S S 2S+0.01

Assumption; $Mg(OH)_2$ being sparingly soluble, $(2S+0.01) \approx 0.01$ ✓

SP stop marking in case assumption is not stated

Mgt $[Mg^{2+}] = S$; $[OH^-] = 0.01M$

$K_{sp} = [Mg^{2+}][OH^-]^2$ ✓ 02

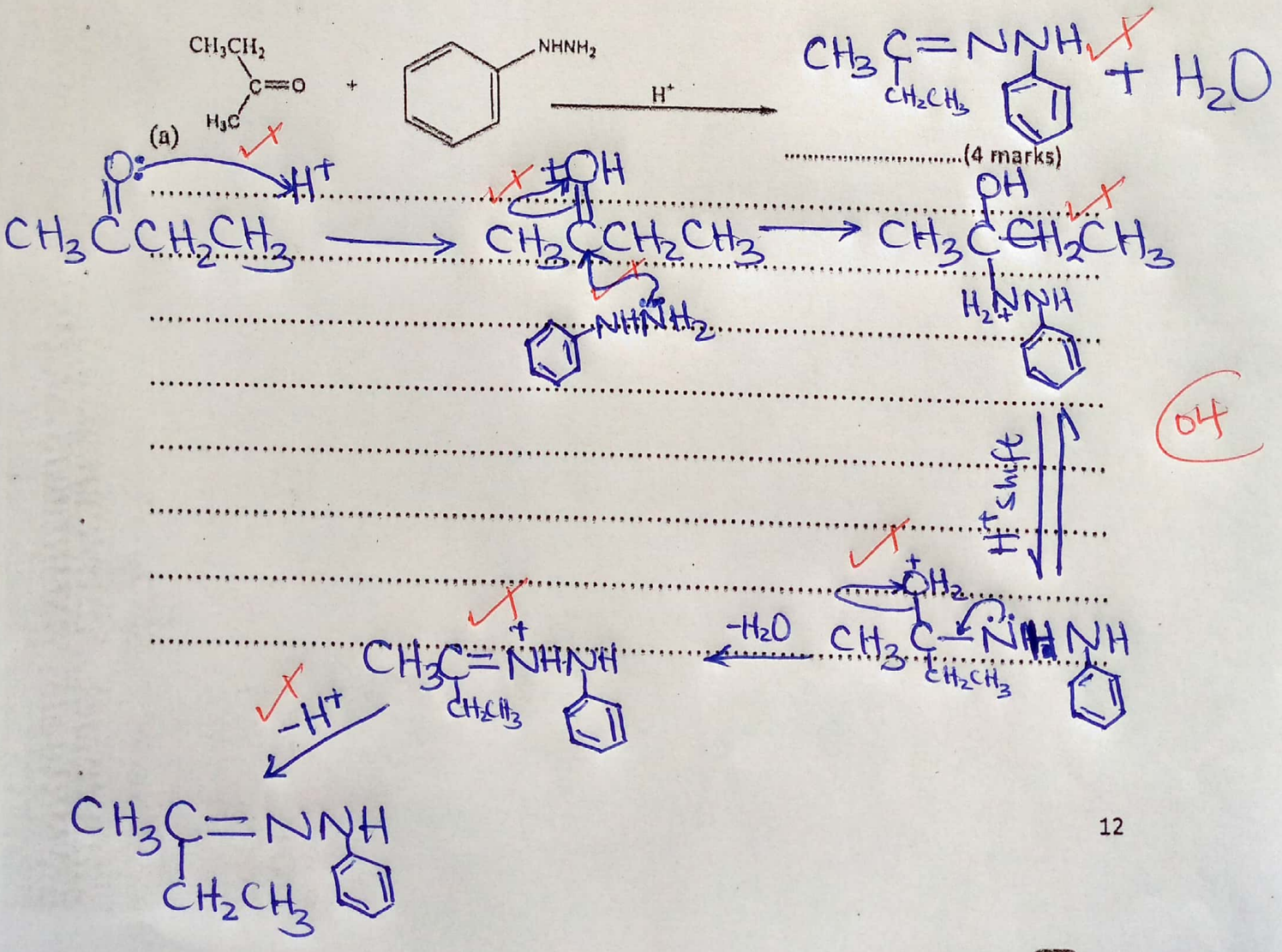
$4.2\times10^{-12} = (S)(0.01)^2$ ✓

$S = 4.2\times10^{-8}$ ✓ $mol\,l^{-1}$

(iii) Comment on your answer in (c) above. (1 mark)

Solubility of magnesium hydroxide in sodium hydroxide is lower than that in water because in sodium hydroxide, the concentration of hydroxide ions is higher hence hydroxide ions react with magnesium ions to precipitate magnesium hydroxide. ✓ 01

14. Complete each of the following equations and write a mechanism for the reaction in each case.



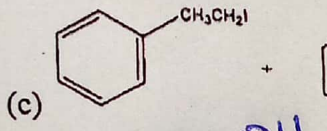
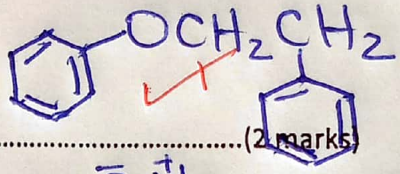
(b) $(CH_3)_2CO$ —dil. NaOH(aq)→ $CH_3C(OH)(CH_3)CH_2COCH_3$ .....(3 marks)

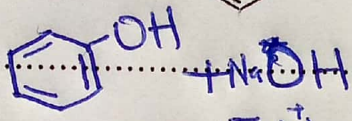
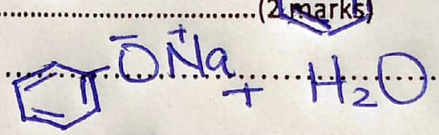
$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + \bar{O}H_{(aq)}$

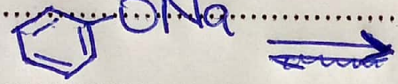
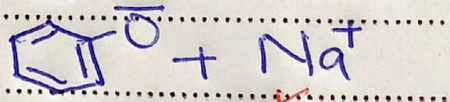
$CH_3COCH_3 \longrightarrow \bar{C}H_2COCH_3$

$CH_3C(O)CH_3 \longrightarrow CH_3C(O^-)(CH_3)CH_2COCH_3$ (03)

$CH_3C(OH)(CH_3)CH_2COCH_3 + \bar{O}H$

(c)  —NaOH (aq), Heat→  + $NaI_{(aq)}$ .....(2 marks)

 + $NaOH \longrightarrow$  + H_2O

 ⇌  + Na^+ (02)

15. (a) Define

(i) Conductivity

$Na^+_{(aq)} + I^-_{(aq)} \longrightarrow NaI_{(aq)}$ (1 mark)

The reciprocal of resistance of an electrolyte. (01) /electrolyte solution

Accept; Conductivity $= \frac{1}{R}$ where R is the resistance of solution.

Accept; Any other correct alternative.

(ii) Molar conductivity (1 mark)

Is electrolyte conductivity divided by concentration ✓ 01

OR $\Lambda_c = \frac{K}{C}$ where K – electrolyte conductivity

C – Concentration

Λ_c – Molar conductivity

Accept alternative definitions which are correct.

(b) The electrolytic conductivity of a 0.1M ethanoic acid at 20°C is 1.96×10^{-2} Sm^{-1}. Its molar conductivity at infinite dilution is 3.52×10^{-2} Sm^2mol^{-1}.

Calculate:

(i) The molar conductivity of ethanoic acid at 20°C. (2 marks)

$\Lambda_c = \frac{K}{C} = \frac{1.96 \times 10^{-2}}{0.1 \times 1000}$ ✓✓

$\Lambda_c = 1.96 \times 10^{-4}$ Sm^2mol^{-1} ✓✓ 02

(ii) The degree of ionization of the acid at 20°C. (1 mark)

$\alpha = \frac{\Lambda_c}{\Lambda_o} = \frac{1.96 \times 10^{-4}}{3.52 \times 10^{-2}}$ ✓✓ 01

$\alpha = 5.568 \times 10^{-3}$ ✓

$\alpha = 0.5568\%$

(iii) The pH of the acid (2 marks)

$[H^+] = C\alpha$ ✓

$= 0.1 \times 5.568 \times 10^{-3}$

$[H^+] = 5.568 \times 10^{-4}$ M ✓

$pH = -\log_{10}[H^+]$ ✓

$= -\log 5.568 \times 10^{-4}$

$pH = 3.25$ ✓ 02

(d) State two other factors other than concentration that can affect the pH of the acid. (2 marks)

Temperature ✓

Strength of an acid ✓ 02

16. (a) Compare the thermal stabilities of silicon (IV) chloride and tin (IV) chloride.
[Include equations of reactions if any]. (2 marks)

Silicon (IV) chloride is more stable than tin (IV) chloride.
The covalent bond between tin and chlorine is longer and weaker since tin has a larger atomic radius than silicon, hence low energy is required to break the bond.
∴ Silicon (IV) chloride is very stable. (02)

$SnCl_4(l) \longrightarrow SnCl_2(s) + Cl_2(g)$

(b) State conditions of reaction between tin and chlorine and write equation of the reaction that took place. (2 ½ marks)

Condition
Heated tin and excess dry chlorine gas. (01)

Equation
$Sn(s) + 2Cl_2(g) \longrightarrow SnCl_4(l)$ (01½)

(c) Silicon (IV) chloride was dissolved in water.

(i) State what was observed. (1 mark) (01)
white precipitate and white fumes.

(ii) Write equation for the reaction that took place. (1 ½ marks) (01½)
$SiCl_4(l) + 4H_2O(l) \longrightarrow SiO_2(s) + 4HCl(g)$
Accept; $SiCl_4(l) + 4H_2O(l) \longrightarrow SiO_2 \cdot 2H_2O(s) + 4HCl(g)$.

(e) When 0.325g of silicon (IV) chloride was dissolved in water, the resultant solution required 48 cm3 of 0.1 M sodium hydroxide for complete neutralization. Calculate the percentage purity of silicon (IV) chloride. (2 marks)

Moles of $NaOH = \left(\frac{0.1}{1000} \times 48\right)$
$= 4.8 \times 10^{-3}$ moles

$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$
Mole ratio of NaOH : HCl is 1 : 1
Moles of HCl reacted $= 4.8 \times 10^{-3}$ moles

4 moles of HCl react with 1 mole of $SiCl_4$
4.8×10^{-3} moles of HCl react with $\left(\frac{4.8 \times 10^{-3} \times 1}{4}\right)$
$= 1.2 \times 10^{-3}$ moles (02)

Molar mass of $SiCl_4 = 28 + (35.5 \times 4) = 170$g
Mass of $SiCl_4 = (170 \times 1.2 \times 10^{-3}) = 0.204$g
% Purity $= \frac{0.204}{0.325} \times 100 = 62.769\%$

(c)(ii) $SiCl_4(l) + 3H_2O(l) \longrightarrow H_2SiO_3(s) + 4HCl(g)$
Accept;

17. Write equations and indicate the conditions under which the following conversions can be effected.

(a) CH_3CH_2OH from bromomethane (2 ½ marks)

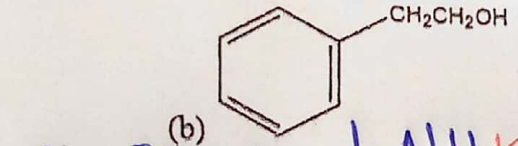
Award even if not in excess

$CH_3Br \xrightarrow[\text{heat}]{KCN \mid CH_3CH_2OH} CH_3CN \xrightarrow[\text{warm}]{H^+_{(aq)} \mid H_2O} CH_3COOH \xrightarrow[\text{dry ether}]{LiAlH_4} CH_3CH_2OH$ (02½)

OR

$CH_3Br \xrightarrow[\text{heat}]{NaOH_{(aq)}} CH_3OH \xrightarrow[\text{heat}]{CrO_{3(s)} \mid H^+} HCH \xrightarrow[2)\ H^+_{(aq)} \mid H_2O]{1)\ CH_3MgBr \mid \text{dry ether}} CH_3CH_2OH$

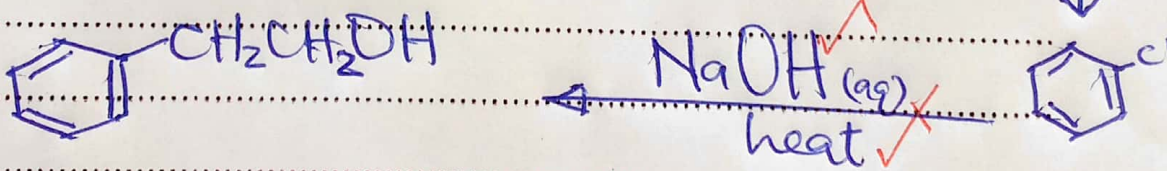
Reject if order is missing

(b) 

from phenylethanone (4 ½ marks)

(04)

$\xrightarrow[CH_3COCH_3]{HBr}$



(c) $CH_3CH_2CH_3$ from 1-iodobutane (2 marks)

$CH_3CH_2CH_2CH_2I \xrightarrow[\text{heat}]{NaOH_{(aq)}} CH_3CH_2CH_2CH_2OH \xrightarrow[\text{heat}]{MnO_{4(aq)}^- / H^+} CH_3CH_2CH_2COOH$ (02)

END

$CH_3CH_2CH_3 \xleftarrow[\text{heat}]{NaOH_{(s)} \mid CaO_{(s)}} CH_3CH_2CH_2COOH$

Accept $CH_3CH_2CH_2COOH$ 16

$CH_3CH_2CH_3 \xleftarrow[\text{heat}]{\text{Sodaline}} CH_3CH_2CH_2COOH$