CAMBRIDGE INTERNATIONAL AS & A LEVEL CHEMISTRY · 9701

CHEMISTRY



MARK SCHEME

10 GROUP 2

SCORE	PERCENTAGE
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Paper 1 Multiple Choice Answers: Group 2

Question	Paper	Q. No.	Answer
537	9701_m22_qp_12	21	D
538	9701_m21_qp_12	14	D
539	9701_m21_qp_12	15	B
540	9701_s21_qp_11	14	A
541	9701_s21_qp_11	15	A
542	9701_s21_qp_12	14	C
543	9701_s21_qp_12	15	D
544	9701_s21_qp_13	17	C
545	9701_s21_qp_13	18	B
546	9701_w21_qp_11	2	C
547	9701_w21_qp_11	14	C
548	9701_w21_qp_12	13	B
549	9701_w21_qp_13	14	C
550	9701_m20_qp_12	13	A
551	9701_m20_qp_12	17	C
552	9701_s20_qp_11	14	A
553	9701_s20_qp_12	17	C
554	9701_s20_qp_13	14	A
555	9701_s20_qp_13	18	B
556	9701_w20_qp_11	13	B
557	9701_w20_qp_11	15	C
558	9701_w20_qp_11	18	D
559	9701_w20_qp_12	13	B
560	9701_w20_qp_12	16	B
561	9701_m19_qp_12	14	A
562	9701_m19_qp_12	15	A
563	9701_m19_qp_12	16	B
564	9701_s19_qp_11	14	A
565	9701_s19_qp_11	15	B
566	9701_s19_qp_12	15	D
567	9701_s19_qp_12	16	D
568	9701_s19_qp_13	11	D
569	9701_s19_qp_13	14	C
570	9701_w19_qp_11	14	B
571	9701_w19_qp_11	15	B
572	9701_w19_qp_12	13	A
573	9701_w19_qp_12	14	C
574	9701_m18_qp_12	20	D
575	9701_m18_qp_12	21	A
576	9701_s18_qp_11	18	D
577	9701_s18_qp_11	19	D
578	9701_s18_qp_12	16	D
579	9701_s18_qp_13	14	C
580	9701_s18_qp_13	15	A
581	9701_w18_qp_11	15	B
582	9701_w18_qp_11	18	D

Paper 1 Multiple Choice Answers: Group 2 (continued)

Question	Paper	Q. No.	Answer
583	9701_w18_qp_12	14	B
584	9701_w18_qp_12	15	B
585	9701_m17_qp_12	14	A
586	9701_s17_qp_11	14	A
587	9701_s17_qp_11	15	C
588	9701_s17_qp_12	3	C
589	9701_s17_qp_12	14	C
590	9701_s17_qp_12	15	D
591	9701_s17_qp_13	15	D
592	9701_w17_qp_11	15	C
593	9701_w17_qp_12	14	C
594	9701_w17_qp_12	19	C
595	9701_s16_qp_11	14	A
596	9701_s16_qp_12	16	B
597	9701_s16_qp_13	14	B
598	9701_s16_qp_13	16	D
599	9701_w16_qp_11	18	D
600	9701_w16_qp_12	17	C
601	9701_s15_qp_11	13	D
602	9701_s15_qp_11	19	C
603	9701_s15_qp_12	12	D
604	9701_s15_qp_12	13	B
605	9701_s15_qp_12	14	C
606	9701_s15_qp_13	18	B
607	9701_w15_qp_11	12	A
608	9701_w15_qp_11	13	A
609	9701_w15_qp_12	12	D

50. 9701_s16_ms_21 Q: 2

(a)	**D** = Ga **G** = Se	[1]
(b) (i)	$D_2O_3 + 6HCl \rightarrow 2DCl_3 + 3H_2O$ M1 = species; M2 = balancing	 [1] [1]
(ii)	$D_2O_3 + 2NaOH + 7H_2O \rightarrow 2NaD(OH)_4(H_2O)_2$ OR $D_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaD(OH)_4$ OR $D_2O_3 + 2NaOH \rightarrow 2NaDO_2 + H_2O$ OR $D_2O_3 + 2OH^- + 7H_2O \rightarrow 2[D(OH)_4(H_2O)_2]^-$ OR $D_2O_3 + 2OH^- + 3H_2O \rightarrow 2[D(OH)_4]^-$ OR $D_2O_3 + 2OH^- \rightarrow 2DO_2^- + H2O$ M1 = species; M2 = balancing	 [1] [1]
(c)	giant ionic / ionic lattice	[1]
(d)	$GO_2 + H_2O \rightarrow H_2GO_3$	[1]

51. 9701_w20_ms_21 Q: 1

(a)	$Mg(g) \rightarrow Mg^+(g) + e^{(-)}$	**1**
(b)	**M1:** distance between nucleus and **outer e⁻** increases **OR outer electron** removed from higher energy shell	**3**
	M2: increased **shielding**	
	M3: decreased **nuclear** attraction	
(c)	**M1**: **greater nuclear attraction**	**2**
	M2: (2nd / 2s) electron being removed from **smaller** (ion)	

52. 9701_w20_ms_22 Q: 2

(a)	more acidic / less basic (from Na to S across period)	**1**
(b)	**M1:** increases (from Na to S / across period)	**2**
	M2: increasing (number of) **valence** electrons **OR** (number of) electrons in **outer** (electron) shell increases	
(c)	reaction: sodium oxide with water — **name** of product: sodium hydroxide reaction: phosphorus(V) oxide with water — **name** of product: phosphoric(V) acid	**2**
(d)	**M1:** *identification of forces broken during melting of phosphorus(V) oxide* intermolecular forces in phosphorus(V) oxide (are broken)	**3**
	M2: *identification of force broken during melting of magnesium oxide* electrostatic forces of attraction between (many oppositely charged) **ions** in magnesium oxide	
	M3: *statement linking difference in strength of appropriate forces described in M1& M2 to explain difference in melting point* (only) **intermolecular forces** weaker than forces (of attraction) between ions / ionic bonds	
(e)(i)	$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$	**1**
(e)(ii)	$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$	**1**
(f)	**M1:** giant	**2**
	M2: covalent **AND** tetrahedral / four Si—O bonds	
(g)(i)	$Na_2O + SiO_2 \rightarrow Na_2SiO_3$	**1**
(g)(ii)	$Na_2CO_3 \rightarrow Na_2O + CO_2$	**1**

53. 9701_s19_ms_21 Q: 1

(a)(i)	**M1** (one) fewer (inner) shell of electrons / less shielding (effect) *ORA*	**1**
	M2 smaller distance of the **outer** electrons (from the nucleus) / stronger nuclear attraction to the (outer) electrons *ORA*	**1**
(a)(ii)	$Sr(s) + 2H_2O(l) \rightarrow Sr(OH)_2(aq) + H_2(g)$ **M1** species AND balancing	**1**
	M2 state symbols	**1**
(a)(iii)	**M1** strontium AND forms a more soluble hydroxide	**1**
	M2 strontium hydroxide is a stronger base / produces more OH^- / it dissociates more	**1**
(a)(iv)	(white) **solid** dissolves / effervescence	**1**
(b)(i)	Similarities (any two from the following list) (both have) +2 ion / (+2) same oxidation state / same stoichiometry of oxide / carbonates decompose (on heating)	**2**
	Difference (X) forms coloured compounds/oxides/ carbonates **OR** Group 2 elements form white compounds/oxides/carbonates	**1**
(b)(ii)	XO	**1**
(b)(iii)	$XCO_3 \rightarrow XO + CO_2$	**1**

54. 9701_s19_ms_23 Q: 3

(a)	white light / flame **AND** (produces a) white / grey solid / ash / powder / smoke	**1**
(b)(i)	$MgO + 2HCl \rightarrow MgCl_2 + H_2O$	**1**
(b)(ii)	neutralisation	**1**
(c)	**M1** giant (structure / lattice) **M2** (so) lots of energy needed to break the bonds OR strong bonds	**2**
(d)(i)	$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$	**1**
(d)(ii)	(thermal) decomposition	**1**

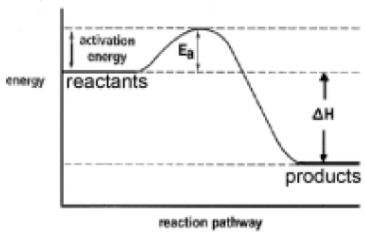
55. 9701_s18_ms_22 Q: 1

(a)(i)	$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$	**1**
(a)(ii)	the product / $Mg(OH)_2$ sparingly soluble / slightly soluble / less soluble (than NaOH)	**1**
(b)(i)	*any two from:* • (from Mg to Ba) larger (atomic) radius / more shells / more shielding • electron(s) are less tightly held (by nucleus) / less attracted (to nucleus) • ionisation energy / ies decrease(s) / electron(s) lost (more) easily (down the group) • lower activation energy (for the reactions down the group)	**2**
(b)(ii)	white light / white flame	**1**
	white smoke / white solid	**1**
	$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$	**1**
(b)(iii)	$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$	**1**
(b)(iv)	*any two from:* • increasing (cation) size / (cat)ionic radius increases / increasing size of atoms • overall charge on (cation) is constant / (+)2 / decreasing charge density of (+2 charged cation) • number of delocalised / outer / valence electrons (per atom) remains the same / 2 • increased shielding	**2**
	decreasing (strength of) attraction between (cat)ion / nucleus / nuclear charge **AND** delocalised electron(s)	**1**

56. 9701_m16_ms_22 Q: 1

(a) (i)	greater attractive force OR greater force between nucleus and (outer) electrons proton number / atomic number / nuclear charge increases across period AND electrons occupy same shell / shielding roughly constant	[1] [1]
(ii)	sulfur's electron removed from full (3p) orbital OR sulfur has two electrons in the same orbital electron–electron repulsion (reduces energy required)	[1] [1]
(iii)	sodium has mobile / free electrons / electrons free (to move throughout the structure) phosphorus is simple / covalent / molecular	[1] [1]
(iv)	magnesium has two free / delocalised / outer / valence electrons per atom OR more free / delocalised / outer electrons than sodium	[1]
(b) (i)	**A** = $Mg(NO_3)_2$ **B** = H_2 **C** = NO_2 OR O_2 **D** = O_2 OR NO_2	[1] [1] [1] [1]
(ii)	any Group I carbonate OR ammonium carbonate	[1]

57. 9701_s16_ms_21 Q: 3

(a) (i)	bubbles / effervescence / fizzing	[1]
	calcium gets smaller / disappears	[1]
	water turns cloudy / milky	[1]
	calcium sinks	[1]
(ii)	$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$	[1]
(iii)	faster bubbling / disappearance of Ba OR no / less precipitate forms (owtte)	[1]
(b) (i)		
	M1 – general layout with products below reactants AND both labelled	[1]
	M2 – E_a and ΔH / energy change / released labelled with vertical lines	[1]
(ii)	activation energy is high	[1]
	so few/no particles with $E \geqslant E_a$	[1]
(iii)	high melting / boiling point	[1]
	strong forces (of attraction / between oppositely charged ions) / strong (ionic) bonding	[1]
(iv)	MgO is basic / reacts with acid	[1]
(c) (i)	increases (down the group)	[1]
(ii)	$MgCO_3 \rightarrow MgO + CO_2$	[1]
(iii)	$2Ca(NO_3)_2 \rightarrow 2CaO + 4NO_2 + O_2$	[1]

58. 9701_s20_ms_23 Q: 1

(a)(i)	**M1** green flame / white flame (with green tinge) **M2** white solid formed	**2**
(a)(ii)	$2Ba(s) + O_2(g) \rightarrow 2BaO(s)$	**1**
(b)(i)	**M1** heat (followed by) add water **M2** $CaCO_3 \rightarrow CaO + CO_2$ **M3** $CaO + H_2O \rightarrow Ca(OH)_2$	**3**
(b)(ii)	thermal decomposition.	**1**
(b)(iii)	neutralise acid soil / reduce the acidity in soil / increase the pH in soil	**1**
(c)(i)	$4Ga + 3O_2 \rightarrow 2Ga_2O_3$	**1**
(c)(ii)	(+)3	**1**
(c)(ii)	reagent and conditions: **M1** gallium oxide+ hot HCl(aq) → Formula of gallium containing product: **M1** $GaCl_3$ reagent and conditions: **M2** gallium oxide+hot concentrated NaOH(aq) → Formula of gallium containing product: **M2** $NaGa(OH)_4$ OR $NaGaO_2$	**2**

59. 9701_s17_ms_21 Q: 3

(a)(i)	**A**	**1**
(a)(ii)	**H**	**1**
(a)(iii)	**G**	**1**
(a)(iv)	**B**	**1**
(a)(v)	**F**	**1**
(b)(i)	(strong) heating	**1**
	(to provide / overcome) high activation energy	**1**
(b)(ii)	white flame / white light / white smoke / white solid	**1**
(b)(iii)	$Mg(s) + 2H_2O(l) \rightarrow Mg(OH)_2(s) + H_2(g)$	**2**
(c)(i)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$	**1**
(c)(ii)	$CaCO_3 \rightarrow CaO + CO_2$	**1**
	$CaO + H_2O \rightarrow Ca(OH)_2$	**1**
(d)(i)	reduce acidity in soil / increase pH of soil	**1**
	(both) basic / base(s)	**1**
(d)(ii)	$CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$ OR $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + H_2CO_3$	**1**
	Total:	**16**

60. 9701_w16_ms_21 Q: 3

(a)(i)	(Atoms/ ions become larger as) the number of (electron) shells increases (down the group) Increased distance of (outer) electrons (from the nucleus) OR Increased shielding results in weaker (nuclear) attraction / pull	1 1	**2**
(a)(ii)	top line / dotted line is atomic radii / bottom line / line with crosses is ionic radii (as atoms bigger than ions) Atom has one more shell (than corresponding ion) (ora) OR Atom loses two electrons / outer (shell) electrons / valency electrons (ora) OR Atom loses electrons and so (nuclear) attraction is stronger OR Nuclear charge in ion is greater than the electron(ic) charge (ora) OR Effective nuclear charge in ion is greater (ora)	1 1	**2**
(b)(i)	Nitrate / Nitrate(V) / NO_3^-	1	**1**
(b)(ii)	Ba / barium OR Sr / Strontium $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4$ OR $Sr^{2+} + SO_4^{2-} \rightarrow SrSO_4$	 1	**1**
(b)(iii)	$Ba(NO_3)_2$ OR $Sr(NO_3)_2$ $2Ba(NO_3)_2 \rightarrow 2BaO + 4NO_2 + O_2$ OR $2Sr(NO_3)_2 \rightarrow 2SrO + 4NO_2 + O_2$	1 1	**2**
(c)(i)	$H^+ + OH^- \rightarrow H_2O$ OR $Ca(OH)_2 + 2H^+ \rightarrow Ca^{2+} + 2H_2O$ $2H^+ + CO_3^{2-} \rightarrow CO_2 + H_2O$ OR $CaCO_3 + 2H^+ \rightarrow Ca^{2+} + CO_2 + H_2O$ OR $H^+ + CO_3^{2-} \rightarrow HCO_3^-$ OR $CaCO_3 + H^+ \rightarrow Ca^{2+} + HCO_3^-$	1 1	**2**
(c)(ii)	Calcium carbonate is insoluble / less soluble (ora) Calcium carbonate is less likely to be / won't get washed away (ora) OR Calcium carbonate lasts longer (ora) OR Calcium carbonate is less reactive / reacts more slowly (ora)	1 1	**2**
(d)	$Mg(OH)_2$ MgO	1 1	**2**
	Total:		**14**

61. 9701_S15_ms_23 Q: 2

(a) (i)	Reactivity increases down the group **OR** reference to observations that indicate trend Outer electrons lost more easily down group Due to increased distance/shielding of outer electrons from nucleus	[1] [1] [1]
(ii)	$Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2$	[1]
(iii)	Magnesium hydroxide sparingly soluble/insoluble	[1]
(iv)	$Mg + H_2O \rightarrow MgO + H_2$	[1]
(b) (i)	$MgO + 2HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$	[1]
(ii)	(thermal stability) increases down the group	[1]
(iii)	$2Mg(NO_3)_2 \rightarrow 2MgO + 4NO_2 + O_2$	[1]
(iv)	N from (+)5 to (+)3 O from –2 to 0 N is reduced **and** O is oxidised	[1] [1] [1]
(c)	(Very) strong electrostatic attraction/ionic bond High charge (density) of cation and anion/Mg^{2+} and O^{2-}	[1] [1]
(d) (i)	$CaCO_3 \rightarrow CaO + CO_2$ $CaO + H_2O \rightarrow Ca(OH)_2$	[1] [1]
(ii)	$2H^+ + CO_3^{2-} \rightarrow CO_2 + H_2O$	[1]
(iii)	$1 \times 10^{-4} \times 8000 = 0.8\,\text{mol}\ H^+$ $\frac{0.8}{2} \times 100.1 = \text{mass}\ CaCO_3 = 40\,\text{g}$	[1] [1]