SUGGESTED BOB-BONUS - 2023

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P525/1
CHEMISTRY
Paper 1
August, 2023
$2\frac{3}{4}$ hours.

JINJA JOINT EXAMINATIONS BOARD

*Uganda Advanced Certificate of Education*

**MOCK EXAMINATIONS –AUGUST, 2023**

# CHEMISTRY

(Principal Subject)

Paper 1

2 hours 45 minutes.

**INSTRUCTIONS TO CANDIDATES:**

Answer **ALL** questions in part **A** and Six questions from part **B**.

All questions are to be answered in the spaces provided.

The Periodic Table with relative atomic masses is provided at the back.

***For Examiner's Use Only***

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04 | 5½ | 04 | 7½ | 05 | 05 | 05 | 06 | 03 | 09 | 09 | 09 | 09 | 09 | 09 | 09 | 09 | 100% |
| | | | | | | | | | | | | | | | | | |

## PART A (46 MARKS)

**Attempt all questions in this section**

1. (a) State what is meant by the term relative atomic mass. (1 mark)

Is the mass of an atom of an element measured relative to a 1/12th mass of carbon-12 isotope atom. (01)

(b) An element X has five naturally occurring isotopes with isotopic masses and percentage relative abundances shown in the table below.

| Isotopic mass | % relative abundance |
|---|---|
| 70 | 20.55 |
| 72 | 27.37 |
| 73 | 7.67 |
| 74 | 36.74 |
| 75 | 7.67 |

Calculate the relative atomic mass of X (2 marks)

RAM of X = (70 × 20.55) + (72 × 27.37) + (73 × 7.67) + (74 × 36.74) + (75 × 7.67)

(20.55 + 27.37 + 7.67 + 36.74 + 7.67)

= 7263.06 / 100

= 72.63 (02)

(Deny ½ mark if (g) unit is indicated on answer)

(c) State two methods used to produce positive ions of X in a mass spectrometer. (1mark)

- Passing gaseous atoms through an electric spark
- Collision of gaseous atoms through an electric spark.
- heating gaseous atoms.

(01) Accept only 2 method don't if extra is wrong 04

2. State what would be observed and write equation for the reaction that takes place when;

(a) Excess potassium iodide is added to Copper(II) nitrate solution.

Observation: (1½ marks)

Blue solution turns brown and a white solid. (1½)

Equation: (1½ marks)

$2Cu^{2+}_{(aq)} + 4I^-_{(aq)} \longrightarrow Cu_2I_{2(s)} + I_{2(aq)}$ (1½)

(b) Solid lead(IV) oxide followed by concentration nitric acid is added to aqueous manganese(II)sulphate solution and mixture heated.

Observation: (1 mark)

Colourless $Mn^{2+}$ solution turns to purple solution. ✓ (01)

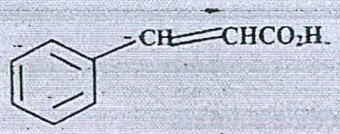
Equation: (1 ½ marks)

BM

$5PbO_{2(s)} + 4H^+_{(aq)} + 2Mn^{2+}_{(aq)} \rightarrow 2MnO^-_{4(aq)} + 5Pb^{2+}_{(aq)} + 2H_2O_{(l)}$ ✓ ✓ ✓ (1½)

Reject Any wrong Symbols - Unbalanced eqns

3. Cinnamic acid ($C_9H_8O_2$) has the structure




(a) Name the functional groups in cinnamic acid. (1 mark)

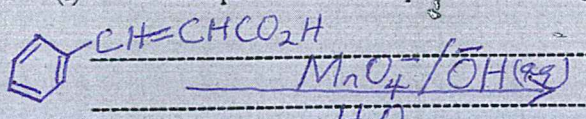
Carbon – Carbon double bond ✓

Carboxylate / carboxyl group. ✓ (01)

reject: double bond Alkene

(b) Write equation for the reaction between cinnamic acid and;

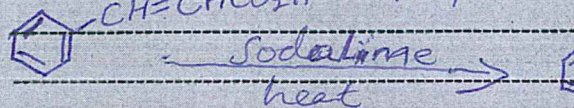
(i) Cold aqueous alkaline potassium manganate(VI) solution (1 mark)




✓ (01)

(ii) State what would be observed in b(i). (1 mark)

Purple solution turns colourless ✓ (02)




Brown solid ✓ (04)

4. (a) Determine the oxidation state of aluminium, chromium and iodine in the following species respectively.

(i) $Al_4C_3$ Let oxidation state of Al = y (1 mark)

$4y + 3(+4) = 0$ ✓

$y = +3$, oxidation state of Al = +3 ✓ (01)

Deny Answer without the Charge

(ii) $Cr_2O_7^{2-}$ let oxidation state of Cr be x (1 mark)

$2(x) + 7(-2) = -2$ ✓ $x = 6$.

∴ Oxidation state of Cr = +6 ✓ (01)

reject: + Deny without the charge

(iii) $IO_3^-$ Let oxidation state of I be y (1 mark)

$y + 3(-2) = -1$ $y = 5$

∴ Oxidation State of I in $IO_3^-$ = +5 01

(b) Write equation for the reaction between; (1 ½ marks)

(i) $Al_4C_3$ and water

$Al_4C_{3(s)} + 12H_2O_{(l)} \longrightarrow 4Al(OH)_{3(s)} + 3CH_{4(g)}$ 1½

(ii) $Cr_2O_7^{2-}$ and hydrogen peroxide in acidic media

$Cr_2O_{7(aq)}^{2-} + 4H_2O_{2(aq)} + 2H^+_{(aq)} \longrightarrow 2CrO_{5(s)} + 5H_2O_{(l)}$ +½ 07½

(iii) $IO_3^-$ and acidified potassium iodide solution

$IO_{3(aq)}^- + 5I^-_{(aq)} + 6H^+_{(aq)} \longrightarrow 3I_{2(aq)} + 3H_2O_{(l)}$

5. The melting points of the oxides of period 3 elements are shown in the table below;

| Oxide | $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $P_4O_{10}$ | $SO_3$ | $Cl_2O_7$ |
|---|---|---|---|---|---|---|---|
| Mpt(°C) | 920 | 3802 | 2027 | 1700 | 360 | 17 | -81 |

(a) State the trend in melting points of the oxides (1 mark)

Melting point of the oxides increases from $Na_2O$ to MgO and then decreases from MgO to $Cl_2O_7$ 01

(b) Explain your answer in (a) (4 marks)

$Na_2O$ and MgO adopt a giant Ionic structure but since $Mg^{2+}$ has a higher charge than $Na^+$, the electrostatic forces of attraction between $Mg^{2+}$ and $O^{2-}$ are stronger than $Na^+$ and $O^{2-}$ requiring a greater amount of energy to break the ionic bond in MgO. $Al_2O_3$ is an ionic compound with more covalent character due to high charge density of $Al^{3+}$ hence its melting point lower than MgO. $SiO_2$, Covalent structure with strong covalent bonds requ smaller amount of energy to break compared to $Al_2O_3$. 04

$P_4O_{10}$, $SO_3$ and $Cl_2O_7$ are simple Covalent molecules held by weak Vandelwaals forces of attraction which requir a smaller amount of energy to break. 05

6. Write equations to show how the following conversions can be effected.

(i) 2-methylchloropropane from 2-methylpropanoic acid (2 ½ marks)

$CH_3CH(CH_3)-COOH \xrightarrow{LiAlH_4 \text{ in dry ether}} CH_3-CH(CH_3)CH_2OH$

$CH_3-CH(CH_3)CH_2OH \xrightarrow{PCl_5 \text{ or } PCl_3 \text{ or } SOCl_2 \text{ in pyridine or anhydrous } ZnCl_2/\text{Conc. HCl}} CH_3-CH(CH_3)-CH_2Cl$

Accept any correct here ✓ 02

(ii) Phenol from nitrobenzene (2 ½ marks)

$C_6H_5NO_2 \xrightarrow{(i)\ Sn/\text{Conc. HCl}} C_6H_5NH_2$

$\xrightarrow{(ii)\ NaOH(aq) \text{ heat or } Na_2CO_3(aq)}$ ✓

$C_6H_5NH_2 \xrightarrow[0-5^\circ C]{NaNO_2(aq)/\text{Conc HCl}} C_6H_5N\equiv NCl$ ✓

$C_6H_5N\equiv NCl \xrightarrow{H^+/H_2O \text{ warm or } H_2O, 50^\circ C} C_6H_5OH$ ✓ 05

reject $LiAlH_4$ in dry ether (for $PNO_2$) only. 03

7. (a) Write;

(i) Equation for ionization of phenylethanoic acid in water. (1 ½ marks)

$C_6H_5CH_2CO_2H + H_2O \rightleftharpoons C_6H_5CH_2C(=O)O^-_{(aq)} + H_3O^+_{(aq)}$ ✓✓

(ii) The expression for the ionization constant Ka for phenylethanoic acid. (1 mark)

$$Ka = \frac{[C_6H_5CH_2COO^-][H_3O^+]}{[C_6H_5CH_2CO_2H]}$$ ✓

(b) (i) Calculate pH of 50cm³ solution of 0.2M phenylethanoic acid. (1 ½ marks)

$pH = -\log[H^+]$ ✓

Number of moles of $H^+$ ions $= \frac{0.2 \times 50}{1000} = 0.01$ mole ✓

$pH = -\log(0.01)$ 1½

$= 2$ ✓

(ii) $20cm^3$ of 0.2M solution of sodium phenylethanate was added to the solution in b(i). Calculate the change in pH of solution
(Ka for phenylethanoic acid=$5.2 \times 10^{-5} moldm^{-3}$) (2 ½ marks)

$pH = pKa + \log \frac{[salt]}{[Acid]}$ ✓ Total volume of solution = 50+20 = 70 $cm^3$

Moles of acid = $\frac{0.01 \times 70}{50} = 0.014$ moles

Moles of salt = $\left(\frac{0.2 \times 20}{1000}\right) \times \frac{70}{20} = 0.014$ (2½)

$pH = -\log(5.2 \times 10^{-5}) + \log\left(\frac{0.014}{0.014}\right)$ $pH = 4.284$

Change in $pH = 4.284 - 2 = 2.284$ ↑ (0.5)

8. (a)(i) State what is meant by Eutectic mixture. (1 mark)

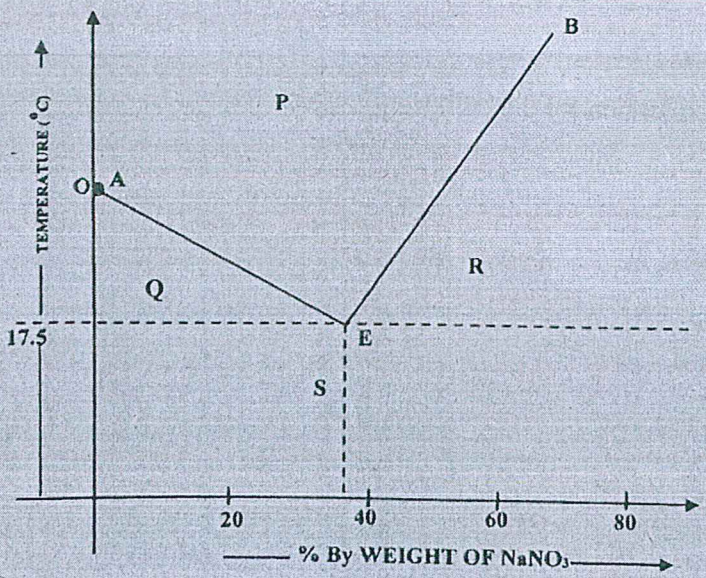
A solid mixture which on heating at constant pressure forms a liquid with the same composition as the solid mixture. (01)

(ii) Give two reasons why eutectic mixture is not a compound (2 mark)

- Eutectic mixture is heterogenous (01)
- Eutectic mixture can be separated into pure components by physical or chemical means.
- Its composition changes with change in pressure

Accept any two correct ones

(b) Temperature-composition diagram for the sodium nitrate-water system is shown below.



(a) Label phases P, Q, R and S

P: Liquid (0 ½ mark)

Q: (Solid water/ice) and liquid mixture of $NaNO_3/H_2O$ (0 ½ mark)

R: Solid $NaNO_3$ and liquid mixture of $NaNO_3/H_2O$ (0 ½ mark)

S: Solid water + solid $NaNO_3$ (0 ½ mark)

02

(b) What do lines AE and BE represent?

AE: depression/lowering of freezing point of water as more sodium nitrate is added (0 ½ mark)

BE: Solubility curve of $NaNO_3$ in water (0 ½ mark)

01

(c) State what happens at point E (1 mark)

At E- liquid mixture solidified forming pure ice crystals and $NaNO_3$ with same composition as liquid mixture at constant temperature.

01

06

9. $20cm^3$ of unsaturated gaseous hydrocarbon P was ignited with $200cm^3$ of oxygen in excess, $140cm^3$ of residual gas was obtained on cooling to room temperature.

On addition of concentrated sodium hydroxide to the residual gas, the volume reduced by $120cm^3$.

(a) Calculate the molecular formula of P. (3 marks)

Volume of $CO_2$ produced $= 120cm^3$, Volume of $O_2$ used $= 200-$

$\Rightarrow$ Volume of $O_2 = 180cm^3$

$20X = 120$

$X = 6$

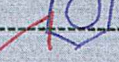
$20\left(6 + \frac{y}{4}\right) = 180$ | $120 + 5y = 180$

$y = 12$

Molecular formula of P = $C_6H_{12}$

02

(b) Write equations to show how P can be converted to benzene. (1 marks)

$C_6H_{12} \xrightarrow[\text{heat, } 600^\circ C]{Al_2O_3/Cr_2O_3}$ 

01

03

## SECTION B: (54 Marks)

Answer **six questions** from this section.

10. (a) State three methods used to determine rates of chemical reactions. (1 ½ marks)

- Calorimetry ✓
- Conductivity measurement ✓ (1½)
- Titration / Titrimetric ✓ Method

Accept others - spectrometry - measurement of pressure - Colour intensity

(b) The table below shows the concentration of bromine at various intervals of time for the reaction;

$Br_{2(aq)} + HCOOH_{(aq)} \longrightarrow 2HBr_{(aq)} + CO_{2(g)}$

| Times(s) | 0 | 30 | 60 | 90 | 120 | 180 | 240 | 360 | 480 | 600 |
|---|---|---|---|---|---|---|---|---|---|---|
| $[Br_2] \times 10^{-3} (moldm^{-3})$ | 10 | 9 | 8.1 | 7.3 | 6.6 | 5.3 | 4.4 | 2.8 | 2.0 | 1.3 |

(i) Plot a graph of concentration of bromine against time. (3 marks)

Axes labelled with units each (½) ✓
- plotting ✓
- shape ✓

Explanation
The graph is a curve showing an exponential decrease of $[Br_2]$ with time and $T_{1/2}$ is nearly constant 01

(ii) Use the graph to find the order of reaction. Explain your answer. (2 marks)

$T_{1/2} = \frac{191.25 + 202.5}{2} = \frac{393.75}{2}$ 01

Average $(T_{1/2}) = 196.88$ s

(iii) Calculate the rate constant and state its units (2 ½ marks)

$\lambda = \frac{\ln 2}{T_{1/2}}$ $\lambda = \frac{0.693}{196.88}$ $= 3.52 \times 10^{-3}\ s^{-1}$ 02½ 09

11. (a) Distinguish between soap and a soapless detergent. (2 marks)

Soap is a sodium salt of a long chain carboxylic acid whereas soapless detergent is a sodium salt of a long chained alkylated aromatic benzene sulphonic acid 02

(b) Write equation(s);

(i) for the reaction leading to formation of soap. (1 mark)

$H_2C(OOCR)CH(OOCR)CH_2(OOCR) + 3NaOH \longrightarrow H_2C(OH)CH(OH)CH_2(OH) + 3RCOO^-Na^+$ 01

(ii) to show how a detergent can be prepared from octadecan-I-ol $CH_3(CH_2)_{16}CH_2OH$. (3 marks)

Deny if condition is missing

$CH_3(CH_2)_{16}CH_2OH \xrightarrow[80^oC]{Conc\ H_2SO_4} CH_3(CH_2)_{15}CH=CH_2$ 01

$CH_3(CH_2)_{15}CH=CH_2 + C_6H_6 \xrightarrow{H^+} C_6H_5CH(CH_3)(CH_2)_{15}CH_3$ 01

$C_6H_5CH(CH_3)(CH_2)_{15}CH_3 \xrightarrow[reflux]{Conc\ H_2SO_4} C_6H_4(SO_3H)CH(CH_3)(CH_2)_{15}CH_3$ 01

$C_6H_4(SO_3H)CH(CH_3)(CH_2)_{15}CH_3 \xrightarrow[reflux]{NaOH(aq)} C_6H_4(SO_3^-Na^+)CH(CH_3)(CH_2)_{15}CH_3$ 03

(c) Explain why soap cannot be used effectively in;

(i) Hard water (1 ½ marks)

Soap reacts with Magnesium ions or Calcium ions in hard water to form scum as a result it is uneconomical to use soap for cleaning fabrics as more soap is used to form foam 1½

(ii) Strongly acidic solutions (1 ½ marks)

The solubility of soap is reduced in strongly acidic solution because the hydrogen ions from the acidic solution react with the alkanoate ion from soap solution to form more soap. This causes soap wastage. 1½

12. (a) A compound G contains 60.0% carbon, 13.3% hydrogen and the rest being oxygen.

(i) Calculate the empirical formula of G. (2 ½ marks)

Percentage by mass of Oxygen = 100 − (60 + 13.3) = 26.7

| | C | H | O |
|---|---|---|---|
| No of moles = | 60/12 | 13.3/1 | 26.7/16 |
| | 5 | 13.3 | 1.669 |
| mole ratio | 5/1.669 | 13.3/1.669 | 1.669/1.669 |
| | 3 | 8 | 1 |

Empirical formula of G = $C_3H_8O$ ✓ 02

(ii) 0.698g of G in 100g of a solvent lowered the freezing point of solvent by 0.190°C. Determine the molecular formula of G

(Kf for solvent = 1.63°C $molL^{-1}Kg^{-1}$) (2 marks) 2½

100g of water dissolved 6.98g of G

1000g of water dissolves $\left(\frac{6.98 \times 1000}{100}\right)$ g of G = 69.8

1.90°C is the freezing pt depression by 69.8g of G

1.63°C is freezing pt depression by $\frac{69.8 \times 1.63}{1.90}$ = 59.

∴ Molecular mass = 60 $(C_3H_8O)n = 60$

$(12\times3 + 1\times8 + 16)n = 60$

$60n = 60$

$n = 1$

Molecular formula of G = $C_3H_8O$

(b) When G was reacted with aqueous iodine and sodium hydroxide solution, a yellow Precipitate was formed.

Write the;

(i) Formula and name of G

Formula: $CH_3\underset{OH}{C}HCH_3$ ✗

Name: propan-2-ol ✗ 01 (0 ½ mark) (0 ½ mark)

(ii) Equation leading to the formation of a yellow precipitate. (1 mark)

$CH_3\underset{OH}{C}HCH_3 \xrightarrow[warm]{I_2/NaOH(aq)} CH_3COOH + CHI_3$ ✓ ✗

(c) Write the mechanism for the reaction between G and hot concentrated orthophosphoric acid. (2 ½ marks)

$CH_3CHCH_3 \longrightarrow CH_2{=}CH{-}CH_3 + OPO_3H_2$ 2½

:OH → H–OPO$_3$H$_2$ ✓ ✗

CH$_2$–CH–CH$_3$ (+OH$_2$) ✓

$-H_2O$ ✓

$CH_3{-}\overset{+}{C}H{-}CH_2$ ✓

$-H^+$ ✓

$CH_3CH{=}CH_2 + H_3PO_4$ ✓

OPO$_3$H ✓

09

OR $CH_3-CH-CH_3$ → $CH_3CH-CH_3$ + $OPO_3H_2$

$CH_3CH-CH_3$ → $CH_3CH=CH_2$ + $H_2O$

$H_3PO_4$ + $CH_3CH=CH_2$ ⇌ $CH_3-CH-CH_3$ + $OPO_3H_2$

2½

13. (a) Distinguish between specific conductivity and equivalent conductivity. (2 marks)

Specific Conductivity is the Conductance of an aqueous solution of electrolyte between two parallel electrodes of Cross-sectional area 1 $m^2$ or 1 $cm^2$ placed in 1m or 1cm distance apart 02

(Accept any other way of defining it)

(b) (i) State two factors that can affect the magnitude of specific conductivity (1 mark)

Accept any two correct factors @ ½

- Nature of electrolyte, Temperature of electrolyte solution
- Concentration/dilution of electrolyte, degree of ionisation of weak electrolyte
- Ionic (mobility/interference/distance)

(ii) Explain how the factors you have stated in b(i) affect specific conductivity of a weak electrolyte. (3 marks)

Temperature: Increase in temperature increases specific conductivity due to increased ionic mobility.

dilution: Specific Conductivity increases with increase in dilution until it becomes nearly constant due to increased inter ionic distance/reduced ionic interference hence increased ionic mobility (for strong electrolytes/due to increased degree of ionisation for weak electrolytes. 03

(c) Equivalent conductivities at Zero concentrations at 25°C for some electrolytes are given in the table below.

| Electrolyte | Equivalent conductivity ($Scm^2mol^{-1}$) |
|---|---|
| AgNo3 | 133.4 |
| KNO3 | 145.0 |
| KCl | 149.9 |

Use the above data to calculate the;

(i) Equivalent conductivity at zero concentrations of silver chloride. (1 ½ marks)

c) $\Lambda_{o}AgCl = (\Lambda_{o}AgNO_3 + \Lambda_{o}KCl) - \Lambda_{o}KNO_3$

$= (133.4 + 149.9) - 145$

$= 138.3$ ✓ 1½

(ii). Solubility product $K_s$ of silver chloride. (Specific conductivity of pure water and a saturated ~~solution of silver chloride~~ are $1.60 \times 10^{-6}$ and $3.14 \times 10^{-6}$ S cm$^{-1}$ at 25$^{o}$C respectively) (1 ½ marks)

$K_s$ solution of $AgCl = (3.41 \times 10^{-6}) - (1.60 \times 10^{-6}) = 1.81 \times 10^{-6}$ ✓

$\Lambda_{AgCl} = 1000K/S$

$S = \left(\frac{1000 \times 1.81 \times 10^{-6}}{138.3}\right)$ ✓ 1½

$K_{sp}$ of $AgCl = (1.31 \times 10^{-5})^2$

$= 1.72 \times 10^{-10}$ mol$^2$ dm$^{-6}$

Reject, without units

14. (a) (i) Write the electronic configuration of chromium. (1 mark)

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ 09

Emphasize half filled d-orbital

rej. $[Ar] 4s^1 3d^5$ reject ---$4s^2 3d^4$ 01

(ii) State the common oxidation states exhibited by chromium in its compounds. (1 mark)

+3 ✓ and +6 ✓

(iii) Write the formulae of the oxides of chromium. (1½ marks)

$CrO_3$ ✗, $Cr_2O_3$ ✗, $CrO$ ✓

(b) Ammonium dichromate was heated.

(i) State what is observed. (1 ½ marks)

Colourless vapour and the orange solid turns green. (1½)

(ii) Write equation for the reaction that takes place. (1 ½ marks)

$(NH_4)_2Cr_2O_7 \longrightarrow Cr_2O_{3(s)} + N_{2(g)} + 4H_2O_{(g)}$ (1½)

(c) To the solid product in (b) was added excess concentrated sodium hydroxide solution.

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

Green solid dissolves forming green solution. (01)

(ii) Write equation for the reaction that takes place. (1 ½ marks)

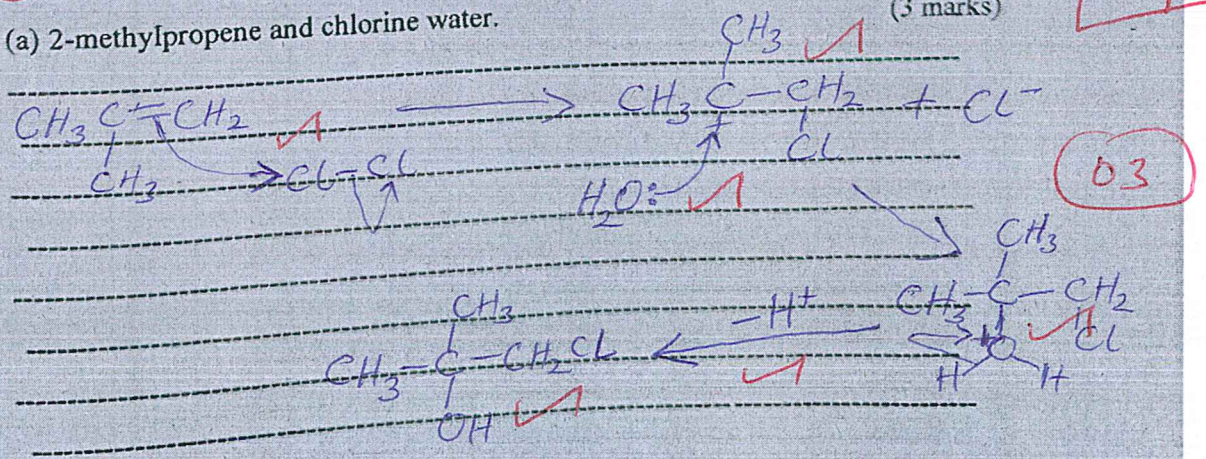
$Cr_2O_{3(s)} + 6OH^-_{(aq)} + 3H_2O_{(l)} \longrightarrow 2Cr(OH)^{3-}_{6(aq)}$ (1½)

(Accept any other correct alternative eqn)

09

15. Write mechanisms for the reaction between;

(a) 2-methylpropene and chlorine water. (3 marks)

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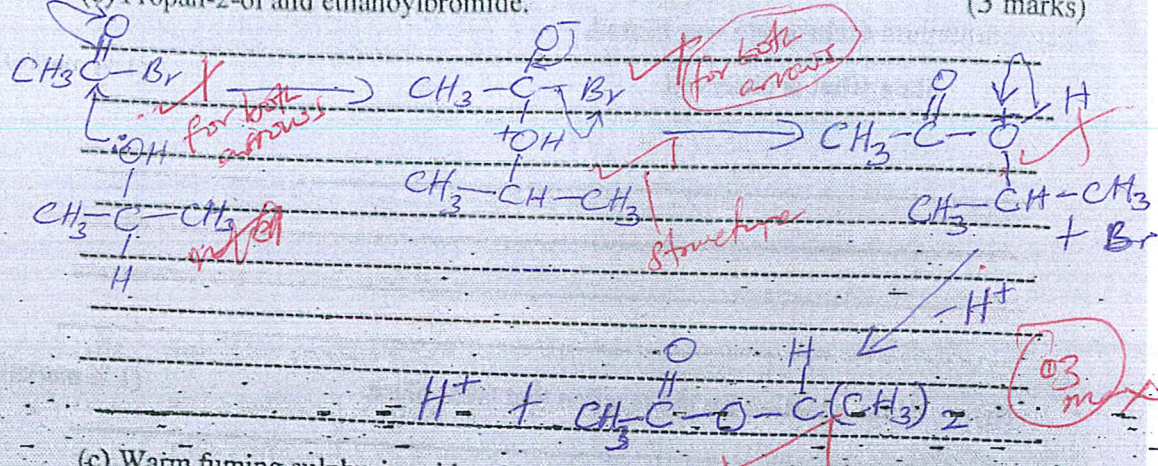
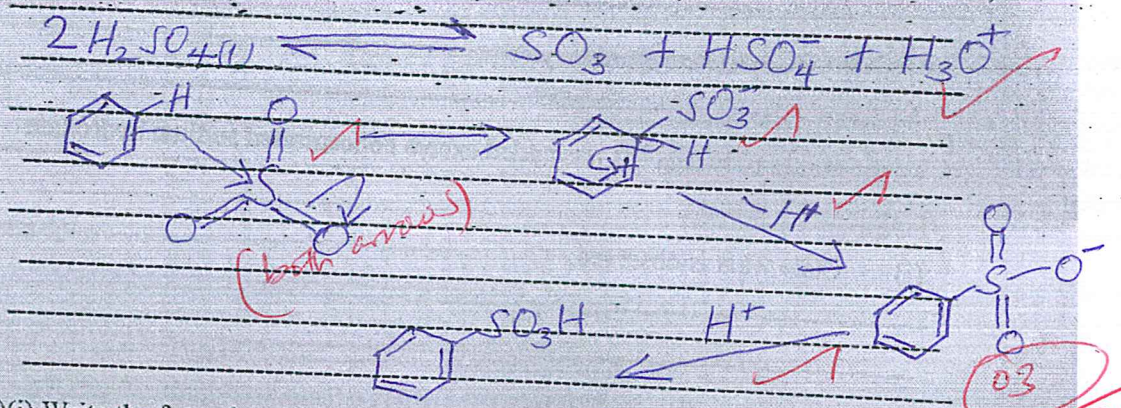
(b) Propan-2-ol and ethanoylbromide. (3 marks)




(c) Warm fuming sulphuric acid and benzene. (3 marks)




16. (a)(i) Write the formula and name of the main ore of aluminium. (1 mark)

Reject: $Al_2O_3 \cdot nH_2O$ name without correct formula

$Al_2O_3 \cdot 2H_2O$, Bauxite 01

Accept – Aluminium oxide dihydrate. 01

(ii) Name the impurities present in the ore in (i) (1 ½ marks)

Iron(III) oxide, Titanium(IV) oxide and Silicon(IV) oxide

Accept (Silicon dioxide) Reject: Iron (III) oxide 1½

(b) Describe how the ore is purified. (4 marks)

Bauxite roasted to drive off water, then the ore is reacted with concentrated Sodium hydroxide solution to dissolve Aluminium oxide and Silicon(IV) oxide, Iron(III) oxide and other materials remain Insoluble.

$Al_2O_{3(aq)} + 2OH^-_{(aq)} + 3H_2O_{(l)} \longrightarrow 2Al(OH)_4^-{}_{(aq)}$

$SiO_{2(s)} + 2OH^-_{(aq)} \longrightarrow SiO_3^{2-}{}_{(aq)} + H_2O_{(l)}$

The mixture is filtered and then seeded by adding freshly prepared Aluminium hydroxide or passing $CO_2$ gas to precipitate Aluminium oxide:

$2Al(OH)_4^-{}_{(aq)} + CO_{2(g)} \longrightarrow 2Al(OH)_{3(s)} + CO_3^{2-}{}_{(aq)} + H_2O_{(l)}$

Aluminium oxide is heated to obtain pure $Al_2O_3$. 04

$2Al(OH)_{3(s)} \longrightarrow Al_2O_{3(s)} + 3H_2O_{(l)}$

(c) Sodium carbonate solution was added to an aqueous solution of aluminium sulphate. State what is observed and write equation for the reaction that takes place.

Observation; (2½ marks)

White precipitate and bubbles of a colourless gas which turns limewater milky
or Effervescence of colourless gas (01)
(Emp spelling of effervescence)

Equation;

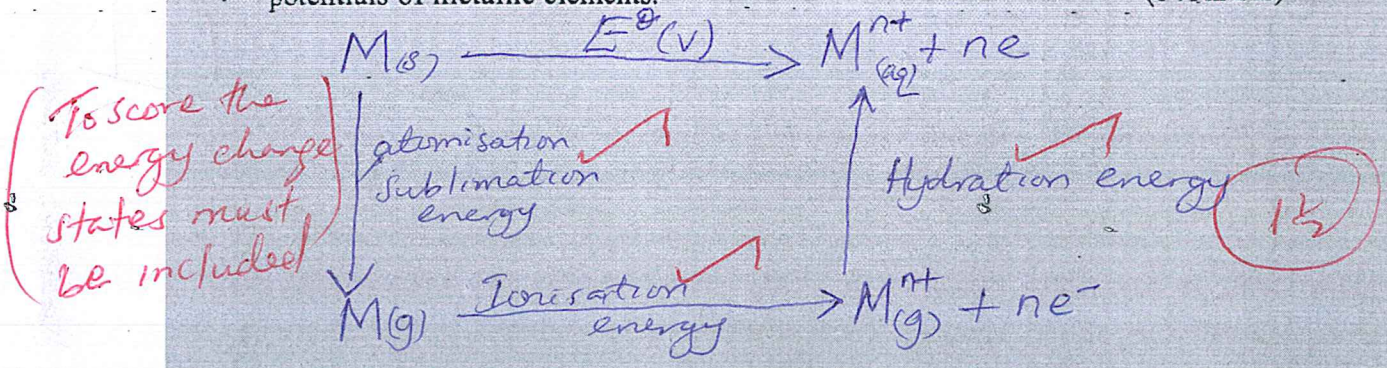
$2Al(H_2O)_6^{3+}(aq) + 3CO_3^{2-}(aq) \longrightarrow 3CO_2(g) + 2Al(OH)_3(s) + 9H_2O_{(l)}$ (1½)

09

17. (a) State what is meant by the term standard electrode potential of an element. (1 mark)

Is the potential difference between an element and its solution containing one mole per $dm^3$ of its ion measured at 1 atm pressure and 25°C temperature. (01)

(b) Draw an energy cycle relating the energy terms that determine the standard electrode potentials of metallic elements. (1 ½ marks)




(To score the energy change states must be included) (1½)

(c) Standard electrode potentials for some half cell reactions are given below.

R; $S_{(s)} + 2H^+_{(aq)} + 2e^- \longrightarrow H_2S_{(g)} + E^{\theta}(v) + 0.14$

S; $Cr_2O^{2-}_{7(aq)} + 14H^+_{(aq)} + 6e^- \longrightarrow 2Cr^{3+}_{(aq)} + 7H_2O_{(l)} + 1.36$

Write the;

(i) Cell notation of the cell formed when R and S are combined. (1 mark)

$Pt_{(s)}/H_2S_{(g)}/S_{(s)}/H^+ // Cr_2O^{2-}_{7(aq)}, H^+_{(aq)}, Cr^{3+}_{(aq)}, H_2O_{(l)}/Pt_{(s)}$ (01)

Accept: without water ($H_2O$)

(ii) Overall equation for the reaction that takes place. (1 ½ marks)

$Cr_2O^{2-}_{7(aq)} + 3H_2S_{(g)} + 8H^+_{(aq)} \longrightarrow 3S_{(s)} + 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$ (01½)

(d) Calculate Gibb's free energy for the reaction in c(ii). (F=96500C) (3 marks)

$\Delta G = -nFE^{\ominus}$ ✓

$E^{\ominus}$ of cell $= +1.36 - 0.14$

$= +1.22V$ ✓

$\Delta G = -[6 \times 96500 \times 1.22]$ ✓

$= -706,380 J mol^{-1}$ ✓ 03

Deny 1 mark if wrong unit is indicated.

Deny 1 mark if no unit indicated

(e) State whether the cell reaction is feasible or not. Give a reason for your answer.

(1 mark)

The cell reaction is feasible because Gibbs free energy is negative / emf of cell reaction is positive. ✓ 01

09

# THE PERIODIC TABLE

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.0 H 1 | | | | | | | | | | | | | | | | 1.0 H 1 | 4.0 He 2 |
| 6.9 Li 3 | 9.0 Be 4 | | | | | | | | | | | 10.8 B 5 | 12.0 C 6 | 14.0 N 7 | 16.0 O 8 | 19.0 F 9 | 20.2 Ne 10 |
| 23.0 Na 11 | 24.3 Mg 12 | | | | | | | | | | | 27.0 Al 13 | 28.1 Si 14 | 31.0 P 15 | 32.1 S 16 | 35.4 Cl 17 | 40.0 Ar 18 |
| 39.1 K 19 | 40.1 Ca 20 | 45.0 Sc 21 | 47.9 Ti 22 | 50.9 V 23 | 52.0 Cr 24 | 54.9 Mn 25 | 55.8 Fe 26 | 58.9 Co 27 | 58.7 Ni 28 | 63.5 Cu 29 | 65.7 Zn 30 | 69.7 Ga 31 | 72.6 Ge 32 | 74.9 As 33 | 79.0 Se 34 | 79.9 Br 35 | 83.8 Kr 36 |
| 85.5 Rb 37 | 87.6 Sr 38 | 88.9 Y 39 | 91.2 Zr 40 | 92.9 Nb 41 | 95.9 Mo 42 | 98.9 Tc 43 | 101 Ru 44 | 103 Rh 45 | 106 Pd 46 | 108 Ag 47 | 112 Cd 48 | 115 In 49 | 119 Sn 50 | 122 Sb 51 | 128 Te 52 | 127 I 53 | 131 Xe 54 |
| 133 Cs 55 | 137 Ba 56 | 139 La 57 | 178 Hf 72 | 181 Ta 73 | 184 W 74 | 186 Re 75 | 190 Os 76 | 192 Ir 77 | 195 Pt 78 | 197 Au 79 | 201 Hg 80 | 204 Tl 81 | 207 Pb 82 | 209 Bi 83 | 209 Po 84 | 210 At 85 | 222 Rn 86 |
| 223 Fr 87 | 226 Ra 88 | 227 Ac 89 | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 139 La 57 | 140 Ce 58 | 141 Pr 59 | 144 Nd 60 | 147 Pm 61 | 150 Sm 62 | 152 Eu 63 | 157 Gd 64 | 159 Tb 65 | 162 Dy 66 | 165 Ho 67 | 167 Er 68 | 169 Tm 69 | 173 Yb 70 | 175 Lu 71 |
| | | | 227 Ac 89 | 232 Th 90 | 231 Pa 91 | 238 U 92 | 237 Np 93 | 244 Pu 94 | 243 Am 95 | 247 Cm 96 | 247 Bk 97 | 251 Cf 98 | 254 Es 99 | 257 Fm 100 | 256 Md 101 | 254 No 102 | 260 Lw 103 |

 End

(i) A GRAPH OF $[Br_2]$ against Time