CAMBRIDGE INTERNATIONAL AS & A LEVEL CHEMISTRY · 9701

CHEMISTRY



MARK SCHEME

9 THE PERIODIC TABLE, CHEMICAL PERIODICITY

SCORE	PERCENTAGE
/	%

STEMUP

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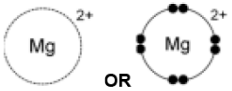
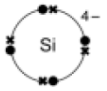
Paper 1 Multiple Choice Answers: The Periodic Table, Chemical Periodi

Question	Paper	Q. No.	Answer
452	9701_m21_qp_12	13	C
453	9701_s19_qp_12	14	D
454	9701_s19_qp_13	12	D
455	9701_w19_qp_11	13	D
456	9701_w19_qp_12	3	A
457	9701_w19_qp_12	12	B
458	9701_w18_qp_12	3	C
459	9701_m17_qp_12	12	C
460	9701_s17_qp_12	12	B
461	9701_s17_qp_13	13	C
462	9701_w17_qp_11	12	A
463	9701_m16_qp_12	12	D
464	9701_s16_qp_11	12	A
465	9701_s16_qp_11	13	D
466	9701_s16_qp_12	12	D
467	9701_w16_qp_11	13	C
468	9701_w16_qp_12	12	D
469	9701_s15_qp_11	15	C
470	9701_s15_qp_13	17	C
471	9701_w15_qp_11	14	A
472	9701_w15_qp_11	15	D
473	9701_w15_qp_12	15	B
474	9701_m22_qp_12	17	A
475	9701_m22_qp_12	18	C
476	9701_m22_qp_12	19	D
477	9701_m21_qp_12	12	B
478	9701_s21_qp_11	12	B
479	9701_s21_qp_11	19	D
480	9701_s21_qp_12	12	B
481	9701_s21_qp_12	13	C
482	9701_s21_qp_13	19	C
483	9701_w21_qp_11	12	D
484	9701_w21_qp_11	13	C
485	9701_w21_qp_12	12	C
486	9701_w21_qp_13	12	D
487	9701_w21_qp_13	13	C
488	9701_m20_qp_12	12	D
489	9701_m20_qp_12	16	D
490	9701_s20_qp_11	15	B
491	9701_s20_qp_11	16	D
492	9701_s20_qp_12	16	B
493	9701_s20_qp_13	15	D
494	9701_s20_qp_13	19	A
495	9701_w20_qp_11	12	B
496	9701_w20_qp_11	19	C
497	9701_w20_qp_12	12	B

Paper 1 Multiple Choice Answers: The Periodic Table, Chemical Periodi

Question	Paper	Q. No.	Answer
498	9701_w20_qp_12	19	D
499	9701_m19_qp_12	12	A
500	9701_m19_qp_12	13	B
501	9701_s19_qp_12	12	D
502	9701_s19_qp_13	13	B
503	9701_w19_qp_11	12	A
504	9701_m18_qp_12	16	D
505	9701_m18_qp_12	17	B
506	9701_m18_qp_12	18	D
507	9701_s18_qp_11	12	D
508	9701_s18_qp_12	12	D
509	9701_s18_qp_12	13	D
510	9701_s18_qp_13	12	C
511	9701_s18_qp_13	13	D
512	9701_w18_qp_11	12	C
513	9701_w18_qp_11	13	C
514	9701_w18_qp_12	12	D
515	9701_w18_qp_12	13	B
516	9701_m17_qp_12	15	C
517	9701_s17_qp_11	13	B
518	9701_s17_qp_12	13	B
519	9701_s17_qp_13	12	C
520	9701_w17_qp_11	13	A
521	9701_w17_qp_12	12	A
522	9701_w17_qp_12	13	B
523	9701_m16_qp_12	13	C
524	9701_s16_qp_12	13	A
525	9701_s16_qp_13	12	D
526	9701_s16_qp_13	13	D
527	9701_w16_qp_12	14	D
528	9701_s15_qp_11	14	B
529	9701_s15_qp_12	15	B
530	9701_s15_qp_13	12	C
531	9701_s15_qp_13	15	B
532	9701_w15_qp_11	16	D
533	9701_w15_qp_12	14	D
534	9701_s19_qp_11	13	C
535	9701_s18_qp_11	10	D
536	9701_s18_qp_11	13	C

36. 9701_s19_ms_21 Q: 2

(a)	**M1** *magnesium* +2 charge on **two** Mg AND both with 0 or 8 electrons  **OR**	**1**
	M2 *silicide* -4 charge on one Si and 8 electrons 	**1**
(b)	$Mg_2Si(s) + 4H_2O(l) \rightarrow 2Mg(OH)_2(aq) + SiH_4(g)$ **M1** correct balancing and formulae	**1**
	M2 state symbols	**1**
(c)	**M1** simple (covalent) / molecular / molecules	**1**
	M2 weak IMF / (temporary) induced dipole (forces)	**1**
(d)(i)	$C^{\delta-}–H^{\delta+}$	**1**
	$Si^{\delta+}–H^{\delta-}$	**1**
(d)(ii)	**M1** tetrahedral (molecule)	**1**
	M2 (so individual bond) dipoles / partial charges cancel	**1**
(e)	**M1** Si—H bond is (much) weaker than C—H bond	**1**
	M2 low activation energy *ORA*	**1**
(f)(i)	**M1** sodium silicate / Na_2SiO_3	**1**
	M2 water / H_2O	**1**
(f)(ii)	acid(ic)	**1**

37. 9701_m18_ms_22 Q: 1

(a)(i)	□ energy required / energy change □ when one electron is removed □ from each atom in one mole of □ gaseous atoms	**max 3**
(a)(ii)	*for element **B*** (outer electron is removed) from a higher energy level more shielding less attraction to nucleus	**3**
(b)	line on graph decreases **P—T** increasing nuclear charge **AND** electrons in same shell greater attraction between nucleus (and electrons)	**3**

38. 9701_w16_ms_22 Q: 3

(a)(i)	Increasing nuclear attraction Increasing nuclear charge / number of protons **AND** constant / similar shielding / same shell	**1** **1**
(a)(ii)	From 12 / Mg to 13 / Al: (Outer) electron in '13' / Al in (3)p (whereas outer electron in '12' / Mg in (3)s) (3p =) higher energy level / more shielded From 15 / P to 16 / S electron repulsion ('16' / S has a) pair of electrons in a (3)p orbital / a (3)p orbital is full ORA	 **1** **1** **1** **1**
(a)(iii)	(decreasing IE down Group 0) due to decreasing nuclear attraction increasing shielding / increasing number of shells / energy levels / increasing distance of (outer) electrons (from nucleus)	**1** **1**
(b)(i)	Increasing strength of / more energy needed to break (metallic) bonding / increasing strength of attraction between (cat)ion / nucleus and delocalised / free / sea of / cloud of electrons Increasing number of delocalised electrons / decreasing (cat)ion size / increasing charge / charge density of (cat)ion	 **1** **1**
(b)(ii)	Attraction for electrons too strong to fully delocalise all 3 in Al **OR** difference in size between 12/Mg^{2+} and 13/Al^{3+} is less than difference in size between 11/Na^{+} and 12/Mg^{2+} **OR** magnitude of increase in charge is less from 2+ to 3+ than from 1+ to 2+	**1**
(b)(iii)	Increase (15 / P to 16 / S) then decrease (to 17 / Cl and 18 / Ar) **OR** general decrease (from 15 / P to 18 / Ar) with an increase from 15 / P to 16 / S **OR** $S_{(8)}>P_{(4)}>Cl_{(2)}>Ar$ (melting point depends on strength of) VdW / IMFs The greater the number of electrons in the molecule (atom for Ar) the greater the strength of VdW / IMFs **OR** the greater the melting point ora	**1** **1** **1**
(b)(iv)	Giant covalent (structure) / many (strong) covalent bonds (need breaking)	**1**
	Total:	**15**

39. 9701_S15_ms_22 Q: 1

(a)

name of particle	relative mass	relative charge	
proton	**1**	+1	[1]
electron	1/1836	**–1**	[1]
neutron	**1**	**0**	[1]

(b) (i)

Mass of an atom(s) [1]

relative to $1/12^{th}$ (the mass) of (an atom of) carbon-12
OR
relative to carbon-12 which is (exactly) 12 [1]

(ii)

% of third isotope = 10 [1]

$$\frac{(24\times 79)+(26\times 11.0)+10x}{100}=24.3$$ [1]

$10x = 248$

$x = 24.8$ (3s.f.) [1]

(c) (i)

anode $2Cl^- \rightarrow Cl_2 + 2e^-$ [1]
cathode $Mg^{2+} + 2e^- \rightarrow Mg$ [1]

(ii)

Mg	O	H	Cl
31.65	20.84	1.31	46.2
24.3	16	1	35.5
1.30	1.30	1.31	1.30 = 1:1:1:1

[1]

$MgOHCl$ [1]

(d) (i)

Na_2O basic / alkaline; Al_2O_3 amphoteric / acidic and basic; SO_3 acidic [1]
Na_2O (giant) ionic **AND** SO_3 (simple / molecular) covalent [1]

(ii)

$Na_2O + 2HCl \rightarrow 2NaCl + H_2O$ [1]

$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ [1]

$Al_2O_3 + 2NaOH + 7H_2O \rightarrow 2NaAl(OH)_4(H_2O)_2$ **OR**
$Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$ **OR**
$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ **OR**
$Al_2O_3 + 2OH^- + 7H_2O \rightarrow 2[Al(OH)_4(H_2O)_2]^-$ **OR**
$Al_2O_3 + 2OH^- + 3H_2O \rightarrow 2[Al(OH)_4]^-$ **OR**
$Al_2O_3 + 2OH^- \rightarrow 2AlO_2^- + H_2O$ [1]

$SO_3 + NaOH \rightarrow NaHSO_4$ **OR**
$SO_3 + 2NaOH \rightarrow Na_2SO_4 + H_2O$ [1]

40. 9701_s20_ms_21 Q: 1

(a)(i)	(different) number of neutrons.	**1**
(a)(ii)	the relative abundance / % abundance of (each) the isotopes.	**1**
(b)(i)	**M1** *attractions between atoms within a gallium trichloride molecule* covalent (bonds) **M2** *attractions between gallium trichloride molecules* temporary induced dipoles	**2**
(b)(ii)	coordinate / dative (covalent)	**1**
(c)(i)	$4Ga + 3O_2 \rightarrow 2Ga_2O_3$ **M1** correct formula of Ga_2O_3 **M2** correctly balanced equation based on Ga + O_2 and formula of gallium oxide in M1	**2**
(c)(ii)	amphoteric	**1**

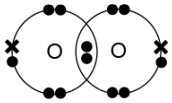
41. 9701_s20_ms_22 Q: 1

(a)	**EITHER** **M1** (weighted) average/mean mass of the isotope(s)/an atom(s) **M2** relative to 1/12 of the mass (of an atom) of ^{12}C (where an atom of ^{12}C is exactly12). **OR** **M1** mass of one mol of atoms **M2** relative / compared to 1/12 (the mass) of 1 mol of C-12 OR in which one mol C-12 (atom) has a mass of (exactly) 12 g	**2**
(b)	**M1** 60.11/100 x 69 + 39.89/100x71 **M2** 69.80	**2**
(c)	isotope: ^{71}Ga | nucleon number: **M1** 71 | total number of electrons in **lowest** energy level: **M2** 2 | type of orbital contains the electron in the **highest** energy level: **M3** p (-orbital)	**3**
(d)	**M1** shape  **M2** bond angle 120(°)	**2**
(e)(i)	$Ga_2O_3 + 6HCl \rightarrow 2GaCl_3 + 3H_2O$	**1**
(e)(ii)	**M1** *Identity of correct gallium containing product* $NaGa(OH)_4$ OR $NaGaO_2$ **M2** *correctly balanced equation for reaction of Ga_2O_3 with NaOH(aq)* **EITHER** $Ga_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaGa(OH)_4$ **OR** $Ga_2O_3 + 2NaOH \rightarrow 2NaGaO_2 + H_2O$	**2**

42. 9701_w19_ms_21 Q: 2

(a)	**Na_2O MgO Al_2O_3 SiO_2 SO_3** ionic / ionic / ionic / covalent / covalent giant / giant / giant / giant / macro-molecular / simple / molecular Award one mark for each correct row.	**2**
(b)(i)	**M1** SiO_2 has a **network** of strong bonds / SiO_2 has **many** strong bonds **M2** SO_3 has weak intermolecular forces **OR** weak VdW forces (between molecules) **M3** high(er) / more energy required to break **bonds** than overcome **forces** (between molecules)	**3**
(b)(ii)	**M1:** reacts with both acid and base / alkali **M2**: use any equation with Al_2O_3 and an acid, e.g. $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$ **M3:** use any equation with Al_2O_3 and a base / alkali, e.g. $Al_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaAl(OH)_4$	**3**
(b)(iii)	solid dissolves / disappears **OR** gets warm / hot	**1**
(c)(i)	octahedral	**1**
(c)(ii)	**M1:** use of the correct expression in terms of specific bond energies. $(514 - xE_{Se—O} = -346)$ **M2:** use of correct stoichiometry AND correct processing of expression given in M1. Provided the values 514 and 346 are used. $(514 - 2E_{Se—O} = -346)$ = (+)430 ($kJ\ mol^{-1}$)	**2**
(c)(iii)	$SeO_2 + 2NaOH \rightarrow Na_2SeO_3 + H_2O$	**1**

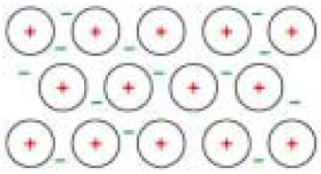
43. 9701_w19_ms_22 Q: 2

(a)	Na_2O / Al_2O_3 / SiO_2 / P_4O_{10} / P_4O_6 / P_2O_3 / P_2O_5 / SO_3 basic / amphoteric / acidic / acidic / acidic **M1:** all formulae correct **M2:** all acid / base behaviour correctly stated	**2**
(b)(i)	reacts with both acid and base	**1**
(b)(ii)	$OH^- + H^+ \rightarrow H_2O$	**1**
(b)(iii)	reaction with strontium / reaction 1 will effervesce / fizz / bubble **OR** no fizzes / bubbles / effervescence with SrO	**1**
(b)(iv)	increases	**1**
(c)(i)	**M1:** correct conversion of quantities $V = 5(.00) \times 10^{-4}$ (m^3) $T = 293$ (K) $p = 5.37(0) \times 10^3$ (Pa) **M2:** calculation to find n using n = PV / RT (n) = 1.1×10^{-3} (mol)	**2**
(c)(ii)	**(i)** $\times 78 = 0.0860$ g	**1**
(c)(iii)	 **M1:** bonding pair between the two O **M2:** total of 14 electrons distributed equally between the two O	**2**

44. 9701_s18_ms_21 Q: 3

(a)(i)	increasing attraction between nucleus and (outer) electrons	1
	increasing nuclear charge with similar shielding / (electrons in) same (outer) shell	1
(a)(ii)	(ions of Na to Si have) lost outer shell / outer electrons OR atoms have one more shell than (corresponding) ions OR effective nuclear charge is greater for the ion	1
(a)(iii)	(P to Cl form ions by) gaining electrons (to the same outer shell / p sub-shell)	1
	Increased repulsion between electrons in same / outer shell / p sub-shell	1
(b)(i)	(outer) electron removed from 3p subshell / orbital	1
	(3p) higher in energy / more shielded / further from the nucleus	1
(b)(ii)	(outer) electron for S is paired in a p orbital / S has a full p orbital	1
	causing (spin / electron) pair repulsion (which reduces attraction)	1
(c)(i)	oxidation numbers / states of elements (Na-Si) increase from +1 to +4 / by 1 every time	1
	increasing number of valence electrons / $NaCl$, $MgCl_2$, $AlCl_3$, $SiCl_4$ / number of chlorines matches group number	1
	chlorine oxidation number / state –1 in all / stays the same	1
(c)(ii)	$NaCl \rightarrow Na^+ + Cl^-$	1
	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$	1
(c)(iii)	<table><tr><td></td><td>structure</td><td>bonding</td></tr><tr><td>sodium chloride</td><td>giant / ionic</td><td>ionic</td></tr><tr><td>silicon(IV) chloride</td><td>simple / molecular</td><td>covalent</td></tr></table>	2

45. 9701_m17_ms_22 Q: 1

(a)(i)	<table><tr><td>max O.N.</td><td>+1</td><td>(+)2</td><td>(+)3</td><td>(+)5</td><td>(+)6</td><td>+7</td></tr></table>	**1**
(a)(ii)	(from Na to C*l*) nuclear charge increases	**1**
	electrons are in the same shell / have same shielding	**1**
	greater / stronger attraction (of electrons to nucleus)	**1**
(a)(iii)	Mg^{2+} **AND** S^{2-}	**1**
	ion of Mg / Mg^{2+} has one fewer shell (than ion of S / S^{2-})	**1**
(b)(i)	$P_4 + 5O_2 \rightarrow P_4O_{10}$ / $2P_2O_5$	**1**
(b)(ii)	any 2 from: • yellow / green colour (of chlorine gas) disappears • white flame • white solid • solid melts	**2**
(b)(iii)	phosphoric(V) acid	**1**
(c)(i)	 diagram showing regular arrangement of (positive) ions surrounded by / sea of (delocalised) electrons	**2** 1 1
(c)(ii)	any 2 from: • high melting / boiling / sublimation point • electrical / thermal insulator • hard / rigid • retains strength at high temperature / pressure	**2**
(c)(iii)	**M1** % abundance of fourth isotope = 100 – (0.185 + 0.251 + 88.450) = 11.114	**1**
	M2 $\frac{(0.185\times135.907)+(0.251\times137.906)+(88.450\times139.905)+(11.114\times RIM)}{100}$ = 140.116 ∴ (140.116 × 100) – 12434.35 = 1577.246 = 11.114 × RIM	**1**
	M3 RIM = $\frac{1577.246}{11.114}$ = 141.915	**1**

46. 9701_w17_ms_21 Q: 2

(a)(i)	due to increasing nuclear attraction (for electrons)	**1**
	due to increasing nuclear charge / atomic / proton number AND similar shielding / same (outer/number of) shell / energy level	**1**
(a)(ii)	Cross shown on first vertical line from the y-axis (Group 0 / Ne) is clearly higher than all shown	**1**
	Cross shown on second vertical line from the y-axis (Group 1 / Na) lower than all shown	**1**
(a)(iii)	A*l* (the outer / valence) electron (which is lost) is in (3)p sub-shell (Mg is in (3)s subshell) OR A*l* (the outer / valence) electron (which is lost) is in higher energy sub-shell ora	**1**
	(electron to be removed) is more shielded / experiences greater screening effect ora	**1**
	S has a pair of electrons in (a) (3)p orbital / (a 3)p orbital is full **ora**	**1**
	electron pair repulsion	**1**
(b)(i)	(**L**=) $MgCl_2$ / magnesium chloride	**1**
	Any two from (giant) ionic (with strong attractions) $Mg^{2+}(aq)$ / $Mg(H_2O)_6^{2+}(aq)$ is neutral / undergoes (partial) hydrolysis $Mg(OH)_2$ is the white precipitate / solid / insoluble / partially soluble $MgCl_2 + 2NaOH \rightarrow Mg(OH)_2 + 2NaCl$	**2**
(b)(ii)	(**M**=) $SiCl_4$ / silicon chloride	**1**
	Any two from (simple) molecular / simple covalent hydrolysis possible due to available d orbitals forms HC*l* (aq) / hydrochloric acid / solution and / or HC*l* gas / fumes white solid is (hydrated) SiO_2 $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$	**2**

47. 9701_w15_ms_21 Q: 1

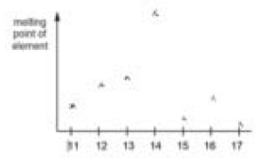
(a)	regular arrangement / lattice of cations / positive ions surrounded by delocalised electrons	[1] [1]
(b) (i)	electrical conductor corrosion resistant low density ductile owtte	[1] [1]
(ii)	Giant / lattice	[1]
(iii)	(electrical) insulator	[1]
(c) (i)	Simple covalent / covalent molecule Weak intermolecular forces / VdW forces OR little energy needed to break down / overcome intermolecular / VdW forces	[1] [1]
(ii)	$\begin{array}{cc} Al & Cl \\ \frac{20.3}{27} & \frac{79.7}{35.5} \\ \frac{0.752}{0.752} & \frac{2.25}{0.752} \\ 1 & 3 \end{array}$ $AlCl_3$	[1] [1]
(iii)	$pV = \frac{m}{M_r}RT$ $\quad M_r = \frac{mRT}{pV} = \frac{1.36 \times 8.31 \times 473}{100 \times 10^3 \times 200 \times 10^{-6}}$ $= 267$ **OR** $pV = nRT$ $\quad n = \frac{pV}{RT} = \frac{100 \times 10^3 \times 200 \times 10^{-6}}{8.31 \times 473}$ $= 5.09 \times 10^{-3}$ $M_r = \frac{1.36}{5.09 \times 10^{-3}} = 267$	[1] [1] [1] [1]
(iv)	Al_2Cl_6	[1]

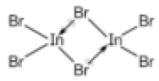
48. 9701_s21_ms_23 Q: 3

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>(a)(i)</td><td>
<table>
<tr><td></td><td>state at room temp</td><td>observations on add'n of sample to water</td><td>identity of sample</td></tr>
<tr><td>R</td><td>solid</td><td>alkaline, colourless solution is made but some white solid remains</td><td>M1 $Ba(OH)_2$
OR
barium hydroxide</td></tr>
<tr><td>S</td><td>solid</td><td>white solid disappears,
solution is neutral</td><td>M2 $NaCl$
OR
sodium chloride</td></tr>
<tr><td>T</td><td>liquid</td><td>misty fumes,
white solid is made in vigorous reaction</td><td>M3 $SiCl_4$
OR
silicon(IV) chloride</td></tr>
<tr><td>U</td><td>solid</td><td>acidic, colourless solution is made in vigorous reaction</td><td>M4 P_4O_{10}
OR
phosphorus(V) oxide</td></tr>
</table>
</td><td>4</td></tr>
<tr><td>(a)(ii)</td><td>SiO_2</td><td>1</td></tr>
<tr><td>(a)(iii)</td><td>phosphoric acid / phosphoric(V)acid</td><td>1</td></tr>
<tr><td>(b)(i)</td><td>any one physical property typical of ceramic materials from:
• strong / retain strength (over certain temperatures / conditions)
• non-conductors of electricity / electrical insulators
• high melting points</td><td>1</td></tr>
<tr><td>(b)(ii)</td><td>SiO_2</td><td>1</td></tr>
</table>

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>(c)</td><td>% of O
M1 100 – 79.29 (= 20.71)</td><td>1</td></tr>
<tr><td></td><td>M2 express W and O as mol by / 183.8 and / 16 respectively</td><td>1</td></tr>
<tr><td></td><td>M3 divide each by smallest number to give empirical formula
WO_3</td><td>1</td></tr>
</table>

49. 9701_w21_ms_22 Q: 2

Question	Answer	Marks
(a)(i)	M M M C C C C	1
(a)(ii)	All 3 points correct scores two marks Any 2 points scores one mark • *nuclear charge increases OR increasing proton number* e.g. 17 / C*l* has a greater nuclear charge • *describe the similarity in shielding between the two elements* e.g. they have almost the same shielding • *describe the overall effect in terms of greater nuclear attraction for (outer) electrons* e.g. (outer) electrons are attracted more (strongly) to the nucleus	2
(a)(iii)	**M1** describes the difference between 1st IE of elements 15 and 16 (P and S) in terms of either: spin-pair repulsion (in element 16 / S) **OR** electron pair repulsion (in element 16 / S) **M2** describes the location of the electron pair in the (3)p orbital which repel each other	2
(a)(iv)	(+)1 (+)2 (+)3 (+)4 (+)5 (+)6	1
(a)(v)	**M1** (anions have) same number of electrons (but increasing proton number) **M2** increasing proton number / nuclear charge AND increasing attraction of nucleus for (outer) electrons **OR** (outer) electrons attracted more (strongly) to the nucleus AND because of increasing proton number / nuclear charge	2
(b)		2

Question	Answer	Marks
(c)	**M1** density of $_{13}Al$: value within range 2.5–5.0 (g cm^{-3}) **M2** cationic radius of $_{31}Ga$: value within range 0.055–0.075 (nm) **M3** boiling point of $_{49}In$: value within range 1500–2300 (K)	3
(d)(i)	$InCl_3$	1
(d)(ii)	$In_2O_3 + 2NaOH + 3H_2O \rightarrow 2NaIn(OH)_4$	1
(d)(iii)	 **M1** correct connectivity of In_2Br_6 **M2** showing the two correct dative covalent bonds	2

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**