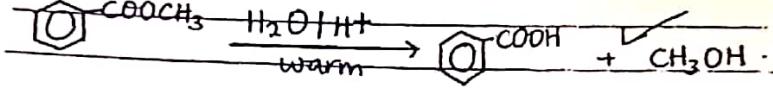
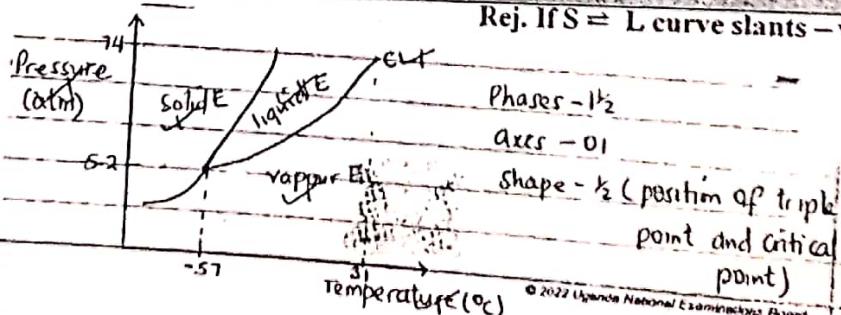


WAKISSHA JOINT MOCK EXAMINATIONS  
MARKING GUIDE  
Uganda Advanced Certificate of Education  
UACE August 2023  
CHEMISTRY P525/1

1. (a)	${}_{11}^{24}\text{Na} \longrightarrow {}_{12}^{24}\text{Mg} + {}_{-1}^0\text{e} + 2\gamma \quad \text{rej. } \beta$	01
(b)	$\lambda = \frac{\ln 2}{t_{1/2}}$ $\lambda = \frac{\ln 2}{15} = 0.046209812 \text{ per hour}$ $\ln \left( \frac{N_0}{N_t} \right) = \lambda t.$ $\ln \left( \frac{2.4}{N_t} \right) = 0.046209812 \times 72 \quad 2.303 \log_{10} \left( \frac{N_0}{N_t} \right) = \lambda t$	04
	$N_t = 0.086152 \text{ g.}$ $\text{Mass decayed} = 24 - 0.086152 \\ = 2.3138 \text{ g}$	
(c)	Carbon dating using carbon - 14 Cobalt-60 gamma radiation for cancer treatment (any 2 correct)	01
2.(a) (i)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ Or rej. - $3d^4 4s^1 / 4s^2 3d^4$	06 marks
(ii)	CrO, Cr <sub>2</sub> O <sub>3</sub> and CrO <sub>3</sub>	01
(b)(i)	$\text{CrO}_{(s)} + 2\text{H}^+_{(\text{aq})} \longrightarrow \text{Cr}^{2+}_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})}$ Accept mineral acid used correctly. $\frac{1}{2}$ for wrong states.	$1\frac{1}{2}$
(ii)	$\text{CrO}_3{}_{(s)} + 2\text{OH}^-_{(\text{aq})} \longrightarrow \text{CrO}_{4-2}{}_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})}$	$1\frac{1}{2}$
3(a)	$\text{CH}_3\text{CH}_2\text{Br} \xrightarrow[\text{Mechanism}]{\text{Heat}} \text{CH}_3\text{CH}_2\text{ONa}^+ \text{ [alcohol]} \longrightarrow \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$ $\text{CH}_3\text{CH}_2\text{ONa}^+ \longrightarrow \text{CH}_3\text{CH}_2\text{O}^- + \text{Na}^+$ $\text{CH}_3\text{CH}_2\text{O}^- + \text{CH}_3\text{CH}_2\text{Br} \longrightarrow \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3 + \text{Br}^-$ $\text{Deny } \frac{1}{2} \text{ Br not shown.}$ $\text{C}_6\text{H}_5\text{Br} + \text{HBr} \longrightarrow \text{C}_6\text{H}_5\text{Br}$	$5\frac{1}{2}$ marks
(b)	$\text{C}_6\text{H}_5\text{Br} + \text{HBr} \longrightarrow \text{C}_6\text{H}_5\text{Br}$ $\text{C}_6\text{H}_5\text{Br} + \text{HBr} \longrightarrow \text{C}_6\text{H}_5\text{Br}$	03

		06 marks
4(a)	The precipitation of a sparingly soluble ionic compound from its saturated solution at constant temperature by adding a solution containing a strong electrolyte with similar ions.	01
(b) (i)	<p>R.F.M of <math>\text{PbCl}_2 = 277.8</math></p> <p>Solubility in <math>\text{CaCl}_2 = 2.951625 / 277.8</math>  <math>= 0.010625 \text{ mol dm}^{-3}</math></p> $[\text{Cl}^-] = 2 \times 0.02 + 0.010625 \times 2 \quad [\text{Cl}^-] = 2 \times 0.02$ $= 0.04 \text{ M}$ $= 0.06125 \text{ mol dm}^{-3}.$ $= 0.06125 \text{ mol dm}^{-3}.$ $\text{PbCl}_{2(s)} + \text{aq} \rightleftharpoons \text{Pb}^{2+}_{(\text{aq})} + 2\text{Cl}^-_{(\text{aq})}$ $K_{\text{sp}} = [\text{Pb}^{2+}] [\text{Cl}^-]^2$ $= 0.010625 \times 0.06125^2 = 3.98604 \times 10^{-5} \text{ mol}^3 \text{ dm}^{-9}.$ <p>Let solubility in pure water be <math>x</math>.</p> $K_{\text{sp}} = 4x^3$ $4x^3 = 3.98604 \times 10^{-5}$ $x = \left( \frac{1}{4} \times 3.98604 \times 10^{-5} \right)^{1/3}$ $= 0.02152 \text{ mol}^3 \text{ dm}^{-9}$ $\text{Solubility} = 0.02152 \times 277.8$ $= 5.90325 \text{ g dm}^{-3}$ $K_{\text{sp}} = 0.010625 \times 0.04^2$ $= 1.696 \times 10^{-5} \text{ mol}^3 \text{ dm}^{-9}$ $4x^3 = 1.696 \times 10^{-5}$ $x = \left( \frac{1}{4} \times 1.696 \times 10^{-5} \right)^{1/3}$ $= 0.016194 \text{ m}$ $\text{Solubility} = 0.016194 \times 277.8$ $= 4.50198 \text{ g dm}^{-3}$	05
(ii)	Lead (II) chloride is less soluble in calcium chloride than in pure water	$\frac{1}{2}$
5(a)	$\text{MgCl}_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \longrightarrow \text{MgO}_{(\text{s})} + 2\text{HCl}_{(\text{aq})}$ $\text{Mg}_{(\text{s})} + 2\text{HCl}_{(\text{aq})} \longrightarrow \text{MgCl}_{2(\text{aq})} + \text{H}_{2(\text{g})}$ $\text{H}_{2(\text{g})} + \frac{1}{2}\text{O}_{2(\text{g})} \longrightarrow \text{H}_2\text{O}_{(\text{l})}$ $\text{Mg}_{(\text{s})} + \frac{1}{2}\text{O}_{2(\text{g})} \longrightarrow \text{MgO}_{(\text{s})}$	$146.2$ $478.4$ $\frac{1}{2} \times 572$ $\Delta H_f = -618.4 \text{ KJ mol}^{-1}$
(b)	Magnesium is stable (relative to its elements) Reason – Negative enthalpy of formation. If (a) correct	$\frac{1}{2}$
		$\frac{6}{2} \text{ marks}$
		$\frac{4}{2} \text{ marks}$

6(a)	Fluorine is more electronegative than Iodine thus hydrogen fluoride molecules are held by strong <u>intermolecular hydrogen bonds</u> while hydrogen iodide molecules are held by <u>weak vander waals forces</u> which require less heat energy to break.	0
(b)(i)	Both HF and HI react with sodium carbonate solution to form corresponding <u>sodium salts</u> , <u>carbon dioxide gas</u> and water. $2\text{HF}_{(\text{l})} + \text{Na}_2\text{CO}_3_{(\text{aq})} \longrightarrow 2\text{NaF}_{(\text{aq})} + \text{CO}_2_{(\text{g})} + \text{H}_2\text{O}_{(\text{l})}$ $2\text{HI}_{(\text{g})} + \text{Na}_2\text{CO}_3_{(\text{aq})} \longrightarrow 2\text{NaI}_{(\text{aq})} + \text{CO}_2_{(\text{g})} + \text{H}_2\text{O}_{(\text{l})}$ Accept general equation $2\text{HX}_{(\text{l})} + \text{Na}_2\text{CO}_3_{(\text{aq})} \longrightarrow 2\text{NaX}_{(\text{aq})} + \text{CO}_2_{(\text{g})} + \text{H}_2\text{O}_{(\text{l})}$	$\frac{1}{2} @$ $\frac{1}{2}$
(ii)	HF does not react with Conc. $\text{H}_2\text{SO}_4$ . HI reduces concentrated Sulphuric acid to <u>Sulphurdioxide and water</u> , itself oxidized to Iodine. $2\text{HI}_{(\text{l})} + \text{H}_2\text{SO}_4_{(\text{l})} \longrightarrow \text{SO}_2_{(\text{g})} + \text{I}_{2(\text{g})} + 2\text{H}_2\text{O}_{(\text{l})}$ $32\text{HI}_{(\text{g})} + \text{H}_2\text{SO}_4_{(\text{l})} \longrightarrow \text{H}_2\text{S}_{(\text{g})} + 4\text{I}_{2(\text{g})} + 4\text{H}_2\text{O}_{(\text{l})}$	$\frac{1}{2}$
7. (a)	 <p>Both products correct</p>	0.5marks 0
(b)	Sodium carbonate solution Observations	0
	 <p>- Bubbles of a colorless gas</p>	
	$\text{CH}_3\text{OH}$ - No observable change	0.2
(c)	Solvent extraction	$\frac{1}{2}$
8.(a)		4½marks 0.3
(b) (i)	Solid E melts into liquid which on further heating is converted into vapour.	0.1
(ii)	All Liquid E and gaseous E (vapour) solidifies.	0.1
9.(a)(i)	hexachloroplumbate (IV) ions/ hexachloroplumbic (iv) acid	0.5marks
(ii)	Ammonium hexachloro plumbate (IV)	$\frac{1}{2}$
(iii)	Lead (IV) chloride / Lead tetrachloride	$\frac{1}{2}$
(b)	$\text{PbCl}_4_{(\text{l})} + 2\text{H}_2\text{O}_{(\text{l})} \longrightarrow \text{PbO}_{2(\text{s})} + 4\text{HCl}_{(\text{g})}$ accept aq on HCl	$\frac{1}{2}$
(c)	Hydrolysis	0.1
		$\frac{1}{2}$
		0.3marks

**SECTION B (54MARKS)**

10(a)	<p align="center">Or Sodalime</p>	3½
(b)	<p align="center"><math>\text{CH}_3\text{Br}</math> to <math>(\text{CH}_3)_2\text{N}-\text{N}=\text{C}(\text{CH}_3)_2\text{NH}_2</math></p> <p align="center"><math>\text{Conc-NH}_3</math>   Heat in a sealed tube</p> <p align="center"><math>\text{CH}_3\text{NH}_2 \xrightarrow{\text{CH}_3\text{Br}} (\text{CH}_3)_2\text{NH}</math></p> <p align="center"><math>\text{NaNO}_2 \text{ (aq)} / \text{Conc-HCl}</math>   <math>0^\circ\text{C} / (0-5^\circ\text{C})</math></p> <p align="center">Or <math>&lt;10^\circ\text{C}</math></p>	Rej. $\text{HNO}_2$ 3½
(c)	<p align="center">Accept with no <math>\text{H}^+</math></p>	02
11.(a)(i)	<p align="center">Copper (II) sulphate is a strong electrolyte which fully dissociates to produce high concentration of copper (II) ions and sulphate ions.</p>	01
(ii)	<p align="center">Excess ammonia is a weak base / alkali which only partially ionizes to produce few ions.</p>	01
(b)(i)	$\text{Cu}^{2+}_{(\text{aq})} + 2\bar{\text{O}}\text{H}_{(\text{aq})} \longrightarrow \text{Cu}(\text{OH})_2_{(\text{s})}$ <p align="center">Deny if <math>\text{Cu}(\text{OH})_2</math> not solid</p>	01
(ii)	$\text{Cu}(\text{OH})_2_{(\text{s})} + 4\text{NH}_3_{(\text{aq})} \longrightarrow [\text{Cu}(\text{NH}_3)_4]^{2+}_{(\text{aq})} + 2\bar{\text{O}}\text{H}_{(\text{aq})}$	01
(c) (i)	<p align="center">Molar conductivity of water</p> $\begin{aligned} &= \frac{k}{c} & 18\text{cm}^3 &\longrightarrow 1 \text{ mole} \\ &= \frac{5.484 \times 10^{-8}}{1/18} & 1000\text{cm}^3 &\longrightarrow \frac{1000}{18} \\ &= 9.8712 \times 10^{-7} \Omega^{-1}\text{cm}^2\text{mol}^{-1} & C &= 55.56\text{M} \end{aligned}$ <p align="center">At infinite dilution, <math>\Lambda_o(\text{H}_2\text{O}) = \Lambda_o(\text{H}^+) + \Lambda_o(\bar{\text{O}}\text{H})</math></p> $\begin{aligned} &= 349.8 + 198.6 \\ &= 548.4^{-1}\text{cm}^2\text{mol}^{-1} \end{aligned}$ $\begin{aligned} \alpha &= \frac{\Lambda_I}{\Lambda_o} \\ &= 9.8712 \times 10^{-7} / 548.4 \\ &= 1.80 \times 10^{-9} \end{aligned}$	3½

	(ii) $K_w = [H^+] [\bar{O}H^-]$ or $K_w = C^2 \alpha^2$ $= \left(\frac{1000}{18}\right)^2 \times (1.80 \times 10^{-9})^2$ $\approx 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$	09 marks
12.(a) (i)	Due to the presence of lone pairs of electrons on the oxygen atom, the hydroxyl group of phenol has a positive inductive effect which increases the electron density of the benzene ring thus phenol is more reactive towards electrophilic substitution than benzene.	02
(ii)	2-nitrophenol is volatile and immiscible with water since its molecules are held by weak vander waals forces while 4-nitrophenol is relatively non-volatile due to strong intermolecular hydrogen bonds. (2-nitrophenol has a fairly high relative formula mass).	02
(b)	Vapour pressure of 2-nitrophenol = $1.0 - 0.825 = 0.175 \text{ atm}$ .  $\frac{\text{V.P of water}}{\text{V.P of 2 nitrophenol}} = \frac{\text{mass of water} \times \text{R.F.M of 2-nitrophenol}}{\text{mass of 2-nitrophenol} \times \text{R.F.M of water}}$ $\frac{0.825}{0.175} = \frac{0.9 \times 139}{M \times 18} \quad \text{R.F.M} = 139$ $M = \frac{0.9 \times 139 \times 0.175}{0.825 \times 18}$ $M = 1.474 \text{ g.}$	03
(c)	- compounds distil below their boiling points hence saves energy. - enables purification of compounds (organic) which decompose near their boiling points.	02
13.(a)(i)	Barium nitrate solution followed by dilute nitric acid $K_2SO_4 \text{ (aq)}$ - White precipitate insoluble in nitric acid. $K_3PO_4 \text{ (aq)}$ - White precipitate soluble in nitric acid. Ammonium molybdate / conc. $HNO_3$ No observable change (bright)yellow precipitate	9 marks
(ii)	Silver nitrate solution followed by dilute nitric acid $KNaCl \text{ (aq)}$ - White precipitate insoluble in nitric acid $Na_2C_2O_4 \text{ (aq)}$ - White precipitate soluble in nitric acid I Calcium nitrate solution. - No observable change - White precipitate	02
(b)(i)	Dichromate ions react with sodium hydroxide to form chromate ( $VI$ ) ions which form sparingly soluble lead(II) chromate on addition of lead(II) nitrate. $\begin{array}{ccc} Cr_2O_7^{2-} \text{ (aq)} + 2\bar{O}H^- \text{ (aq)} & \longrightarrow & 2CrO_4^{2-} \text{ (aq)} + H_2O \text{ (l)} \\ Pb^{2+} \text{ (aq)} + CrO_4^{2-} \text{ (aq)} & \longrightarrow & PbCrO_4 \text{ (s)} \end{array}$	2 1/2

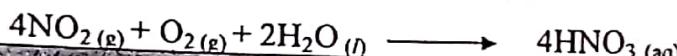
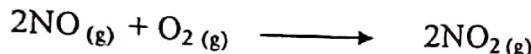
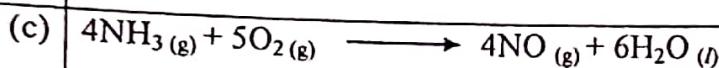
(ii)	Manganese (II) ions are oxidized to Manganate (VII) ions which is purple and the bismuthate is reduced to bismuth (III) ions. $2\text{Mn}^{2+}_{(\text{aq})} + 5\text{BiO}_3^- + 14\text{H}^+_{(\text{aq})} \longrightarrow 2\text{MnO}_4^- + 5\text{Bi}^{3+}_{(\text{aq})} + 7\text{H}_2\text{O}_{(\text{l})}$	2½
14 (a)(i)	<u><math>\text{CH}_3\text{CHCH}_2\text{CHO}</math></u> ✓	9 marks 01
(ii)	<u>3-hydroxybutanal</u> ✓	01
(b)(i)	$\text{CH}_3\text{CH(OH)CH}_2\text{CHO} \xrightarrow[\text{Cnc. HCl}]{\text{ZnCl}_2(\text{s})} \text{CH}_3\text{CHCH}_2\text{CHO}$	01
(ii)	$\text{CH}_3\text{CH(OH)CH}_2\text{CHO} + 2\text{Ag}^+_{(\text{aq})} + 2\text{NH}_3_{(\text{aq})} + \text{H}_2\text{O}_{(\text{l})} \rightarrow \text{CH}_3\text{CH(OH)CH}_2\text{COOH} + 2\text{Ag}^+$ or $\text{CH}_3\text{CH(OH)CH}_2\text{CHO} \xrightarrow[\text{OH}^-]{\text{AgNO}_3 \text{ / NH}_3_{(\text{aq})}} \text{CH}_3\text{CH(OH)CH}_2\text{COOH} + \text{Ag}.$	01
(iii)	$\text{CH}_3\text{CH(OH)CH}_2\text{CHO} + \text{NaHSO}_3_{(\text{aq})} \rightarrow \text{CH}_3\text{CH(OH)CH}_2\text{CHSO}_3^- \text{Na}^+$	01
(c)	<p style="text-align: center;">Rej. – one ion – covalent bond by 4 Na</p>	09 Mks
15.(a)(i)	<p>Yield of ammonia increases      The formation of ammonia (forward reaction) occurs <u>with a decrease in volume</u> (number of molecules) thus high <u>pressure shifts</u> the equilibrium position from left to the right.</p>	1½
(ii)	<p>Yield of ammonia decreases      The forward reaction (formation of ammonia) is exothermic thus an increase in temperature favours the <u>dissociation of ammonia</u> reducing its concentration at equilibrium. (from right to the left)</p>	1½

(b)(i)	$N_2(g) + 3H_2(g) \rightleftharpoons N_2(g) 3N_2(g) \rightleftharpoons 2NH_3$			
	Initial Moles Reacted Moles Equilibrium Moles	3.0 $\frac{1}{2} \times 0.02$ 0.01 2.99	1.0 $\frac{1}{2} \times 0.02$ 0.03 0.97	— 0.02 0.02 $[N_2] = 2.99 / 0.5$ $= 5.98 \text{ moldm}^{-3}$ $[H_2] = 0.97 / 0.$ $= 1.94 \text{ moldm}^{-3}$ $[NH_3] = 0.02 / 0.5$ $= 0.04 \text{ moldm}^{-3}$

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

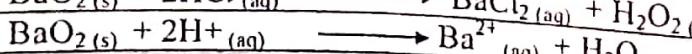
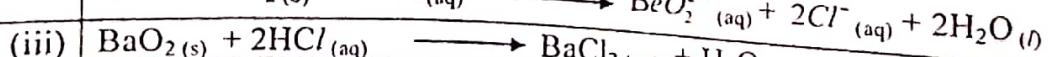
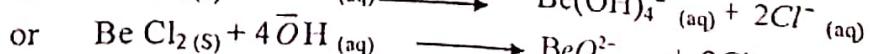
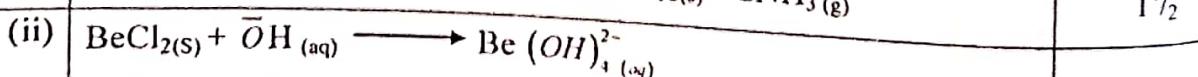
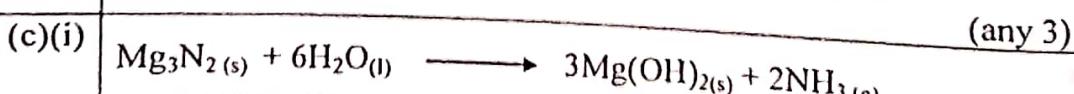
$$= \frac{0.04}{5.98 \times 1.94^3}$$

$$= 3.6645 \times 10^{-5} \text{ mol}^{-2} \text{ dm}^6$$



- 16.(a)(i) Lithium has the smallest atomic radius  
 Lithium ion has the highest charge density.  
 Lithium has the most negative electrode potential.  
 Lithium is the least electropositive / most electronegative alkali metal.  
**1 highest polarizing power**

- (b)
- Lithium only forms the normal oxide.
  - Lithium hydroxide is only sparingly soluble in water
  - When heated Lithium carbonate decomposes to form lithium oxide and carbon dioxide gas. Any 3
  - The nitrate of Lithium decomposes when heated to form an oxide, nitrogen dioxide gas and oxygen.
  - Lithium reacts with nitrogen to form Lithium nitride.



09 marks

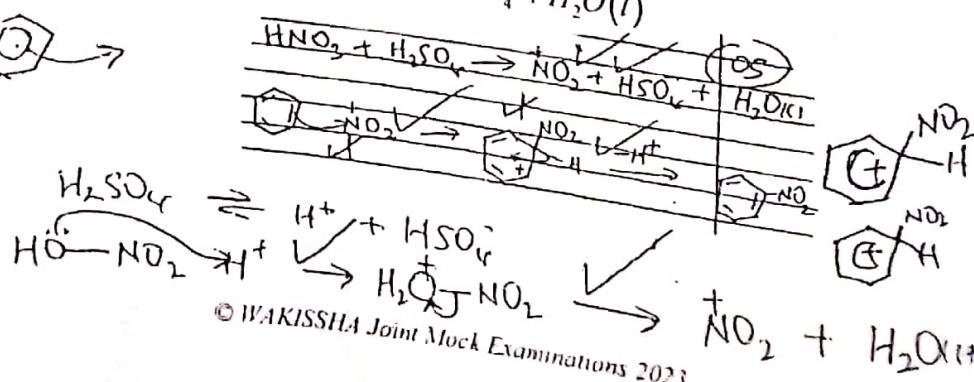
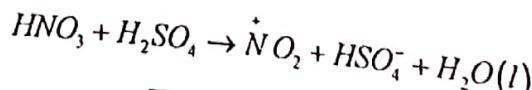
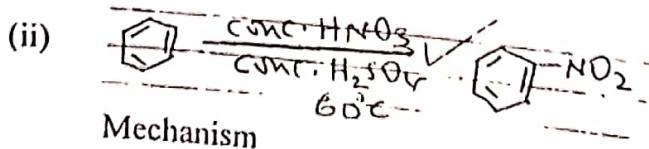
17(a) (i)	Positive deviation	01
(ii)	Addition of hexane <u>weakens</u> the intermolecular hydrogen bonds between ethanol molecules. This <u>increases</u> the escaping tendency of ethanol and hexane molecules from solution into vapor phase hence <u>increasing</u> the vapor pressure above solution which is <u>greater than</u> that expected for ideal solutions.	02
(b)(i)		02
(ii)	distillate – azeotropic mixture or liquid mixture 61.58% hexane and 38.42% ethanol. Residual liquid – Pure hexane.	01
(c)	Mass of ethanol in azeotrope = $\frac{38.42}{100} \times (50 \times 0.687) = 13.2\text{g}$ Let the mass extracted be $x\text{g}$ . $K_o = \frac{[\text{ethanol}] \text{ in chlorine chloride}}{[\text{ethanol}] \text{ in hexane}}$ $15.8 = \frac{x/100}{(13.2-x)/50}$ $15.8 \times 2 (13.2 - x) = x; x = 417.12/32.6 \approx 12.8\text{g}$	03

09 marks

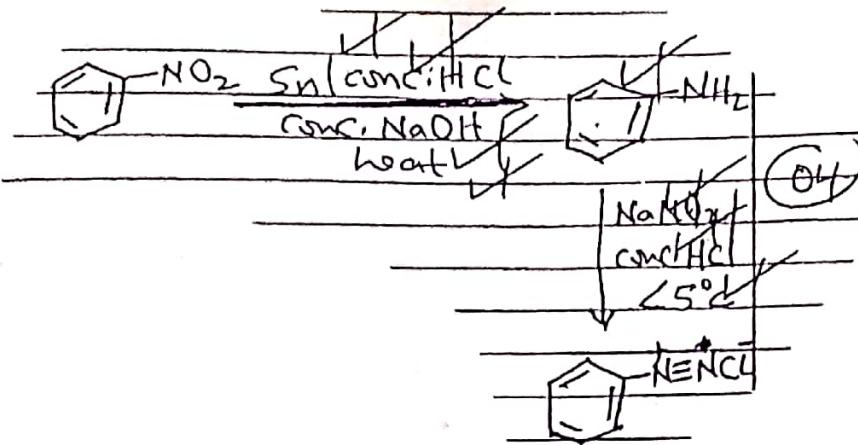
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WAKISSHA JOINT MOCK EXAMINATIONS  
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CHEMISTRY P525/2  
July/August 2023

1. (a) Transition element is one which has partially filled 3 d- sub energy level in one of its stable oxidation states. (01 mark)
- (b) (i) They use both 3d and 4s electrons for bonding. (1½ marks)  
Small energy difference between 3d and 4s sub energy level. (02 marks)
- (ii) For chromium : +2, +3, and 6.  
For manganese: +2, +3, +4, +6 and +7 (2½ marks) (04 marks)
- (iii) CrO, Cr<sub>2</sub>O<sub>3</sub> and CrO<sub>3</sub> (1½ marks)
- (c) (i) CrO<sub>3</sub>(s) + H<sub>2</sub>O(l) → H<sub>2</sub>CrO<sub>4</sub>(aq) Chromic (VI) acid  
Mn<sub>2</sub>O<sub>7</sub>(s) + H<sub>2</sub>O(l) → 2HMnO<sub>4</sub>(aq) <sub>1/2</sub> for wrong state(s) (04 marks)
- (ii) CrO<sub>3</sub>(s) + 2OH(aq) → CrO<sub>4</sub><sup>2-</sup>(aq) + H<sub>2</sub>O(l) <sub>1/2</sub> for states missing (04 marks)  
Mn<sub>2</sub>O<sub>7</sub>(s) + 2OH(aq) → 2MnO<sub>4</sub><sup>-</sup>(aq) + H<sub>2</sub>O(l)
- (d) (i) Accept molecular equations (brown)  
**Green solution turned to purple and black precipitate formed.** (2½ marks)
- 3MnO<sub>4</sub><sup>2-</sup>(aq) + 4H<sup>+</sup>(aq) → 2MnO<sub>4</sub>(aq) + MnO<sub>2</sub>(s) + 2H<sub>2</sub>O(l)
- (ii) Orange solution turned green  
Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup>(aq) + 3SO<sub>2</sub>(g) + 2H<sup>+</sup>(aq) → 2Cr<sup>3+</sup>(aq) + 3SO<sub>4</sub><sup>2-</sup>(aq) + H<sub>2</sub>O(l)  
K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>(aq) + 3SO<sub>2</sub>(g) + H<sub>2</sub>SOK(aq) → Cr<sup>3+</sup>(SO<sub>4</sub>)<sub>3</sub>(aq) + K<sub>2</sub>SO(aq) + H<sub>2</sub>O(l)
- (iii) Green solid turned yellow solid. (2½ marks)  
Cr<sub>2</sub>O<sub>3</sub>(s) + 3Na<sub>2</sub>O<sub>2</sub>(s) → 2Na<sub>2</sub>CrO<sub>4</sub>(s) + Na<sub>2</sub>O(s) (2½ marks)
2. (a) (i) (Pale) yellow solution formed.  
Reject yellow solid (01 mark)



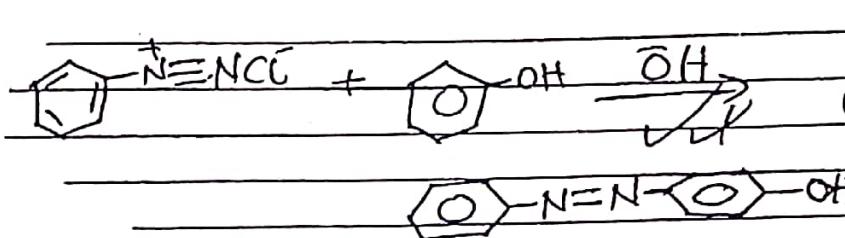
(b)



(05 marks)

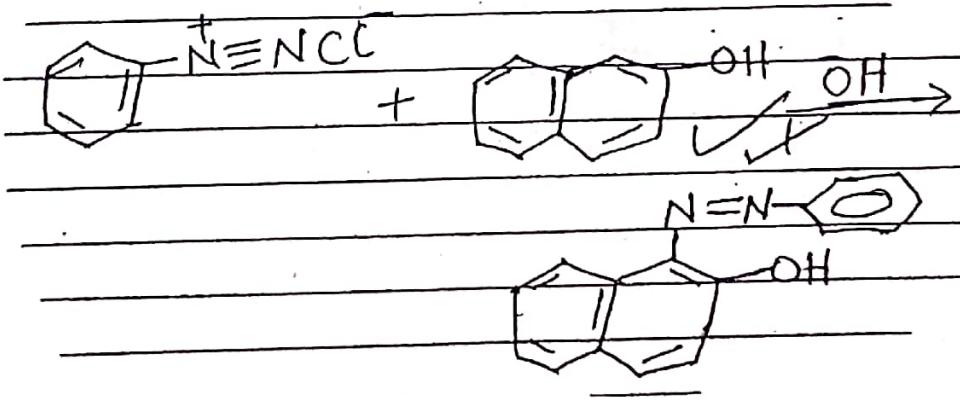
(c) (i) Yellow precipitate is formed.

Accept yellow solid



(03 marks)

(ii) Red precipitate

 $\frac{1}{2}$  for  $\bar{O}H$  missing $\frac{1}{2}$  for  $OH$  missing

(02 marks)

(e) Benzene diazonium chloride is reacted with potassium cyanide in the presence of Copper(1) cyanide to form benzene cyanide, it is refluxed with dilute mineral acid (hydrochloric acid or nitric acid) to form benzoic acid. [20 marks]

Or a acidified water.

(03 marks)

(01 mark)

3. (a) Raoult's law states that the partial vapour pressure of a volatile component in solution at a given temperature is equal to the product of the mole fraction of the component and the vapour pressure of the pure component at that temperature.

(01 mark)

(b) (i) RMM of  $\text{CH}_3\text{COCH}_3 = 12 \times 3 + 1 \times 6 + 16 = 58$ 

$$\text{RMM of } \text{CHCl}_3 = 12 + 1 + 35.5 \times 3 = 119.5$$

$$\text{No. of moles of } \text{CH}_3\text{COCH}_3 = \frac{203}{58} = 3.5$$

$$\text{No. of moles of } \text{CHCl}_3 = \frac{179.5}{119.5} = 1.5021.$$

(05 marks)

$$\begin{aligned}\text{Total number of moles} &= 3.5 + 1.5021 \\ &= 5.0021\end{aligned}$$

$$\begin{aligned}P_{\text{CH}_3\text{COCH}_3} &= \frac{3.5}{5.0021} \times 38.5 \\ &= 26.937 \text{ KNm}^{-2}\end{aligned}$$

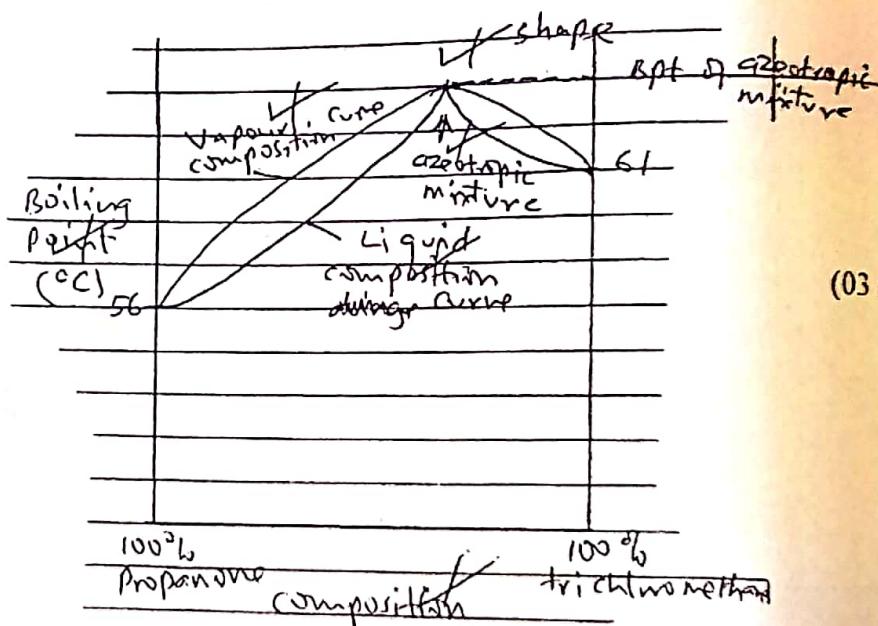
(05 marks)

$$\begin{aligned}P_{\text{CHCl}_3} &= \frac{1.5021}{5.0021} \times 26.7 \\ &= 8.0178 \text{ KNm}^{-2}\end{aligned}$$

$$\begin{aligned}\text{Total vapour pressure} &= 26.937 + 8.0178 \\ &= 34.9548 \text{ KNm}^{-2}\end{aligned}$$

- (ii) Solution deviates negatively from Raoult's law. (01 mark)

(iii)



(03 marks)

- (iv) When a mixture of propanone and trichloroethane is distilled, either pure propanone or pure trichloroethane is obtained as a distillate and the residue in the flask is richer in the azeotropic mixture because the azeotropic mixture has a higher boiling point than either of the components.

(c) (i) RMM of  $\text{C}_{10}\text{H}_{16} = 12 \times 10 + 1 \times 16 = 136$  (04 marks)

$$\text{RMM of H}_2\text{O} = 1 \times 2 + 16$$

$$= 18$$

$$\frac{\% \text{ of turpentine in the distillate}}{\% \text{ of water in the distillate}} = \frac{V.P \times \text{RMM}(\text{C}_{10}\text{H}_{16})}{V.P \times \text{RMM of H}_2\text{O}}$$

$$\frac{55}{45} = \frac{P \times 136}{(101325 - P) \times 18}$$

$$45 \times P \times 136 = 55 \times 18 \times (101325 - P)$$

$$6,120P = 100,311,750 - 990P$$

(04 marks)

$$7110P = 100, 311, 750$$

$$P = 1,450.3165 \text{ Pa.}$$

- (ii) - By use of separating funnel  
- By use of solvent extraction.

(02 marks)

[20 MARKS]

4. (a)  $KC = \frac{[\text{CH}_3\text{CH}_2\text{O}_2\text{CCH}_2\text{CH}_3][\text{H}_2\text{O}]}{[\text{CH}_3\text{CH}_2\text{COOH}][\text{CH}_3\text{CH}_2\text{OH}]}$  (01 mark)
- (b) Known  $a$  moles of propanoic acid and  $b$  moles of ethanol are sealed in tube and the tube is placed in a thermostat for a week (water bath) for sometime. The tube is then broken into cold water and known volumes of the diluted mixture are titrated against standard sodium hydroxide solution using phenolphthalein indicator.
- The reaction that takes place is
- $$\text{CH}_3\text{CH}_2\text{COOH}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{CH}_3\text{CH}_2\text{COONa}(\text{aq}) + \text{H}_2\text{O}(\text{l})$$
- The amount of propanoic acid in the equilibrium mixture is determined. If  $x$  moles of propanoic acid are present at equilibrium, then the KC can be determined.



Initial	$a$	$b$	$0$	$0$
Moles				
Equilibrium				
Moles	$x$	$b - ((a-x))$	$(a-x)$	$(a-x)$

If  $V \text{ dm}^3$  is the volume of the sealed tube.

$$[\text{CH}_3\text{CH}_2\text{COOH}] = \frac{x}{V}$$

$$[\text{CH}_3\text{CH}_2\text{OH}] = \frac{b-(a-x)}{V}$$

$$[\text{CH}_3\text{CH}_2\text{O}_2\text{CCH}_2\text{CH}_3] = [\text{H}_2\text{O}] = a-x \quad (06 \text{ marks})$$

$$\therefore KC = \frac{[\text{C}_2\text{H}_5\text{O}_2\text{CCH}_2\text{CH}_3][\text{H}_2\text{O}]}{[\text{C}_2\text{H}_5\text{OH}][\text{CH}_3\text{CH}_2\text{COOH}]}$$

$$= \frac{\frac{(a-x)(a-x)}{V^2}}{\frac{x}{V} - \frac{b-(a-x)}{V}}$$

$$= \frac{(a-x)(a-x)}{x(b-a+x)}$$

- (c) (i) Increase in temperature favours the backward reaction shifting the equilibrium position to the left since the reaction is exothermic. The concentration of the products reduces while that of the reactants increases and thus the equilibrium constant decreases.

(03 marks)

- (ii) The equilibrium position shifts to the left because calcium carbonate reacts with propanoic acid at equilibrium and the backward reaction is favoured to restore the concentration of propanoic acid. The equilibrium constant does not change. (02 marks)
- (iii) The equilibrium position shifts to the right because anhydrous copper(II) sulphate absorbs water and this favours the forward reaction. The equilibrium constant does not change. (02 marks)

(d) RMM of  $\text{CH}_3\text{CH}_2\text{OH} = 12 \times 2 + 1 \times 6 + 16 = 46$   
 RMM of  $\text{CH}_3\text{CH}_2\text{COOH} = 12 \times 3 + 1 \times 6 + 16 \times 2 = 74$

$$\text{No. of moles of ethanol} = \frac{62.1}{46} = 1.35$$

$$\text{No. of moles of propanoic acid} = \frac{185}{74} = 2.5$$

Let  $x$  moles be the number of moles of ethylpropanoate.

$$K_C = \frac{\frac{x}{V} \cdot \frac{x}{V}}{\left(\frac{1.35-x}{V}\right)\left(\frac{2.5-x}{V}\right)} = \frac{x^2}{(1.35-x)(2.5-x)}$$

$$4 = \frac{x^2}{(1.5-x)(2.5-x)}$$

$$4(3.75 - 4x + x^2) = x^2$$

$$15 - 16x + 4x^2 = x^2$$

$$3x^2 - 16x + 15 = 0$$

$$x = 1.2137.$$

(06 marks)

$$\text{RFM of } \text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3 = 12 \times 5 + 1 \times 10 + 16 \times 2 = 102$$

$$\begin{aligned} \text{Mass of ethylpropanoate} &= 102 \times 1.2137 \\ &= 123.7974 \text{ g} \end{aligned}$$

5. (a) First electron affinity is the heat evolved when an electron is added to a gaseous atom to form a uninegatively charged gaseous ion. (02 marks)

OR

First electron affinity is the enthalpy change that occurs when one mole of electrons is added to one mole of gaseous atoms to form one mole of uninegatively charged gaseous ions.

- (b)  $X(g) + e \rightarrow X^-(g) \quad \Delta H = Q \text{ kJ mol}^{-1}$  -1/2 for  $\Delta H$  missing  
 Generally electron affinities increase across period 2 of the periodic Table. This is because from one element to the next, an electron is being added to the same energy level and protons are added to the nucleus. Nuclear charge increases while screening effect almost remains constant and thus effective nuclear charge increases across the period and the incoming electron is strongly attracted and this leads to increase in electron affinity.

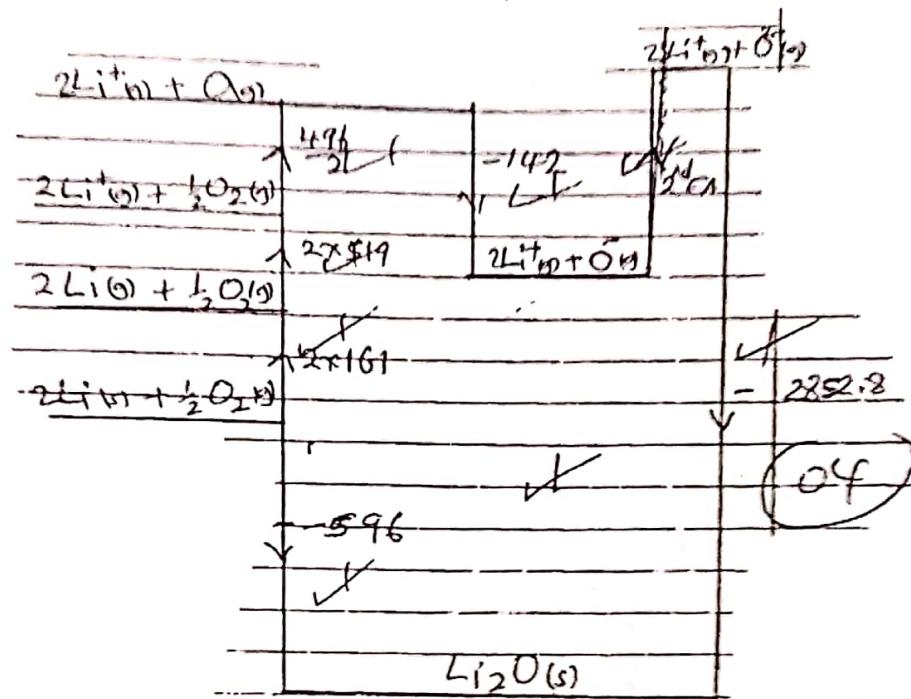
However, beryllium has a positive electron affinity because beryllium has the electronic configuration,  $1S^2 2S^2$ . The 2S orbital is full and thermodynamically

**stable.** The incoming electron experience repulsion and thus energy must be supplied for the electron to be added to the atom.

Nitrogen has abnormally low electron affinity because  $7N 1s^2 2s^2 2p^3$ .

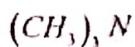
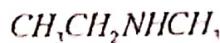
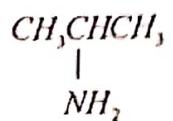
The 3p sub-energy level is half filled stable and thus less energy is released on addition of the electron. (07 marks)

(c) (i)



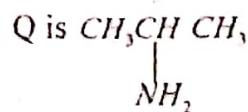
$$(c) \text{ (ii)} \quad 2^{\text{nd}} \text{EA} = -596 - \left( 161 \times 2 + 519 \times 2 + \frac{496}{2} + -2852.8 + -142 \right) \\ = +790.8 \text{ kJmol}^{-1} \quad \text{missing reject} \quad (03 \text{ marks})$$

$$(d) \quad K(s) + \frac{1}{2} Cl_2(g) \rightarrow KCl(s) \Delta H^\circ_f = ? \quad \text{units missing } ^{-1}/_2 \\ \Delta H^\circ_f(KCl) = (\text{i}) + (\text{iii}) + (\text{iv}) + -(\text{ii}) + -(\text{v}) \text{ units wrong Reject} \\ = -57.3 + -164.2 + -487.0 \\ + 285.9 + -18.4 \\ = -441 \text{ KJmol}^{-1} \quad (04 \text{ marks})$$



(02 marks)

(b) P is  $CH_3CH_2NHCH_3$

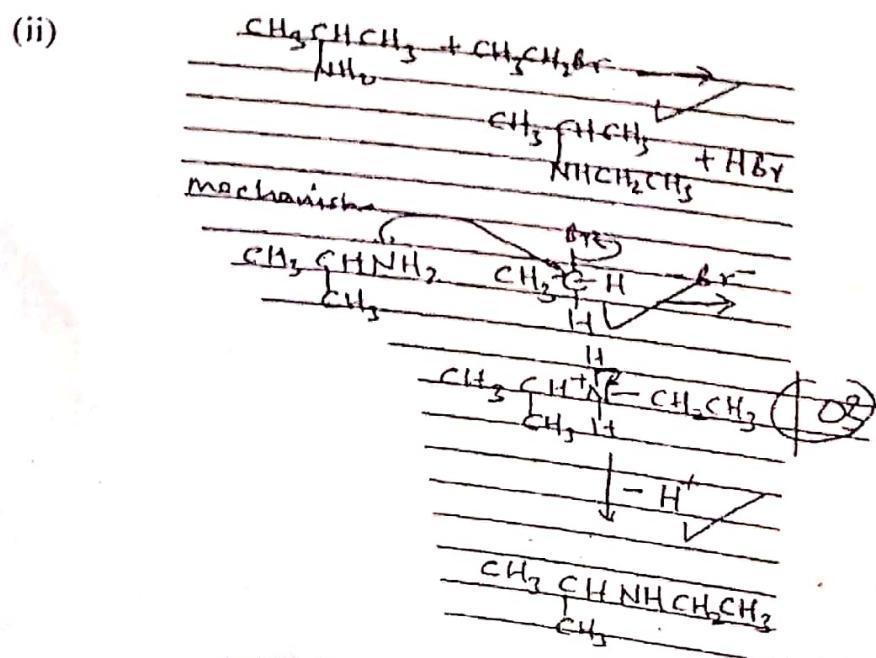
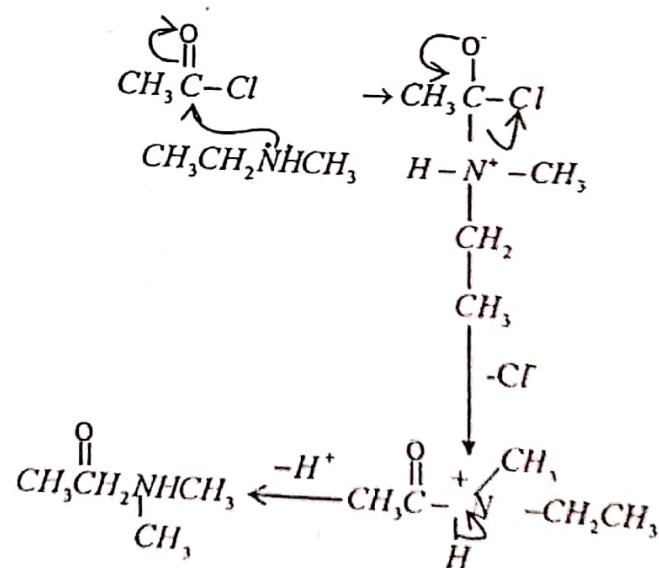
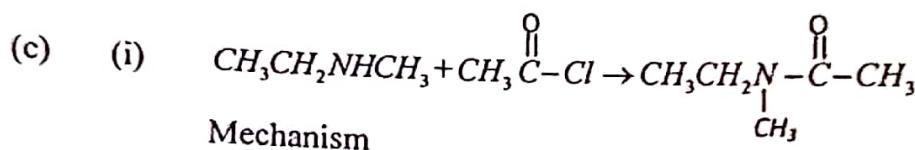
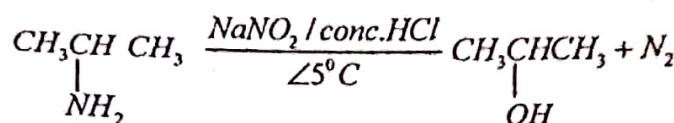
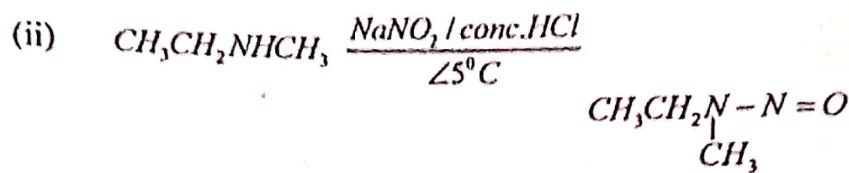


R is  $\text{CH}_3\text{CH}_2\overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{N}}}-\text{N}=\text{O}$

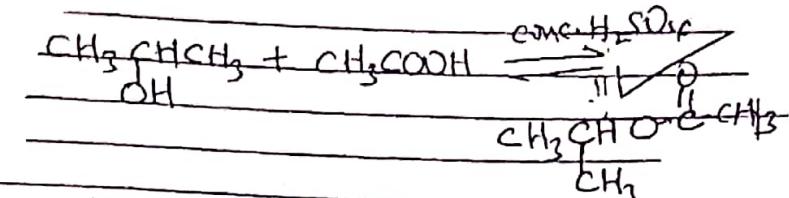
S is  $\text{CH}_3\overset{\text{OH}}{\underset{\text{CH}_3}{\text{CH}}}\text{CH}_3$

T is  $\text{N}_2$  (Nitrogen gas)

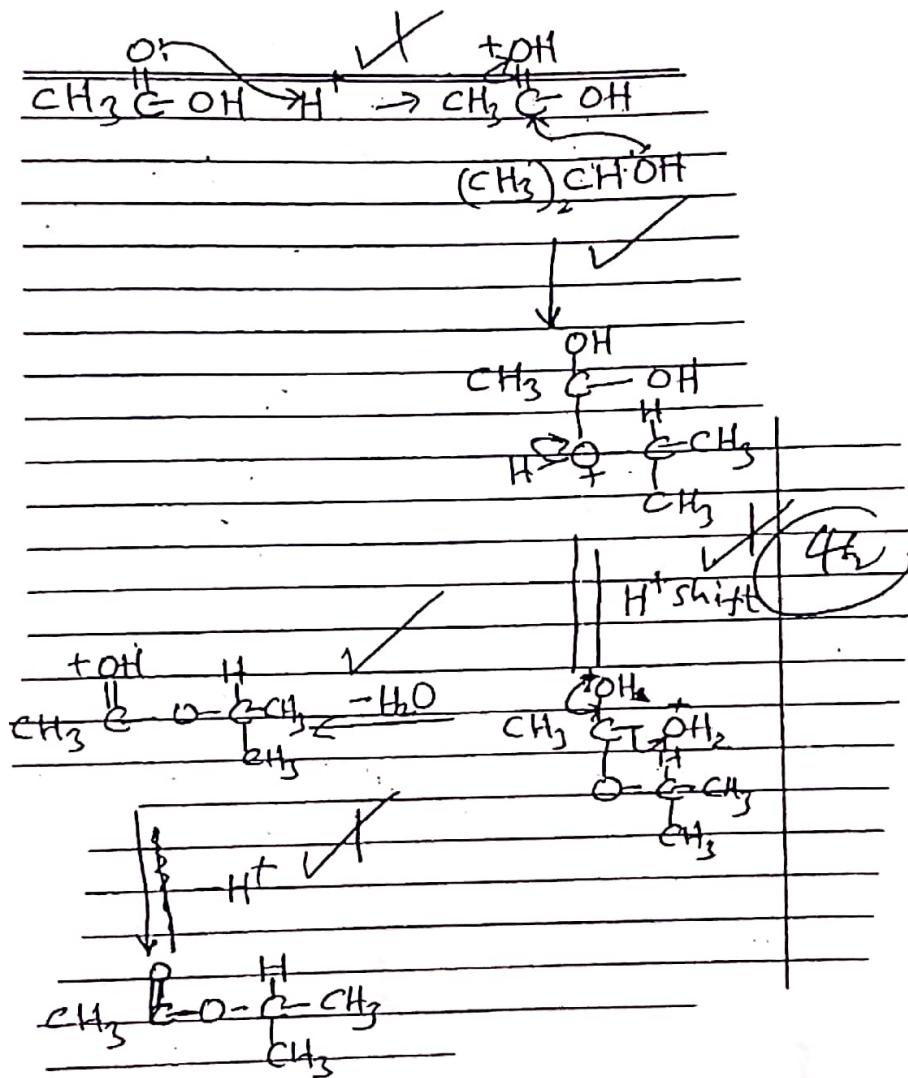
(2)



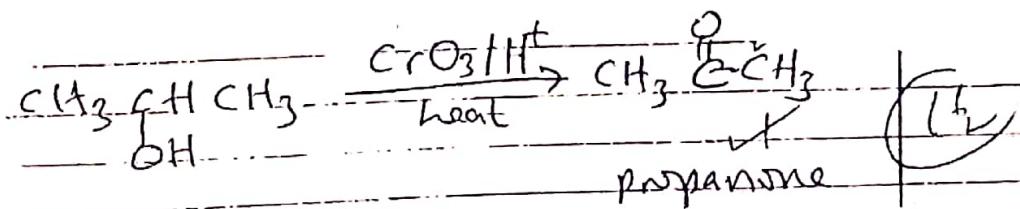
(iii)



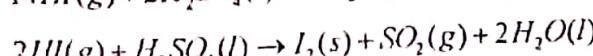
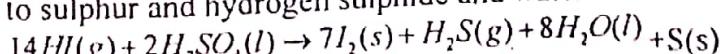
mechanism



(d) (i) Orange solution turns green



7. (a) Concentrated sulphuric acid oxidises hydrogen iodide to iodine and itself reduced to sulphur and hydrogen sulphide and water. (05 marks)



- (b) Copper(I) oxide disproportionates in sulphuric acid to form copper which is solid and copper (II) sulphate solution which is blue. (04 marks)  
 $Cu_2O(s) + H_2SO_4(aq) \rightarrow Cu(s) + CuSO_4(aq) + H_2O(l)$   
Accept  $Cu_2O(s) + 2H^+(aq) \rightarrow Cu(s) + Cu^{2+}(aq) + H_2O(l)$
- (c) Iron (III) ethanote is formed which undergoes hydrolysis to form iron (III) oxide and ethanoic acid. (04 marks)  
 $FeCl_3(aq) + CH_3COONa(aq) \rightarrow (CH_3COO)_2Fe(aq) + 3NaCl$   
 $2(CH_3COO)_2Fe(aq) + 3H_2O(l) \rightleftharpoons Fe_2O_3(s) + 6CH_3COOH$
- (d) Trimethylamine lack a hydrogen atom on the amino functional group and therefore does not associate through hydrogen bonding instead molecules associate through weak vander waals forces which require less energy to break while Propylamine possesses hydrogen atoms on the amino functional group and therefore molecules associate through hydrogen bonds which are stronger than vander waals forces.
- (e) Sulphurous acid processes fewer oxygen atoms and thus exert less negative inductive effect and the O – H bond is less polar and cannot easily break it.
- 8.
- (a)  $NaH, MgH_2, AlH_3, SiH_4, PH_3, H_2S, HCl$
- (b) (i)  $2Na(s) + H_2(g) \rightarrow 2NaH(s)$   
(ii)  $Mg_2Si(s) + 4H_2O(l) \rightarrow 2Mg(OH)_2(g) + SiH_4(g)$   
(iii)  $FeS(s) + 2HCl(q) \rightarrow FeCl(aq) + H_2S(g)$   
 $SiCl(l) + LiAlH_4 \rightarrow 4SiH_4(g) + AlCl_3LiCl(s)$  (4½ marks)
- (c) (i) Sodium hydride does not react with Sodium hydroxide because it is basic. Silicon (IV) hydride reacts to form Sodium silicate and hydrogen gas.  
 $SiH_4(g) + 2NaOH_{(aq)} + H_2O(l) \rightarrow Na_2SiO_3(aq) + 4H_2(g)$   
Hydrogen sulphide reacts with aqueous Sodium hydroxide solution to form Sodium Sulphide and water.  
 $H_2S(g) + 2NaOH(aq) \rightarrow Na_2S(aq) + 2H_2O(l)$
- (ii) Sodium hydride reacts with cold concentrated to form Sodium Sulphate and hydrogen sulphide gas.  
 $Na_2S(s) + 2H_2SO_4(l) \rightarrow 2NaHSO_4(s) + H_2S(g)$   
Silicon (IV) hydride being acidic does not react with concentrated Sulphuric acid.
- Hydrogen sulphide reduces concentrated sulphuric acid to sulphur dioxide and hydrogen sulphide itself is oxidized to sulphur. (05 marks)  
 $H_2S(g) + H_2SO_4(l) \rightarrow S(s) + SO_2(g) + 2H_2O(l)$
- (d) (i) Yellow solid is formed  
 $2H_2S(g) + O_2(g) \rightarrow 2S(s) + 2H_2O(l)$   
(ii) White fumes of a gas.  
 $2H_2S(g) + 3O_2(g) \rightarrow 2SO_2(g) + 2H_2O(l)$  (04 marks)
- (e) Sodium hydride is melted and electrolyzed between platinum electrodes. Hydrogen gas is evolved at the anode showing that the hydride ion is negatively charged.  
 $NaH(l) \rightarrow Na^+(l) + H^-(l)$   
 $2H^-(l) \rightarrow H_2(g) + 2e^-$  (03 marks)

END

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120 MARKS

**WAKISSHA JOINT MOCK EXAMINATIONS**

**MARKING GUIDE**

**Uganda Advanced Certificate of Education**

**UACE August 2023**

**CHEMISTRY P525/3**



**Procedure 1**

Volume of pipette used ..... 25.0 ..... cm<sup>3</sup>

½

½mark

Experiment Number	1	2	3
Final burette reading (cm <sup>3</sup> )	11.30	22.60	33.90
Initial burette reading (cm <sup>3</sup> )	0.00	11.30	22.60
Volume of GA <sub>2</sub> used (cm <sup>3</sup> )	11.30	11.30	11.30

04½mark

01mark

Titre values used to calculate average volume

11.30 cm<sup>3</sup> and 11.30 cm<sup>3</sup>                          ½

Average volume of GA<sub>2</sub> used      2½

$$\left( \frac{11.30 + 11.30}{2} \right)$$

$$= 11.30 \text{ cm}^3$$

02½marks

a) (i) Molar mass of NaNO<sub>2</sub>

$$(23 \times 1) + (14 \times 1) + (16 \times 2)$$

$$23 + 14 + 32$$

$$= 69 \text{ g}$$

69g of NaNO<sub>2</sub> contain 1 mole

0.4g of NaNO<sub>2</sub> contain

$$\left( \frac{0.4 \times 1}{69} \right) = 0.0058 \text{ moles}$$

2½

02½marks

250 cm<sup>3</sup> of GA<sub>1</sub> contain 0.0058 moles

25cm<sup>3</sup> of GA<sub>1</sub> contain

$$\left( \frac{25 \times 0.0058}{250} \right)$$

$$= 0.00058 \text{ moles}$$

(ii) From equation

5 moles of NO<sub>2</sub><sup>-</sup> react with 2 moles of MnO<sub>4</sub><sup>-</sup>

0.00058 moles of NO<sub>2</sub><sup>-</sup> react with

1½

$$\left( \frac{0.00058 \times 2}{5} \right)$$

$$= 0.00023 \text{ moles of MnO}_4^-$$

01mark

b)  $11.30 \text{ cm}^3$  of  $\text{MnO}_4^-$  contain 0.00023 moles 1 1/2  
 $1000 \text{ cm}^3$  of  $\text{MnO}_4^-$  contain  

$$\left( \frac{1000}{11.3} \times 0.00023 \right) = 0.02 \text{ M}$$

### Procedure 2

Mass of container + Z ..... 2.60 g

Mass of container alone ..... 2.00 g

Mass of Z alone ..... 0.60 g

Volume of pipette used ..... 25.0  $\text{cm}^3$

Experiment Number	1	2	3
Final burette reading ( $\text{cm}^3$ )	11.90	10.00	10.00
Initial burette reading ( $\text{cm}^3$ )	0.00	0.00	0.00
Volume of $\text{GA}_2$ used ( $\text{cm}^3$ )	11.90	10.00	10.00

Titre values used to calculate average volume 2  
 $10.00 \text{ cm}^3$  and  $10.00 \text{ cm}^3$

Average volume of  $\text{GA}_2$  used

$$\left( \frac{10.00 + 10.00}{2} \right)$$

$$= 10.00 \text{ cm}^3$$
2 1/2

a) (i)  $1000 \text{ cm}^3$  of  $\text{GA}_2$  contain 0.02 moles 01  
 $10.00 \text{ cm}^3$  of  $\text{GA}_2$  contain 1 1/2  

$$\left( \frac{10.00 \times 0.02}{1000} \right) = 0.0002 \text{ moles}$$

(ii) 2 moles of  $\text{GA}_2$  react with 5 moles of  $\text{GA}_4$  01m  
0.0002 moles of  $\text{GA}_2$  react with  

$$\left( \frac{0.0002 \times 5}{2} \right) = 0.0005 \text{ moles of acidic compound}$$

b) (i)  $25.0 \text{ cm}^3$  of  $\text{GA}_4$  contain 0.0005 moles 01m  
 $1000 \text{ cm}^3$  of  $\text{GA}_4$  contain 1 1/2  

$$\frac{1000 \times 0.0005}{2} = 0.02 \text{ M}$$

(ii)  $250 \text{ cm}^3$  of  $\text{GA}_4$  contain 0.6g  
 $1000 \text{ cm}^3$  of  $\text{GA}_4$  contain  

$$\frac{1000 \times 0.6}{250}$$
  
 $= 2.4\text{g/l}$

0.02 moles of  $\text{GA}_4$  weigh 2.4g  
 $1 \text{ mole} \left( \frac{1 \times 2.4}{0.02} \right) = 120 \text{ g}$

$$\begin{aligned}\text{T.nH}_2\text{O} &= 120 \\ (90 \times 1) + n [(1 \times 2) + (16 \times 1)] &= 120 \\ 90 + 18n &= 120 \\ 18n &= 120 - 90 \\ 18n &= 30 \\ n &= 1.667 \approx 2 \\ n &= 2\end{aligned}$$

OR  
 $1000 \text{ cm}^3$  of  $\text{GA}_4$  contain 0.02 moles  
 $250 \text{ cm}^3$  of  $\text{GA}_4$  contain  $\frac{0.02 \times 250}{1000} = 0.005$   
0.005 moles of  $\text{T.nH}_2\text{O}$  weigh 0.6g  
 $1 \text{ mole of } 2 \text{ T.nH}_2\text{O} \text{ weigh } \left( \frac{0.6}{0.005} \right) = 120 \text{ g}$

Total = 29marks

### Question 2

a)	White crystalline solid Colorless gas that turns lime water milky and moist blue litmus paper red. Turn acidified  Sweet smelling colourless gas that has no effect on litmus paper and forms a yellow precipitate with 2,4 – dinitrophenyl hydrazine yellow residue when hot and white when cold Colourless condensate turn calydiun Cason blue hydrated	$\text{Zn}^{2+}, \text{Al}^{3+}, \text{Pb}^{2+}, \text{NH}_4^+, \text{Ca}^{2+}, \text{Mg}^{2+}, \text{Ba}^{2+}, \text{Sn}^{2+}$ $\text{CO}_2$ gas evolved $\text{CO}_3^{2-}, \text{HCO}_3^-$ , $\text{C}_2\text{O}_4^{2-}$ , $\text{CH}_3\text{COO}^-$ suspected present $\text{SO}_2 \text{ or } \text{SO}_4^{2-}$ $\text{CH}_3\text{CCH}_3$ gas evolved $\text{CH}_3\text{COO}^-$ suspected present  $\text{ZnO}$ residue, $\text{Zn}^{2+}$ suspected present	Max 07½marks
b)	White fumes with a Vinegar smell and turns wet blue litmus paper red	Acetic acid fumes evolved $\text{CH}_3\text{COO}^-$ suspected present	02½marks
c)	Dissolves to form a colorless solution	$\text{Zn}^{2+}, \text{Al}^{3+}, \text{Pb}^{2+}, \text{NH}_4^+, \text{Mg}^{2+}, \text{Ca}^{2+}, \text{Sn}^{2+}, \text{Ba}^{2+}$	01mark
i)	White precipitate insoluble in acid and as heating.	$\text{SO}_4^{2-}, \text{Br}^-, \text{Cl}^-$ suspected present	01mark
ii)	White precipitate insoluble in acid	$\text{SO}_4^{2-}$ Confirmed present	01mark
iii)	sweet fruity pleasant smell observed	Ester formed $\text{CH}_3\text{COO}^-$ Confirmed present	02marks
d)	Dissolves to form a colorless solution	$\text{Zn}^{2+}, \text{Pb}^{2+}, \text{Al}^{3+}, \text{Ca}^{2+}, \text{Mg}^{2+}, \text{NH}_4^+, \text{Ba}^{2+}, \text{Sn}^{2+}$	

	White precipitate insoluble in excess	$\text{Pb}^{2+}, \text{Al}^{3+}, \text{Mg}^{2+}, \text{Ba}^{2+}$
	White residue Colorless filtrate	$\text{Pb}^{2+}, \text{Al}^{3+}, \text{Mg}^{2+}, \text{Ba}^{2+}$ $\text{Zn}^{2+}$ suspected
e)	White precipitate soluble in the acid to form a colorless solution	$\text{Zn}^{2+}$ suspected
	i) White precipitate soluble in excess to form a colorless solution	$\text{Zn}^{2+}$ suspected present
	ii) White precipitate soluble in excess to form a colorless solution	$\text{Zn}^{2+}$ confirmed present
	iii) White precipitate soluble in excess ammonia solution	$\text{Zn}^{2+}$ confirmed present
f)	Residue dissolves to form a colorless solution	$\text{Al}^{2+}, \text{Pb}^{2+}, \text{Ba}^{2+}, \text{Mg}^{2+}$
	(i) white precipitate soluble in excess to form a colorless solution	$\text{Al}^{3+}$ and $\text{Pb}^{2+}$
	(ii) No observable change	$\text{Pb}^{2+}$ absent, $\text{Al}^{3+}$ present
	(iii) Add ammonia solution drop wise until the solution is alkaline followed by alizarin reagent Pink / red coloration formed OR Add 2 to 3 drops of dilute HCC acid followed by 3 to 4 drops of litmus solution and then ammonia solution drop wise until in excess	$\text{Al}^{3+}$ confirmed present
	A blue lake solution is formed	

- (h) identify;
- (i) Cations .....  $\text{Zn}^{3-}$  ..... and .....  $\text{Al}^{3+}$  .....
  - ii) Anions .....  $\text{SO}_4^{2-}$  ..... and .....  $\text{CH}_3\text{COO}^-$  .....

### Question 3

	OBSERVATION	DEDUCTION
a)	White conshete solid burns with a blue non sooty flame	Aliphatic, saturated low carbon content compound
b)	Dissolves with water forming a colorless solution	Polar, low molecular mass compound
	(i) Solution turned blue litmus paper to red.	Acidic compound preach Carboxylic acid present
	(ii) No observable change	Benzole acid absent

(iii) Effervescence occurred	Carboxylic present	02marks
(iv) Purple solution turn colorless	Reducing agent present probably primary alcohol, secondary alcohol, aldehyde	2½marks
(v) No yellow precipitate formed	Aldehyde confirmed absent	01½marks
(vi) No observable change	Aldehyde confirmed absent	01½marks
(vii) Orange solution turns green and a yellow precipitate is formed	Secondary alcohol present which is oxidized into a carbonyl or ketone.	03marks
(viii) Cloudy solution formed in the 5 <sup>th</sup> or 6 <sup>th</sup> or 7 <sup>th</sup> minule	Present secondary alcohol present	01½marks
		<b>20 marks</b>

Comment on Q.

Q is aliphatic, polar, carboxylic acid, with a secondary alcohol.

01½marks

Aliphatic secondary alculin with Carboxyl group.

Aliphere carboxylic acid with hydroxyl group secondary attached to carbon atom.

**END**