

Question	Answer	Marks	AO Element	Notes	Guidance
1(a)(i)	A (1) H (1)	2			
1(a)(ii)	B	1			
1(a)(iii)	D	1			
1(a)(iv)	C and G OR C and E	1			
1(b)	F (1) third / outer shell is being filled before second shell is full; second shell has 6 electrons: it should have 8 electrons (1)	2			
1(c)	12	1			
1(d)(i)	H ⁻	1			
1(d)(ii)	aluminium / Al	1			
2	ethanol: (forces of attraction) between molecules (1) sodium chloride: (force of attraction) between positive and negative ions/ionic bonding (1)	2			

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3	same number of electrons same electronic configuration	2			
4	Mg octet of eight dots O octet of six crosses and two dots correct charges on both ions	3			
5(a)	functional group	1			
5(b)	M1 4 × C–H dot cross bonds and 1 C–C dot cross bond M2 1 × C=O dot cross bond M3 non-bonding electrons on O	3			
6(a)	magnesium 2.8 (all crosses) (1) fluorine 2.8 (seven dots and one cross in outer shell) (1) Mg ²⁺ and F ⁻ (1)	3			
6(b)	MgF ₂	1			
7	two single bonds (1) one double bond (1) six non-bonding electrons on both F atoms and four non-bonding electrons on O atom to complete the octet in each case (1)	3			

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8	Ca has 2 and Cl has 7 outer electrons (1) Ca (atoms) lose electrons (1) Cl (atoms) gain electrons (1) Ca ²⁺ (ions) (1) Cl ⁻ (ions) (1)	5			
9	oppositely charged ions (ions) are attracted	2			
10(a)	any number in the range 72–129 °C	1			
10(b)	attraction increase (1) between molecules (1)	2			
11	3 P–Cl dot cross bonds (1) 2 (only) non-bonding electrons to make an octet on P (1) 6 (only) non-bonding electrons to make an octet on each Cl (1)	3			

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12	all bonding pairs correct (1) H atoms have 2 electrons and C and O atoms have 8 electrons (1)	2			
13(a)	F	1			
13(b)	I (1)	1			
13(c)	F (1) H (1) I (1)	3			
13(d)	G (1) good conductor when solid (1)	2			
13(e)	D (1) high melting point (1) non-conductor of electricity when solid or liquid (1)	3			
13(f)	E (1) only conducts when liquid / conducts when liquid but not when solid (1)	2			

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14(a)	$P_4 + 6Cl_2 \rightarrow 4PCl_3$ formulae correct (1) equation balanced (1)	2			
14(b)	3 bonding pairs and 1 lone pair on P (1) six non-bonding electrons on 3 chlorine atoms (1)	2			
15	electrons (1) electrons (1) Cu^{2+} (ions) (1) Br^- (ions) (1)	4			
16	4 electrons in double bond between C and O (1) all single bonds correct (1) C and O each have 8 electrons in outer shell, all H have 2 electrons in outer shell (1)	3			

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17	<table border="1"> <tr> <td data-bbox="398 217 501 347">number of electrons</td> <td data-bbox="501 217 604 347">number of neutrons</td> <td data-bbox="604 217 707 347">number of protons</td> <td data-bbox="707 217 806 347">symbol</td> </tr> <tr> <td data-bbox="398 347 501 405">M1 13</td> <td data-bbox="501 347 604 405"></td> <td data-bbox="604 347 707 405"></td> <td data-bbox="707 347 806 405"></td> </tr> <tr> <td data-bbox="398 405 501 462">M2 10</td> <td data-bbox="501 405 604 462">M3 13</td> <td data-bbox="604 405 707 462"></td> <td data-bbox="707 405 806 462"></td> </tr> <tr> <td data-bbox="398 462 501 663"></td> <td data-bbox="501 462 604 663"></td> <td data-bbox="604 462 707 663"></td> <td data-bbox="707 462 806 663"> M4 19 9 M5 F M6 – </td> </tr> </table>	number of electrons	number of neutrons	number of protons	symbol	M1 13				M2 10	M3 13						M4 19 9 M5 F M6 –	6			
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18(a)	$4\text{KI} + 2\text{CuSO}_4 \rightarrow 2\text{CuI} + \text{I}_2 + 2\text{K}_2\text{SO}_4$ (2)	2			allow multiples / fractions																
18(b)	1+ / +1	1																			
18(c)	gains electron(s)	1																			
18(d)	KI / potassium iodide / iodide (ions) / I^-	1																			
19	${}^9_4\text{Be}$ any element symbol with a single negative charge (1) use of Cl (1) use of ${}^{37}_{17}$ (1)	4																			

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20(a)	<p>M1 magnesium ion second shell shown containing 8 electrons shown as X</p> <p>M2 oxide ion second shell shown containing 8 electrons, two as X and six as ●</p> <p>M3 charges: magnesium ion as 2+ and oxide as 2-</p>	3			
20(b)	strong forces of attraction (between oppositely charged ions)	1			
20(c)	ions / Mg^{2+} and O^{2-} / anions and cations can move (throughout the structure)	1			
21(a)	<p>M1 same number of electrons</p> <p>M2 (same number of) electrons in outer shell</p>	2			
21(b)	<p>$Mg + 2HCl \rightarrow MgCl_2 + H_2$</p> <p>M1 $MgCl_2$ as product</p> <p>M2 fully correct equation</p>	2			

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21(c)	M1 test: lighted / burning splint M2 result: (squeaky) pop	2			
22	M1 (lattice of) positive ions / cations M2 (delocalised / sea of) electrons M3 attraction / attract between positive and negative	3			
23(a)	covalent	1			
23(b)	forces of attraction between molecules AND are weak / need a small amount of energy to break	1			
23(c)	no moving or flowing or mobile charged particles or ions or electrons	1			
24(a)	PbF ₂	1			
24(b)	covalent	1			
24(c)	giant ionic lattice	1			

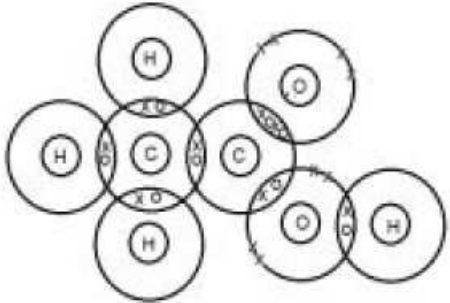
Question	Answer	Marks	AO Element	Notes	Guidance
24(d)	M1 (It or lead(II) fluoride) forces of attraction between ions / ionic bonds M2 (tetrafluoromethane) forces of attraction between molecules M3 ionic bonds stronger than attractive forces between molecules / ionic bonds need more energy to break than attractive forces between molecules	3			
25(a)	gas / gaseous	1			
25(b)	M1 1 shared pair of electrons M2 6 non-bonding electrons on each atom to complete an octet	2			
25(c)	$2\text{Na} + \text{F}_2 \rightarrow 2\text{NaF}$ M1 NaF anywhere M2 equation fully correct	2			
25(d)	chlorine less reactive than fluorine ORA	1			
26(a)	(oxidation is) loss of electrons	1			

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26(b)	<p>one shared pair between each H and S (1)</p> <p>four unpaired electrons on S giving S a total of 8 outer shell electrons and no other unpaired electrons (1)</p>	2			
26(c)	<p>weak (attractive) forces OR (attractive) forces need little energy to overcome (1)</p> <p>forces between molecules / intermolecular (1)</p>	2			
27	<p>Mg shown with new outer shell with 8 crosses (1)</p> <p>Both Cl with a new outer shell with 7 dots and 1 cross (1)</p> <p>'2+' charge on Mg and '-' charge on each Cl (1)</p>	3			A 8 dots
28	<p>nucleons: 27 (1)</p> <p>neutrons: 14 (1)</p> <p>electrons: 10 (1)</p>	3			

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29	(potassium bromide): ionic bonds / attraction between ions (1) (iodine monochloride): intermolecular forces / forces between molecules / named intermolecular forces, e.g. van der Waals / London forces / dispersion forces / dipole-dipole (1) bonds in KBr are stronger / need more energy to break bonds / ORA (1)	3			
30(a)	a shared pair of electrons (between two atoms) M1 shared electrons M2 pair of / two electrons	2			
30(b)	M1 three correct bonding pairs from one N atom to each of three F atoms M2 (3 pairs of) non-bonding electrons on each of three F atoms to complete an octet M3 (1 pair of) non-bonding electrons on N atom to complete an octet	3			

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31(a)	two (or more) substances not chemically combined	1			
31(b)	21 (%)	1			
31(c)	M1 air is made into a liquid M2 (allow air to) boil or evaporate M3 condense the vapours / collect the vapours in order (of evaporation) fractional distillation gets M2 and M3	3			
31(d)	boiling points	1			
32(a)	diffusion	1			
32(b)	silicon(IV) oxide is a solid, whereas carbon dioxide is a gas	1			

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32(c)	photosynthesis (1) chlorophyll / chloroplasts (1) sunlight / UV (light) (1) $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ (2) M1 species correct M2 balanced	5			
33	SCl_2 has intermolecular forces (of attraction) (1) LiCl has (electrostatic) forces (of attraction) between ions (1) intermolecular forces are weaker / less energy is needed to break intermolecular forces (1)	3			
34	Li shown as having one shell with 2 electrons OR no electrons OR no outer shell (1) Cl shown as having an outer shell of 7 electrons of one type, plus one different electron which matches Li electrons (1) '+' charge on Li AND '-' charge on Cl (1)	3			

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35(a)	(acidified) potassium manganate(VII) OR potassium (di)chromate(VI)	1			
35(b)	 <p data-bbox="398 778 808 1098"> M1 all shared pairs of electrons correct for single bonds M2 2 shared pairs of electrons for the C=O bond M3 total of 8 electrons on each O including 4 non-bonding electrons and no additional non-bonding electrons </p>	3			
36	two shared pairs of electrons (1) both Cl with complete outer shells (1) S with complete outer shell (1)	3			

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37(a)	positive ions / cations (1) sea of electrons / mobile electrons / delocalised electrons / moving electrons / flowing electrons (1) attraction between positive ions and electrons (1)	3			
37(b)	layers / rows / sheets of ions (1) slide / slip / shift (over each other or past each other) (1)	2			
37(c)	particles have different sizes / radii (1) layers cannot slide / slip / shift (1)	2			
38(a)	soft because weak forces between layers/sheets/rows	1			
	layers can slip/slide	1			
	good conductor because electrons can move/mobile	1			
38(b)	it is soft: pencils or lubricant or polish	1			

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	good conductor: electrodes or brushes (in electric motors)	1																																			
39(a)	$6\text{Li} + \text{N}_2 = 2\text{Li}_3\text{N}$ species (1) balancing (1)	2																																			
39(b)	N^{3-} ion drawn correctly	1																																			
	charges correct (minimum 1 × Li ion and 1 nitride ion)	1																																			
40(a)	<table border="1" style="display: inline-table; vertical-align: top;"> <tr> <td>group number</td> <td>I</td> <td>II</td> <td>III</td> <td>IV</td> <td>V</td> <td>VI</td> <td>VII</td> </tr> <tr> <td>symbol</td> <td>Na</td> <td>Mg</td> <td>Al</td> <td>Si</td> <td>P</td> <td>S</td> <td>Cl</td> </tr> <tr> <td>number of valency electrons</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> </tr> <tr> <td>valency</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>3</td> <td>2</td> <td>1</td> </tr> </table> <p>(1) for each line</p>	group number	I	II	III	IV	V	VI	VII	symbol	Na	Mg	Al	Si	P	S	Cl	number of valency electrons	1	2	3	4	5	6	7	valency	1	2	3	4	3	2	1	2			
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valency	1	2	3	4	3	2	1																														
40(b)	number of valency electrons = the group number	1																																			

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40(c)	for Na to Al the valency is the same as the number of valency (outer) electrons (1) (because) this is the number of electrons lost (for full energy level) (1)	2			
	for P to Cl the valency is 8 – [number of valency (outer) electrons] or valency + valency electrons = 8 (1) (because) this is number of electrons needed (or to be gained) (for full energy level) (1)	2			
[Total: 178]					