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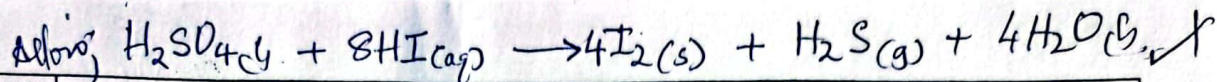**CHEMISTRY P525/1**

COORDINATED GUIDE
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1. (a)	$^{24}_{11}Na \longrightarrow {}^{24}_{12}Mg + {}^{0}_{-1}e + 2\gamma$ ✓ rej; β	01
(b)	$\lambda = \dfrac{\ln 2}{t_{1/2}}$ ✓ $\lambda = \dfrac{\ln 2}{15} = 0.046209812$ per hour ✗ $\ln\left(\dfrac{No}{Nt}\right) = \lambda t.$ ✓ $\ln\left(\dfrac{2.4}{Nt}\right) = 0.046209812 \times 72$ ✓ Acc. $2.303 \log_{10}\left(\dfrac{No}{Nt}\right) = \lambda t$ $Nt = 0.086152g.$ ✓ Mass decayed $= 24 - 0.086152$ ✓ $= \underline{23.913848}\,g$ $2.3138\,g$ ✗	04
(c)	Carbon dating using (carbon – 14) ✓ determination of mechanism for esterification reaction. (Cobalt-60 gamma radation) for cancer treatment (any 2 correct) ✓	01
		06 marks
2.(a) (i)	$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ ✓	01
(ii)	CrO, Cr_2O_3 and CrO_3 ✗	1½
(b)(i)	$CrO_{(s)} + 2H^+_{(aq)} \longrightarrow Cr^{2+}_{(aq)} + H_2O_{(i)}$ ✓✗ Acc. If correct mineral acid used correctly.	1½
(ii)	$CrO_{3(s)} + 2\bar{O}H_{(aq)} \longrightarrow CrO_4^{2-}{}_{(aq)} + H_2O_{(l)}$ ✓✗ Acc. Molecular equations. deny ½ for physical states	1½
		5½ marks
3(a)	$CH_3CH_2Br \xrightarrow[\text{Heat}]{CH_3CH_2\bar{O}Na^+ \vert alcohol} CH_3CH_2OCH_2CH_3$ ✓ Mechanism. $CH_3CH_2\bar{O}Na^+ \longrightarrow CH_3CH_2\bar{O} + Na^+$ ✗ $CH_3CH_2\!-\!Br$ ✓✗ $CH_3CH_2\bar{O} \longrightarrow CH_3CH_2OCH_2CH_3 + Br^-$ $\bigcirc\!-\!Br \xrightarrow{HBr} \bigcirc\!\substack{Br\\Br}$ ✓ rej; alkene rej; ½ for failure to breakage of C-Br	03
(b)	$\bigcirc\!-\!Br \cdots H\!-\!Br \longrightarrow \bigcirc^{+} + Br^-$ ✓ $\bigcirc\!-\!Br\; :Br \longrightarrow \bigcirc\!\substack{Br\\Br}$ ✓ Acc. Br^- use of a charge for attack: Ignore partial charges;	03
		06 marks

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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)	R.F.M of $PbCl_2 = 278$ ✗ ✓ Solubility in $CaCl_2 = 2.951625 / 278$ $= 0.010625$ moldm^{-3} ✓ *Assumption;* $[Cl^-] = (2 \times 0.02) + 0.010625 \times 2)$ *$[Cl^-] = 0.04M$* ✗ $= 0.06125$ moldm^{-3}. $K_{sp} = 1.69 \times 10^{-5}$ Mol^{3}dm^{-9} $PbCl_{2(s)} + aq \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^-_{(aq)}$ $K_{sp} = [Pb^{2+}][Cl^-]^2$ $(0.04)^2$ ✗ *1.69×10^{-5} Mol^{3}dm^{-9}* ✓ $= 0.010625 \times 0.06125^2 = 3.98604 \times 10^{-5}$ mol^{3}dm^{-9}. ✓ Let solubility in pure water be x. $K_{sp} = 4x^3$ $4x^3 = 3.98604 \times 10^{-5}$ ✗ *1.69×10^{-5} Mol^3* $x = \left(\frac{1}{4} \times \frac{1.69 \times 10^{-5}}{3.98604 \times 10^{-5}} \right)^{1/3}$ $= 0.02152$ mol^{3}dm^{-9} *g dm^{-3}* *$x = 4.5198$ g dm^{-3}* ✗ Solubility $= 0.02125 \times 278$ ✗ $= 5.90325$ gdm^{-3} ✗	05
(ii)	Lead (II) chloride is less soluble in calcium chloride than in pure water. *Acc. Lead (II) Chloride has a higher Solubility in pure water than*	½
		6½ marks
5(a)	$MgCl_{(aq)} + H_2O_{(l)} \longrightarrow MgO_{(s)} + 2HCl_{(aq)}$ 146.2 $Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$ $^-478.4$ ✓✗ $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$ $\frac{1}{2} \times ^-572$ $Mg_{(s)} + \frac{1}{2}O_{2(g)} \longrightarrow MgO_{(s)}$ ✗ $\Delta Hf = -618.2$ KJmol^{-1} ✓	03
(b)	Magnesium is stable (relative to its elements) Reason – Negative enthalpy of formation. *rej: If the correct answer in (a) Wrong*	1½
		4½marks
6(a)	Fluorine is <u>more electronegative</u> than Iodine thus hydrogen fluoride molecules are held by <u>strong intermolecular hydrogen bonds</u> while hydrogen iodide molecules are held by <u>weak vander waals forces</u> ✗ which require <u>less heat energy to break.</u> ✗	02
(b)(i)	Both HF and HI react with sodium carbonate solution to form corresponding sodium salts, carbon dioxide gas and water ✗ *½ for all the products correct.* $2HF_{(l)} + Na_2CO_{3(aq)} \longrightarrow 2NaF_{(aq)} + CO_{2(g)} + H_2O_{(l)}$ ✗ $2HI_{(g)} + Na_2CO_{3(aq)} \longrightarrow 2NaI_{(aq)} + CO_{2(g)} + H_2O_{(l)}$ ✗ Accept general equation $2Hx + Na_2CO_{3(aq)} \longrightarrow 2NaX_{(aq)} + CO_{2(g)} + H_2O_{(l)}$	1½

(ii)	HF does not react with Conc. H_2SO_4. HI reduces concentrated Sulphuric acid to Sulphurdioxide and water, itself oxidized to Iodine.. ✓ $2HI + H2SO_{4(l)} \longrightarrow SO_{2(g)} + I_{2(g)} + 2H_2O_{(l)}$ ✓	1½
		05marks
7. (a)	$\underset{}{\text{⬡-COOCH}_3} \xrightarrow[\text{warm}]{H_2O/H^+} \text{⬡-COOH} + CH_3OH \cdot$ for both products.	01
(b)	Sodium carbonate solution ✓ Penalise if solution missing	01
	Observations	
	⬡-COOH - Bubbles of a colorless gas ✓	02
	CH_3OH - No observable change ✓	
(c)	Solvent extraction ✗	½
		4½marks
8.(a)		Phases – 1½ axes – 01 Shape – ½ (position of triple point and critical point) 03
(b) (i)	Solid E melts into liquid which on further heating is converted into vapour. ✗	01
(ii)	All Liquid E and gaseous E (vapour) solidifies. ✓ Awarded if the candidate indicates all phases 01	
		05marks
9.(a)(i)	hexachloroplumbate (IV) ions Acc. hexachloroplumbic (IV) acid.	½
(ii)	Ammonium hexachloro plumbate (IV) ✗	½
(iii)	Lead (IV) chloride ✓ Acc. Lead tetra chloride.	½
(b)	$PbCl_{4 (l)} + 2H_2O_{(l)} \longrightarrow PbO_{2(s)} + 4HCl_{(g)}$ ✓ or(aq)	01
(c)	Hydrolysis ✗	½
		03marks

Margin notes for 8.(a): If the axes are interchanged, penalise. If the phase behaves anomalous to that of water, penalise.

$CrO_4^{2-} = -2$
$+2 \, \text{||}$

10(a)		
	Benzene-COOH, Heat NaOH(s)/CaO(s), Acc. Sodalime heat → benzene; CH$_3$Cl/AlCl$_3$ → toluene (CH$_3$); Cl$_2$/AlCl$_3$ → chlorotoluene; KMnO$_4$/H$^+$ Heat → chlorobenzoic acid (COOH, Cl)	3½

(b)		
	CH$_3$Br, Conc.NH$_3$ Heat in a sealed tube → CH$_3$NH$_2$; CH$_3$Br → (CH$_3$)$_2$NH; NaNO$_2$(aq)/Conc.HCl 0°C (0-5°C) → (CH$_3$)$_2$N-N=O; Acc. CH$_3$Br $\xrightarrow{CH_3NH_2}$ (CH$_3$)$_2$NH; rej's nitrous acid or HNO$_2$(aq)	3½

(c)		
	benzene-N$_2^+$Cl$^-$, Na$_2$SO$_3$(aq) or (1. SnCl$_2$/Conc.HCl, 2. NaOH(aq)) → benzene-NHNH$_2$, HCHO/H$^+$ with Acc or without H$^+$(aq) → benzene-NHN=CH$_2$	02

		09 marks
11.(a)(i)	Copper (II) sulphate is a strong electrolyte which fully dissociates to produce high concentration of copper (II) ions and sulphate ions.	rej. ·01 ·ionise
(ii)	Excess ammonia is a weak base / alkali which only partially ionizes to produce few ions.	01
(b)(i)	$Cu^{2+}_{(aq)} + 2\bar{O}H_{(aq)} \longrightarrow Cu(OH)_{2(S)}$	01
(ii)	$Cu(OH)_{2(S)} + 4NH_{3(aq)} \longrightarrow [Cu(NH_3)_4]^{2+}_{(aq)} + 2\bar{O}H_{(aq)}$	01
(c) (i)	Molar conductivity of water $= \dfrac{k}{c} \times 1000$ $$= \dfrac{5.484 \times 10^{-8}}{1/18}$$ $$= 9.8712 \times 10^{-7} \, \Omega^{-1} cm^2 mol^{-1}$$ At infinite dilution, $\Lambda_o(H_2O) = \Lambda_o(H^+) + \Lambda_o(\bar{O}H)$ $$= 349.8 + 198.6$$ $$= 548.4 \, \Omega^{-1} cm^2 mol^{-1}$$	3½

$$\alpha = \frac{\Lambda_c}{\Lambda_0}$$ ✗

$18cm^3$ of water Contain 1 mole

$1000cm^3$ of water Contain $\left(\frac{1000}{18}\right)$ moles

$= 9.8712 \times 10^{-7} / 548.4$ ✗

$$N_c = \frac{5.484 \times 10^{-8} \times (1000)}{\left(\frac{1000}{18}\right)}$$

$= 1.80 \times 10^{-9}$ ✗

$= 9.8712 \times 10^{-7} \bar{\Omega}^{-1} cm^2 mol^{-1}$.

(ii)	$Kw = [H^+][\bar{O}H]$ or $Kw = C^2\alpha^2$ ✗		1½
	$= \left(\frac{1000}{18}\right)^2 \times (1.80 \times 10^{-9})^2$ ✗		
	$\approx 1.0 \times 10^{-14} \ mol^2 dm^{-6}$ ✗		
	✗	**09marks**	
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.	Acc. Strong intra-molecular forces of attraction 02 Acc. stronger intermolecular 02	
	2-nitrophenol has a fairly high relative formula mass.		
(b)	Vapour pressure of 2-nitrophenol = 1.0 – 0.825 = 0.175atm. ✗ Molar mass of 2-nitrophenol $= (6\times12)+(5\times1)+(14\times1)+(3\times16)=139g$. ✗	03	
	$$\frac{V.P \ of \ water}{V.P \ of \ 2 \ nitrophenol} = \frac{mass \ of \ water \times R.F.M \ of \ 2\text{-}nitrophenol}{mass \ of \ 2\text{-}nitrophenol \times R.F.M \ of \ water}$$ ✗		
	$$\frac{0.825}{0.175} = \frac{0.9 \times 139}{m \times 18}$$ ✗		
	$$M = \frac{0.9 \times 139 \times 0.175}{0.825 \times 18}$$		
	$M = \cancel{1.30455g.} \ 1.4714g$ ✗		
(c)	- compounds distil below their boiling points hence saves energy. ✓	02	
	- enables purification of compounds (organic) which decompose near their boiling points. ✓		
		9marks	
13.(a)(i)	Acc. $BaCl_{2(aq)}$/dilute HCl ✗✗ Barium nitrate followed by dilute nitric acid ✓✓ ✗	02	
	$K_2SO_{4 \ (aq)}$ – White precipitate insoluble in nitric acid. ✓		
	$K_3PO_{4 \ (aq)}$ - White precipitate soluble in nitric acid. ✗		
(ii)	Silver nitrate solution followed by dilute nitric acid Acc. lead(II) nitrate solution and	02 soluble ✓	
	K NaCl(aq) – White precipitate insoluble in nitric acid warm. →White ppt on warming ✓		
	$Na_2C_2O_4$(aq) – White precipitate soluble in nitric acid →White precipitate insoluble on warming. ✓		
(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.	2½	
	$Cr_2O_7^{2-}{}_{(aq)} + 2\bar{O}H_{(aq)} \longrightarrow 2CrO_4^{2-}{}_{(aq)} + H_2O_{(l)}$ ✓		
	$Pb^{2+}{}_{(aq)} + CrO_4^{2-}{}_{(aq)} \longrightarrow PbCrO_{4(s)}$ ✗		

✓ $Na_2C_2O_{4(aq)}$

$KMnO_{4(aq)} / H^+{}_{(aq)}$ ✓Purple solution turn colourless ✓

$NaCl_{(aq)} \rightarrow$ ✓Greenish yellow gas. ✗

(ii)	Maganese (II) ions are oxidized to Manganate (VII) ions which is purple and the bismuthate is reduced to bismuth (III) ions. $2Mn^{2+}_{(aq)} + 5BiO_3^- + 14H^+_{(aq)} \longrightarrow 2MnO_4^-(aq) + 5Bi^{3+}_{(aq)} + 7H_2O_{(l)}$		
14 (a)(i)		9marks	
	CH_3CHCH_2CHO with OH ✓	01	
(ii)	3-hydroxybutanal ✓	01	
(b)(i)	$CH_3CH(OH)CH_2CHO \xrightarrow{ZnCl_{2(s)}/Conc.HCl} CH_3CHCH_2CHO$ (Cl)	01	
(ii)	Acc. $CH_3CHCH_2CHO + 2Ag(NH_3)_2^+_{(aq)} + 2OH^-_{(aq)} \longrightarrow CH_3CHCH_2COONH_4^+ + 2Ag_{(s)} + H_2O + 3NH_{3(aq)}$ (OH) (OH)	01	
	$CH_3CHCH_2CHO + 2Ag^+_{(aq)} + 2NH_{3(aq)} + H_2O_{(l)} \longrightarrow CH_3CHCH_2COOH + 2Ag_{(s)} + NH_4^+_{(aq)}$ (OH) (OH)	01	
	or $CH_3CHCH_2CHO \xrightarrow{AgNO_3/NH_{3(aq)}} CH_3CHCH_2COOH + Ag$ (OH) (OH)		
(iii)	$CH_3CHCH_2CHO + NaHSO_{3(aq)} \longrightarrow CH_3CHCH_2CHSO_3^-Na^+$ (OH) (OH) (OH)	01	
(c)		04	
15.(a)(i)	Yield of ammonia increases ✓ The formation of ammonia (forward reaction) occurs with a decrease in volume (number of molecules) thus high pressure shifts the equilibrium position from left to the right. ✓	1½	
(ii)	Yield of ammonia decreases ✓ The forward reaction (formation of ammonia) is exothermic thus an increase in temperature favours the dissociation of ammonia reducing its concentration at equilibrium/shifts eq=m from right to left ✓ Acc. backward reaction.	1½	

(b)(i)	$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$			
Initial	3.0	1.0	—	
Moles	$3 - \alpha$	$1 - 3\alpha$	2α	
Reacted	$\frac{1}{2} \times 0.02$	$\frac{3}{2} \times 0.02$	$0.34 / 17 = 0.02$	
Moles	0.01	0.03	0.02	
Equilibrium Moles	2.99 ✓	0.97 ✓	0.02 ✓	03

$[N_2] = 2.99 / 0.5$ $[H_2] = 0.97 / 0.5$ $[NH_3] = 0.02 / 0.5$
$\quad = 5.98 \text{ moldm}^{-3}$ $= 1.94 \text{ moldm}^{-3}$ $= 0.04 \text{ moldm}^{-3}$

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

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

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

(c)	$4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(l)}$ ✓	
	$2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$ ✓	03
	$4NO_{2(g)} + O_{2(g)} + 2H_2O_{(l)} \longrightarrow 4HNO_{3(aq)}$ ✓	
		9marks
16.(a)(i)	Lithium has the smallest atomic radius ✓ Lithium ion has the highest charge density ✓ or highest polarising power. Lithium has the most negative electrode potential. ✗ Lithium is the least electropositive / most electronegative alkali metal. **Any 3 Corr.**	$1\frac{1}{2}$
(ii)	- 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 Corr.** - The nitrate of Lithium decomposes when heated to form an oxide, nitrogen dioxide gas and oxygen. - Lithium reacts with nitrogen to form Lithium nitride. (any 3)	03
(b)(i)	$Mg_3N_{2(s)} + 6H_2O_{(l)} \longrightarrow 3Mg(OH)_{2(aq)} + 2NH_{3(g)}$ ✓✓ or (s)	$1\frac{1}{2}$

(ii)	$BeCl_{2(S)} + 4NaOH_{(aq)} \longrightarrow Na_2Be(OH)_{4\,(aq)} + 2NaCl_{(aq)}$ ✓ ✗ or $BeCl_{2\,(S)} + 4\bar{O}H_{(aq)} \longrightarrow Be(OH)_4^{2-}{}_{(aq)} + 2Cl^-{}_{(aq)}$ or $BeCl_{2\,(S)} + 4\bar{O}H_{(aq)} \longrightarrow BeO_2^{2-}{}_{(aq)} + 2Cl^-{}_{(aq)} + 2H_2O_{(l)}$	$1\frac{1}{2}$
(iii)	$BaO_{2\,(s)} + 2HCl_{(aq)} \longrightarrow BaCl_{2\,(aq)} + H_2O_{2\,(aq)}$ ✓ ✗ Allow: $BaO_{2\,(S)} + 2H^+_{(aq)} \longrightarrow Ba^{2+}_{(aq)} + H_2O_{2\,(aq)}$	$1\frac{1}{2}$ **09marks**
17(a) (i)	Positive deviation ✓	01
(ii)	Addition of hexane weakens the intermolecular hydrogen bonds between ethanol molecules. This increases the escaping tendency of ethanol and hexane molecules from solution into vapor phase hence increasing the vapor pressure above solution which is greater than that expected for ideal solutions. ✓	02
(b)(i)		Acc. If a candidate labels the curves 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 $= \dfrac{38.42}{100} \times (50 \times 0.687) = 13.2g$ ✓ Let the mass extracted be xg. $K_D = \dfrac{[ethanol]\ in\ choline\ chloride}{[ethanol]\ in\ hexane}$ ✗ ✓ $15.8 = \dfrac{x/100}{(13.2-x)/50}$ ✓ $15.8 \times 2\,(13.2 - x) = x;\quad x = 417.12/32.6 \approx 12.8g$ ✓	Award if the candidate gets mass of azeotrope first in 50cm³. 11
		09marks

END