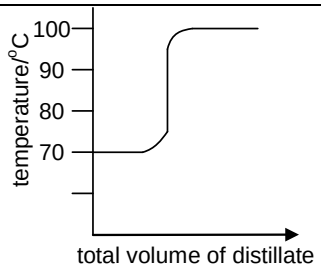
2014 Secondary Three
End-of-Year Examination (Chemistry)
Paper 1

1	D	6	B	11	C	16	A	21	A	26	D
2	B	7	A	12	A	17	A	22	B	27	B
3	B	8	C	13	C	18	C	23	A	28	B
4	C	9	B	14	C	19	C	24	B	29	D
5	B	10	D	15	B	20	D	25	A	30	C

Paper 2 Section A

No	Answers	Marks
A1(a)	Hexane and Heptane are **miscible** [1]. They have **different boiling points that are close to each other/ less than 25^{o}C** [1].	[2]
(b)	 axes – 1m graph – 1 m	[2]
A2 (a)	XO_2	[1]
(b)	Percentage composition of oxygen in $XO_2 = \frac{2\times16}{x+2\times16} = \frac{32}{x+32}$ $\frac{32}{x+32} = 0.533$ [1] $0.533(x+32) = 32$ $0.533x + 17.056 = 32$ $0.533x = 14.944$ $x = 28.0$ [1] Practise Error Carry Forward (E.C.F.) if the formula of the oxide from (a) is incorrect. Example: X_4O : 56.1, X_2O : 7.00, X_3O_2: 9.35, X_8O_9: 53.3, X_2O_4: 28.0, X_4O_2: 7.00, X_9O_8: 12.5, X_2O_3: 21	[1]
A3(a)(i)	Reaction 1: $CaCO_3 \rightarrow CaO + CO_2$ [1] Reaction 2: $CaO + H_2O \rightarrow Ca(OH)_2$ [1]	[2]
(a)(ii)	Lime is used in agriculture to **reduce the acidity** of the soil so as to obtain appropriate pH for growth of plants./neutralise/ increase the pH of the soil.	[1]
(a)(iii)	Sodium hydroxide is a stronger alkali which ionises completely to give a **higher concentration of OH^-**.	[1]

No	Answers	Marks
(b)(i)	$CaMg(CO_3)_2 + 4HCl \rightarrow CaMgCl_4 + 2CO_2 + 2H_2O$ Accept this answer : $CaMg(CO_3)_2 + 4HCl \rightarrow MgCl_2 + CaCl_2 + H_2O + 2CO_2$	[1]
(b)(ii)	$\text{No. of moles of } CO_2 = \frac{0.450}{12+16\times 2}$ $= 0.01023 \text{ mol}$ From the equation, 1 mole of $CaMg(CO_3)_2$ forms 2 mole of CO_2. $\text{No. of moles of } CaMg(CO_3)_2 = \frac{0.01023}{2}$ $= 0.005115 \text{ mol}$ [1] $\text{Mass of } CaMg(CO_3)_2 = 0.005115 \times [40 + 24 + 2\times(12 + 3\times 16)]$ $= 0.94116 \text{ g}$ $\text{Percentage Purity} = \frac{0.94116}{1.000}\times 100\%$ $= 94.1\%$ [1] Practise Error Carry Forward (E.C.F.) if the equation from (b)(i) is not balanced.	[2]
A4(a)	**J**: van der waals forces/ intermolecular forces of attraction. (intermolecular forces and hydrogen bond is not accepted.)	[1]
(b)	Greater energy is required to overcome the **strong ionic bonds/electrostatic forces of attraction between oppositely charged ions** [1] in **K** than the **weak van der waals forces between molecules** of **J** [1].	[2]
(c)	A large amount of energy [1] is required to overcome the **strong electrostatic forces of attraction** between the **positive ions and the delocalised electrons/** overcome the strong metallic bond. [1]	[2]
A5(a)(i)	sulfuric acid chemical formula is not accepted.	[1]
(a)(ii)	Reaction of aqueous sodium hydroxide and sulfuric acid will yield sodium sulfate and water according to the equation **$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$** [1] With the use of 0.100 mol/dm^3 of NaOH, half the volume **H_2SO_4** with the same concentration must be reacted with it to form Na_2SO_4. /Titrate fixed volume of NaOH with H_2SO_4. [1] The salt solution is then **heated until a saturated solution is formed** and crystallised [1]. The crystals are **dried by pressing between pieces of filter paper** [1].	[4]
(b)	White precipitates are formed.	[1]
A6(a)	Element X: nitrogen (or any Group V element) [1] Element Z: hydrogen/ any Group VII element [1]	[2]
(b)(i)	H_3AsO_3 / Na_2HAsO_3 / NaH_2AsO_3	[1]

No	Answers	Marks
	Chemical formula of Arsenic is As and NOT Ar or AS **No award of mark if Ar or AS was given as the answer.**	
(b)(ii)	Na_3AsO_3 / Na_2HAsO_3 / NaH_2AsO_3	[1]
A7(a)	Oxidising agent: Ag_2O or H_2O_2 [1] Reducing agent: H_2O_2 [1] **Need to have both answers correct to score 1 mark.**	[1]
(b)(i)	$\text{No. of moles of nitrogen oxide} = \frac{2400/1000}{24}$ $= 0.1\,\text{mol}$	[1]
(b)(ii)	$\text{No. of moles of } H_2O = \frac{7.2}{2\times1+16}$ $= 0.400\,\text{mol}\,[1]$ $\text{No. of moles of } NH_3 = 1\times\frac{200}{1000}$ $= 0.200\,\text{mol}\,[1]$	[2]
(b)(iii)	$x = \frac{0.2}{0.1} = 2$ $y = \frac{0.4}{0.1} = 4\,[1]$ OR No of mole of N_xO_y : No of mole of H_2O : No of mole of NH_3 0.1 : 0.4 : 0.2 1 : 4 : 2 [1] Formula of nitrogen oxide = N_2O_4 [1]	[2]
(b)(iv)	$\text{Oxidation number of N} = \frac{0-(-2\times4)}{2}$ [1] $= +4$ [1] Error Carry Forward (E.C.F.) if the formula of the oxide from (b)(iii) is incorrect.	[2]
(c)	N_2O_5 [1] When nitric acid reacts with a reducing agent (zinc), it is **reduced and the oxidation number** of nitrogen is decreased[1]. The oxidation number of nitrogen remains **unchanged at +5** [1] if N_2O_5 is produced and hence, N_2O_5 is least likely to be produced.	[3]

Paper 2 Section B

B8(a)	**D**: zinc hydroxide/ $Zn(OH)_2$ **E**: barium sulfate/ $BaSO_4$ **F**: carbon dioxide/ CO_2	[4]

	G: calcium chloride/ $CaCl_2$ **H**: calcium carbonate/ $CaCO_3$ **I**: calcium hydroxide/ $Ca(OH)_2$ **J**: silver chloride/ $AgCl$ 1M for each correct answer, maximum 4m	
(b)	Observation: T**he white precipitate dissolves to give a colourless solution/ solution turns clear** [1]. Not accepted: 1. Effervescence (this will occur during bubbling of **F**, cannot tell that it is due to reaction of **H** and **F**.) 2. Same products **F** and **G** will be formed. (Is this still called a reaction if nothing changed?) Explanation: Carbon dioxide is **acidic/ H_2CO_3, carbonic acid is** formed when **F** dissolves in water/ **H** is basic/ Reaction between **F** and **H forms a soluble salt**, **calcium hydrogen carbonate**. [1] Not accepted: **F** (CO_2) reacts with limewater (This is not **H.**). **F** and **H** will react. (Repeating the question) No e.c.f for this question.	[2]
(c)	$ZnSO_4(aq) + Ba(NO_3)_2(aq) \rightarrow BaSO_4(s) + Zn(NO_3)_2(aq)$ Only e.c.f. from identitiy of **D**. Equation must still be chemically correct and sound to obtain any e.c.f.	[1]
(d)	$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ $\text{No. of moles of } HCl = 0.100 \times \frac{25.0}{1000}$ $= 0.00250 \text{ mol}$ [1] $\text{No. of moles of } CaCO_3 = \frac{5.00}{40 + 12 + 3 \times 16}$ $= 0.0500 \text{ mol}$ [1] HCl is the limiting reactant. $\text{No. of moles of } CaCl_2 = \frac{0.00250}{2}$ $= 0.00125 \text{ mol}$ [1] Those who did not check for limiting reactant, maximum 2m. Error Carry Forward (E.C.F.) if the **G** is wrongly identified and only if the reaction given is a carbonate acid reaction. For e.c.f, will still deduct marks if working is wrong.	[3]

B9(a)(i)	Volume of unburnt octane $= \frac{0.05}{100} \times 1.0$ $= 0.000500\ dm^3$ [1]	[1]
(a)(ii)	No. of moles of unburnt octane $= \frac{0.000500}{24}$ $= 0.0000208$ mol/ 2.08×10^{-5} mol [1] E.c.f from (a)(i)	[1]
(a)(iii)	Volume of CO and $CO_2 = \frac{13.3}{100} \times 1.0$ $= 0.133\ dm^3$ [1]	[1]
(a)(iv)	No. of moles of CO and $CO_2 = \frac{0.133}{24}$ $= 0.00554$ mol [1] E.c.f from (a)(iii)	[1]
(a)(v)	No. of moles of octane $= \frac{1}{8} \times 0.00554$ $= 0.000693$ mol [1] E.c.f from (a)(iv)	[1]
(b)(i)	Observations: A **brown solution/ black solid** of iodine is formed./ Purple $KMnO_4$ decolourised. [1] Not accepted: 1. Brown solid. 2. Solution/ Mixture turned colourless.(Solution/ Mixture appears as brown at the end due to presence of iodine. 3. $KMnO_4$ turned colourless. (without mentioning that it was originally purple) Explanation: The oxidation state of manganese decreases from **+7 to +2** while the oxidation state of iodine increases from **-1 to 0** [1]. (If student wrote explanation for change in oxidation state of either iodine/ manganese only, explanation must match observation.) Not accepted: 1. Iodine increased/ oxidized from -1 to 0. 2. Manganese decreased/ reduced from +7 to +2. 3. Oxidation state of manganate (MnO_4^-) decreased from +7 to +2. 4. Oxidation state of iodide (I^-) increased from -1 to 0. 5. Writing oxidation states as 7+, 2+, 1- 6. Described changes in charge instead of oxidation states.	[2]

(b)(ii)	No. of moles of I_2 from reaction with $KMnO_4 = 0.0300 \times \frac{25}{1000} \times \frac{5}{2}$ $= 0.001875$ mol [1] No. of moles of $K_2Cr_2O_7 = 0.001875 / 3$ $= 0.000625$mol [1] Concentration of $K_2Cr_2O_7 = 0.000625 / 0.025 = 0.025$ mol/dm^3 [1] Alternatively, method No. of moles of $KMnO_4$: No. of moles of $K_2Cr_2O_7$ is 6:5 [1] No. of moles of $K_2Cr_2O_7$ = (0.0300 x 0.025) ÷ 6 x 5 = 0.000625 mol [1] [$K_2Cr_2O_7$] = 0.001875 ÷0.025 = 0.0250mol/dm^3 [1]	[3]

10	Either			
	(a)			
		i.	$Li_2CO_3 + 2HCl \rightarrow 2LiCl + H_2O + CO_2$	[1]
		ii	Moles of pure lithium carbonate = (0.635 x 5.00) ÷ Mr of Li_2CO_3 = 0.04290 mol Li_2CO_3 = 0.0429 mol No mark if student used 5.00g of impure lithium carbonate divided by Mr of Li_2CO_3	[1]
		iii	Mole ratio Li_2CO_3: CO_2 is 1:1. Volume of gas = 0.04290 x 24 = 1.029dm^3 = 1.03dm^3 E.C.F from (a)(i) and (a)(ii).	[1]
		iv	Moles of acid added =0.150x 1.20 = 0.180 mol HCl [1] Moles of acid reacted = 0.04290 x 2 = 0.08581 mol HCl Moles of acid left = 0.180-0.08581 = 0.09418 =0.0942 mol HCl left [1] E.C.F from (a)(i) and (a)(ii).	[2]
	(b)			
		i	New concentration of acid in FA1 = 0.09418 ÷ 2 = 0.0471 mol/dm^3 HCl E.C.F from (a)(iv).	[1]

		ii	Moles of acid in 25.0cm^3 FA1 = 0.0250 x 0.04709 = 0.001177 mol HC*l* = 0.00118 mol HC*l* E.C.F from (b)(i) .	[1]
		iii	Mole ratio HC*l*: $Ba(OH)_2$ is 2:1 Moles of $Ba(OH)_2$ reacted = 0.001177 ÷ 2 = 5.886 x 10^{-4} mol [1] $[Ba(OH)_2]$ = 5.886 x 10^{-4} ÷ 0.0290 = 0.02029 mol/dm^3 = 0.0203 mol/dm^3 [1] E.C.F from (b)(ii).	[2]
		iv	The salt will not be able to completely crystallize out (due to insufficient time or temperature during crystallization is not low enough), thus the percentage yield will be less than 100%[1] Not accepted: Impurities present. (This can cause yield to increase though percentage purity would decrease.)	[1]
10	OR			
	(a)			
		i	$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$ [1]	[1]
		ii	Moles of H_2SO_4 = 0.380 x 0.0170 = 0.00646 mol H_2SO_4 Moles of $Ba(OH)_2$ = 0.275 x 0.0240 = 0.00660 mol $Ba(OH)_2$ [1] 0.00646 mol H_2SO_4 require 0.00646 mol $Ba(OH)_2$ thus H_2SO_4 is limiting reagent. [1] E.C.F from (a)(i).	[2]
		iii	Theoretical yield of $BaSO_4$ = 0.00646mol $BaSO_4$ Actual yield = 0.989 x 0.00646 = 0.006388mol $BaSO_4$ [1] Mass of salt obtained = 0.006388 x Mr of $BaSO_4$ = 1.49g $BaSO_4$ [1] E.C.F from (a)(i) and (a)(ii).	[2]
	(b)	i	Moles of NaOH reacted = 0.160 x 0.008 = 0.00128 mol NaOH Mole ratio H_2SO_4:NaOH is 1:2 Moles of H_2SO_4 reacted with NaOH = 0.00128 ÷ 2 =0.000640 mol H_2SO_4 [1]	[1]

		ii	Moles of H_2SO_4 added at the start = 0.500 x 0.028 = 0.0140 mol H_2SO_4 [1] Moles of H_2SO_4 reacted with barium hydroxide = 0.0140 – 0.00064 = 0.01336 = 0.0134 mol H_2SO_4 [1] E.C.F from (b)(i).	[2]
		iii	Mole ratio H_2SO_4: $Ba(OH)_2$ is 1:1 Moles of $Ba(OH)_2$ reacted = 0.01336 mol $[Ba(OH)_2]$ = 0.01336 ÷ 0.0200 = 0.668 mol/dm^3 [1] E.C.F from (b)(ii).	[1]
		iv	Filter funnel left on top of burette during titration./ Meniscus of the acid in pipette was below the mark./ The acidic solution was accidently diluted with water before it was pipetted into conical flask./ Impurities present which reacted with the acid. [1] Not accepted: 1. Mentioned presence of impurities without specifying how the impurities affected the volume. (Must at least say the impurities reacted with acid.) 2. Due to impurities/ contamination from reaction between barium hydroxide and sulfuric acid. 3. Apparatus uncleaned or not rinsed properly. (Must be specific about which apparatus was contaminated and how it diluted the acid or increase concentration of alkaline) 4. Spillage. (Must specify what was spilled and when) 5. Parallax error.	[1]