Questions

Q1.

Ionisation energies provide information about the number of electrons and the arrangement of the electrons in an atom of an element.

A student's definition of first ionisation energy is shown.

> First ionisation energy is the energy released when one mole of gaseous atoms loses one mole of electrons to form one mole of gaseous 1+ ions.

There is one incorrect word in the student's definition.

Identify the word, giving the reason why this word is incorrect.

(2)

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(Total for question = 2 marks)

Q2.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Bromine exists as two stable isotopes. The two isotopes are represented by the symbols $^{79}_{35}Br$ and $^{81}_{35}Br$.

(i) Complete the electronic configuration of a bromine atom.

(1)

$1s^2\ 2s^2$ .....

(ii) What is the number of electrons in the fourth quantum shell of bromine?

(1)

- ☒ **A** 2
- ☒ **B** 7
- ☒ **C** 17
- ☒ **D** 18

(Total for question = 2 marks)

Q3.

This question is about aluminium chloride.

Complete the electronic configuration of an aluminium atom.

(1)

$1s^2$ .....

(Total for question = 1 mark)

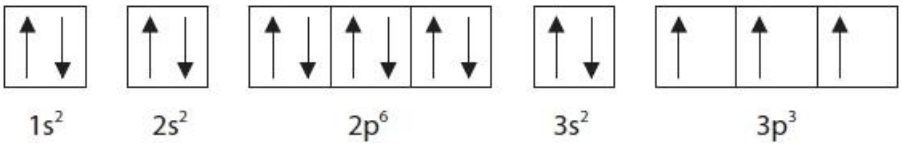
Q4.

This question is about the electronic structure of some Group 5 elements.

The electronic configuration of a phosphorus atom can be written

$$1s^2 2s^2 2p^6 3s^2 3p^3$$

An alternative way to express the electronic configuration is



(i) State what is meant by the two arrows in the first box.

(1)

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(ii) State why the arrows are all pointing in the same direction in the 3p boxes.

(1)

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(Total for question = 2 marks)

Q5.

Chlorine and iodine are in the same group in the Periodic Table.

(i) Complete the electronic configuration of chlorine using the s, p, d notation.

(1)

$1s^2$ .....

(ii) Explain why iodine and chlorine have many similar chemical reactions.

(2)

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(Total for question = 3 marks)

Q6.

This question is about magnesium.

(i) Complete the electronic structure of a magnesium atom.

(1)

$1s^2$

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(ii) The bonding in magnesium results from

(1)

☒ **A** strong electrostatic attractions between oppositely charged ions

☒ **B** strong electrostatic attractions between the nuclei of magnesium atoms and a shared pair of electrons

☒ **C** strong electrostatic attractions between positively charged ions and a sea of delocalised electrons

☒ **D** weak dispersion forces between magnesium atoms

(Total for question = 2 marks)

Q7.

Magnesium bromide, $MgBr_2$, is an ionic compound.

(i) The first ionisation energy of sodium is 496 kJ mol^{-1}.

Explain why the first ionisation energy of magnesium is higher than that of sodium.

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(ii) Write the equation, including state symbols, to show the **third** ionisation energy of magnesium.

(1)

(Total for question = 4 marks)

Q8.

* A student suggested that the difference in the rates of reaction of strontium and barium with water is due to the difference in the sum of their first and second ionisation energies. Discuss this suggestion.

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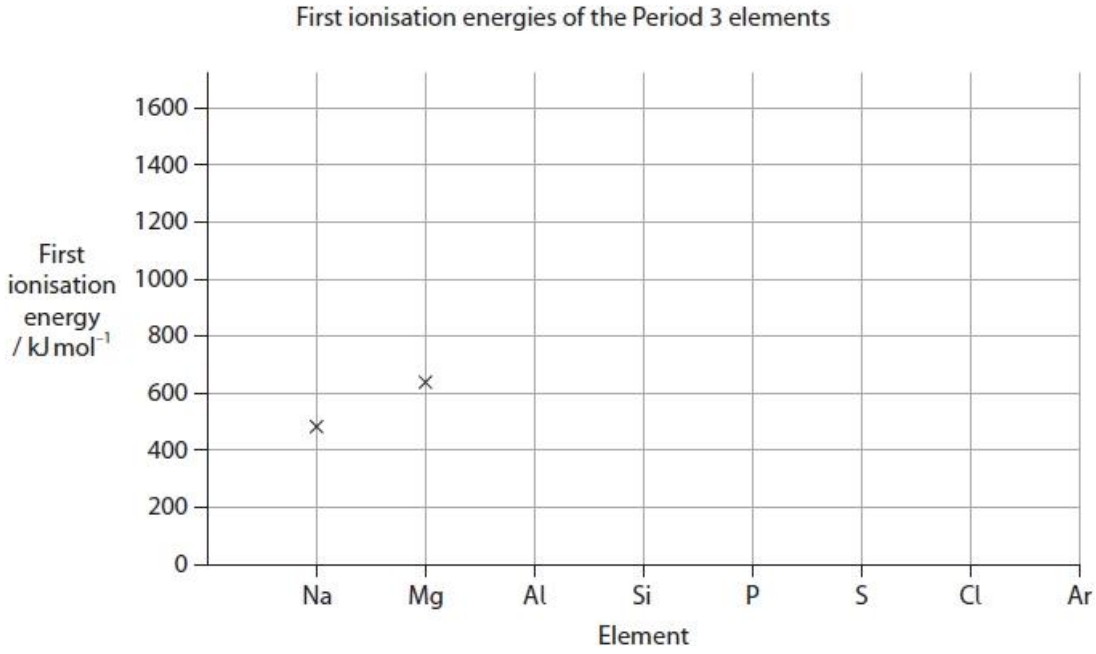
(Total for question = 6 marks)

Q9.

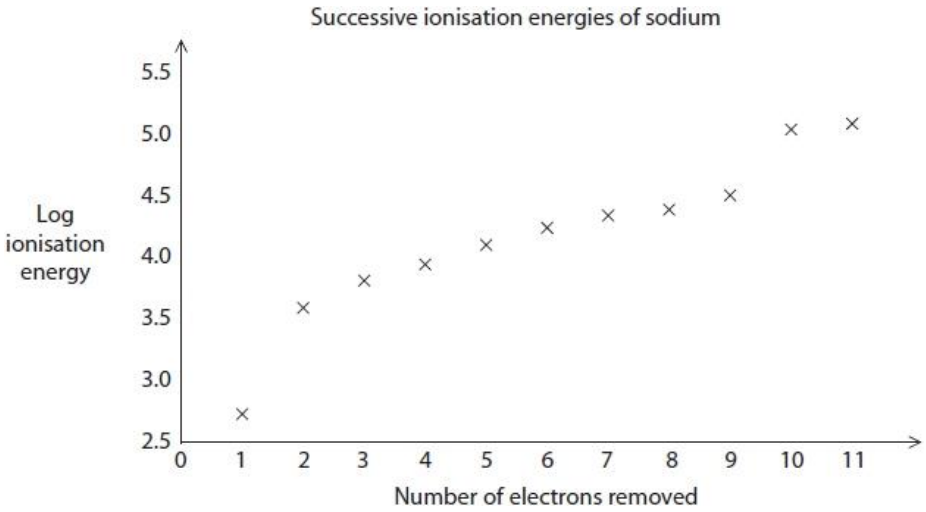
This question is about ionisation energies.

(i) Complete the graph to show how the first ionisation energies of the Period 3 elements change across the period. Precise figures are not required.

(3)



(ii) The successive ionisation energies of sodium are shown on the graph.



State what deductions can be made from this graph.

(2)

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(Total for question = 5 marks)

Q10.

Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .

Sulfur is a bright yellow crystalline solid at room temperature.

Sulfur forms rings of 8 sulfur atoms so the formula of the yellow solid is S_8.

A section of a periodic table showing values of first ionisation energy in kJ mol^{-1} is shown.

N 1400	O 1310	F 1680
P 1010	S 1000	Cl 1250
As 950	Se 940	Br 1140

(i) Which equation represents the first ionisation energy of sulfur?

(1)

☒ **A** $S(s) \rightarrow S^+(g) + e^-$

☒ **B** $S_8(s) \rightarrow S_8^+(g) + e^-$

☒ **C** $S(g) \rightarrow S^+(g) + e^-$

☒ **D** $S_8(g) \rightarrow S_8^+(g) + e^-$

(ii) Explain the trend in the values of the first ionisation energies for the group containing sulfur.

(3)

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(iii) Explain why the first ionisation energy of sulfur is lower than that of chlorine.

(2)

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(iv) Explain why the first ionisation energy of sulfur is lower than that of phosphorus.

(2)

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(Total for question = 8 marks)

Q11.

This question is about hydrogen, the element with atomic number $Z = 1$.

(i) Write an equation to represent the first ionisation energy of hydrogen. Include state symbols.

(2)

(ii) The sequence of the first three elements in the Periodic Table is hydrogen, helium and then lithium.

Explain why the first ionisation energy of hydrogen is less than that of helium, but greater than that of lithium.

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(Total for question = 6 marks)

Q12.

Ionisation energies provide information about the number of electrons and the arrangement of the electrons in an atom of an element.

A sodium atom has 11 protons whereas a potassium atom has 19 protons.

Explain why the first ionisation energy of sodium is greater than that of potassium.

(3)

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(Total for question = 3 marks)

Q13.

This question is about ions and ionic compounds.

The first three ionisation energies of calcium are shown in the table.

	First ionisation	Second ionisation	Third ionisation
Ionisation energy / kJ mol^{-1}	590	1145	4912
Orbital			

(i) Complete the table by identifying the specific orbital from which each electron is removed.

(2)

(ii) Write the equation for the **third** ionisation energy of calcium.

Include state symbols.

(1)

(iii) Explain why the difference between the second and third ionisation energies of calcium is much larger than the difference between the first and second ionisation energies.

(2)

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(Total for question = 5 marks)

Q14.

Ionisation energies provide information about the number of electrons and the arrangement of the electrons in an atom of an element.

The successive ionisation energies for magnesium are given in the table.

Electron number removed	1	2	3	4	5	6	7	8	9	10	11	12
Ionisation energy / kJ mol^{-1}	738	1451	7733	10 541	13 629	17 995	21 704	25 657	31 644	35 463	169 996	189 371
Log (ionisation energy)	2.87	3.16	3.89	4.02	4.13		4.34	4.41	4.50	4.55	5.23	

(i) Complete the table.

(1)

(ii) Give a reason why the logarithm of the ionisation energy, rather than just the ionisation energy, is used to plot a graph.

(1)

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(iii) Give a reason why the successive ionisation energies increase.

(1)

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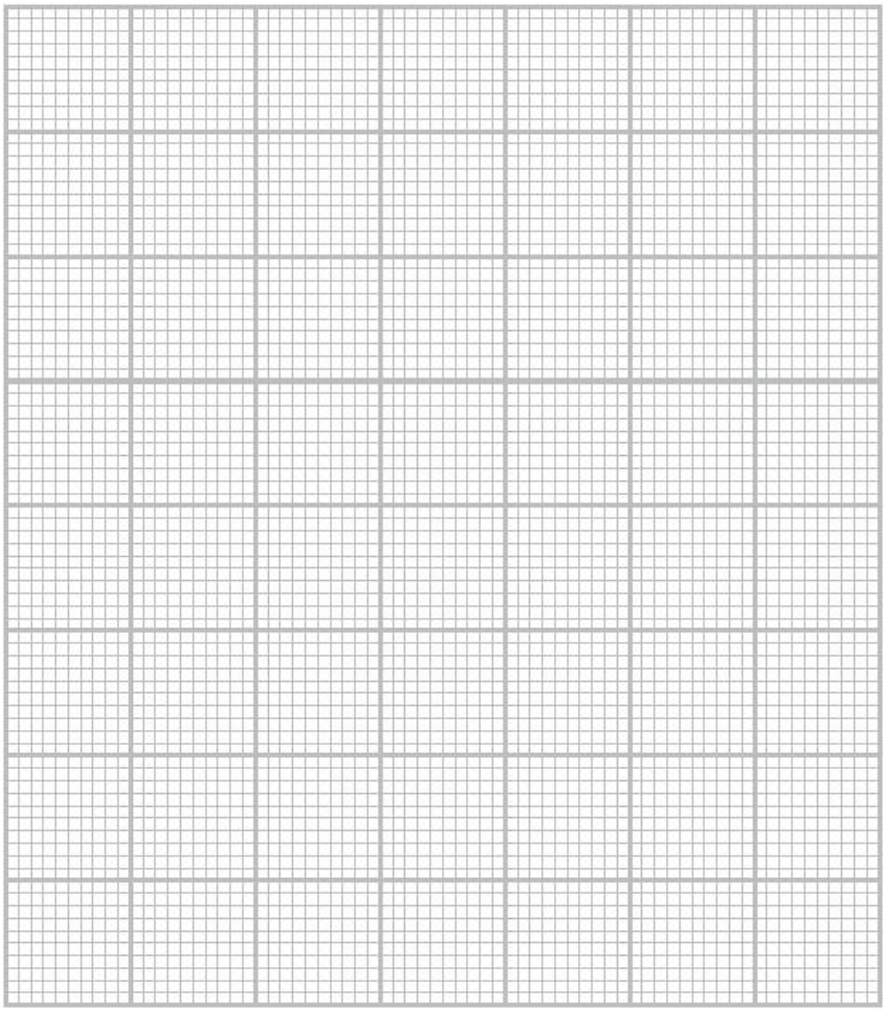
(iv) Plot the graph of log(ionisation energy) against electron number removed.
Join the individual points using straight lines.

(3)



(v) Identify on the graph, using a circle, the points that represent the removal of the electrons in the **outermost** energy level of magnesium.

(1)

(Total for question = 7 marks)

Q15.

Ionisation energies provide information about the number of electrons and the arrangement of the electrons in an atom of an element.

Write an equation for the **second** ionisation energy of oxygen.
Include state symbols.

(2)

(Total for question = 2 marks)

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Q16.

This question is about atoms, molecules and ions.

Complete the table to show the maximum number of electrons which can fill each region of an atom.

(3)

Region	Maximum number of electrons
the 1s orbital	
the 2p subshell	
the third quantum shell	

(Total for question = 3 marks)

Q17.

Electrons in atoms occupy orbitals.

State what is meant by the term **first ionisation energy**.

(3)

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(Total for question = 3 marks)

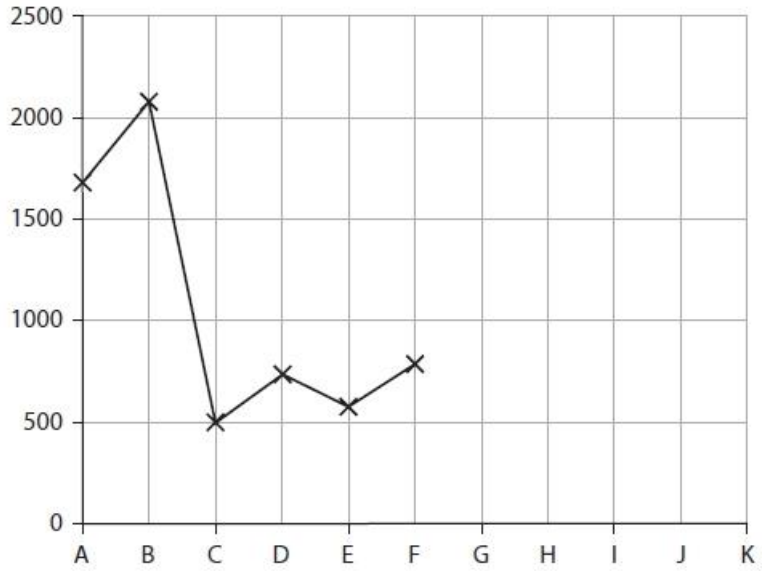
Q18.

Electrons in atoms occupy orbitals.

(i) The graph shows the first ionisation energies for a series of six consecutive elements **A**–**F**. The letters are not their chemical symbols.

Complete the graph of the first ionisation energies for the next five elements.

(3)



(ii) Explain why the value of the first ionisation energy for **D** is **greater** than for **C**.

(2)

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(iii) Explain why the value of the first ionisation energy of **E** is **less** than for **D**.

(2)

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(Total for question = 7 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following points • (energy) released (1) • energy is required to overcome the (electrostatic) attraction from the nucleus for the electron (1)	Allow energy is required to remove an electron Allow (the removal of an electron) is endothermic	(2)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following point: • correct electronic configuration	$(1s^2\ 2s^2)\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^5$ Allow $3d^{10}$ before $4s^2$ Ignore repeat of $1s^2\ 2s^2$ Allow upper case letters, numbers not superscript, numbers subscript and p and / or d orbitals shown (e.g. $2p_x^2$, $2p_y^2$, $2p_z^2$ instead of $2p^6$)	(1)

Question Number	Answer	Mark
(ii)	The only correct answer is **B** (7) *A is not correct because this is the number of electrons in the fourth occupied subshell* *C is not correct because this assumes the electrons in the 3d orbitals are in the fourth quantum shell* *D is not correct because this is the number of electrons in the third quantum shell of bromine*	(1)

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Q3.

Question Number	Answer	Additional Guidance	Mark
	• $(1s^2)2s^22p^63s^23p^1$	Allow numbers of electrons as subscripts or large numbers Allow p orbitals designated as x, y and z Ignore $1s^2$ repeated	(1)

Q4.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following point: • (up and down arrows represent) electrons with opposite spin or two electrons in the same orbital with opposite spins	Answer must refer to spin Ignore just number of electrons Ignore 'moving / opposite direction' in place of 'spin' Ignore comments re repulsion, same orbital etc	(1)

	Acceptable Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following point: • (three) electrons with parallel / same spin / direction of rotation (because the electrons are in different orbitals)	Allow 'spinning in the same direction' Allow electrons are added into separate orbitals first because of Hund's rule Do not award for just 'direction' of spin, with no reference to 'same'	(1)

Q5.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	$(1s^2)2s^22p^63s^23p^5$	Ignore repeat of $1s^2$ Allow 1s2 2s2..... 1S2 2S2..... For $3p^5$ accept $3p_x^2$, $3p_y^2$, $3p_z^1$	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following points: • iodine (also) has 7 electrons in the **outer shell** / is $5s^2 5p^5$ / is (also) np^5 **(1)** • electronic configurations / number of electrons in the outer shell govern their chemical reactions **(1)**	Allow has the same number of electrons in the outer shell / valence electrons for M1 M2 is dependent on M1 being scored	**(2)**

Q6.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	$(1s^2)\ 2s^2\ 2p^6\ 3s^2$	ALLOW $1s^2$ repeated	**(1)**

Question Number	Answer	Mark
(ii)	**The only correct answer is C** ***A*** *is not correct because this describes ionic bonding and magnesium has metallic bonding* ***B*** *is not correct because this describes covalent bonding and magnesium has metallic bonding* ***D*** *is not correct because this describes intermolecular forces and magnesium has metallic bonding*	**(1)**

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following points: • **Nuclear charge** magnesium (atom) / Mg has more protons than sodium (atom) / Na **or** magnesium / Mg has a greater (effective) nuclear charge (than sodium / Na) **(1)** • **Shielding** (outer) electron in magnesium (atom) / Mg in the same (quantum) shell / energy level / sub-shell / orbital as in a sodium atom / Na **or** shielding in magnesium atom / Mg similar to / same as that in sodium atom / Na **(1)** • **Attraction** so the force of attraction between the nucleus and the (outer) electron is greater in magnesium (atom) / Mg (than in sodium atom / Na) **(1)**	Penalise reference to ion once only Ignore reference to atomic radius Allow correct E.C of both atoms Allow same number of (quantum) shells / energy levels in Mg and Na Allow the (outer) electron in Mg is held more tightly to the nucleus (than in Na) **Note** An answer that describes the trend across a period, without one reference to either sodium or magnesium, scores maximum (2) marks	**(3)**

Question Number	Answer	Additional Guidance	Mark
(ii)	• correct equation with state symbols	<u>Examples of equations</u> $Mg^{2+}(g) \rightarrow Mg^{3+}(g) + e^{(-)}$ $Mg^{2+}(g) - e^{(-)} \rightarrow Mg^{3+}(g)$ Ignore state symbol for the electron Do not allow ⇌	**(1)**

Q8.

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td></td>
<td>This question assesses the student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning.

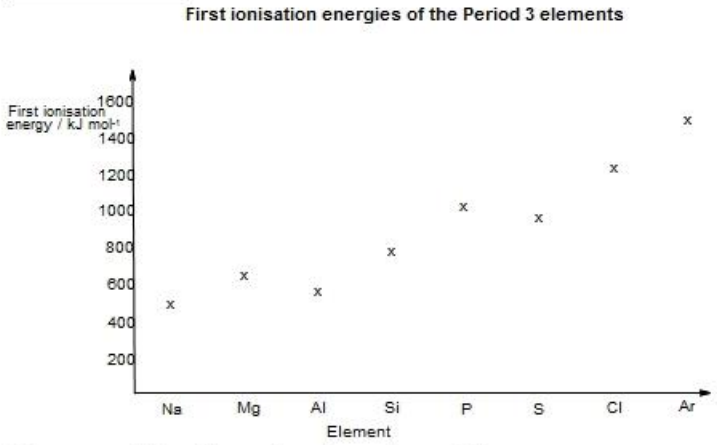
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
</td>
<td>Guidance on how the mark scheme should be applied:
The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with four indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).
If there were no linkages between the points, then the same indicative marking points would yield and overall score of 3 marks (3 marks for indicative content and zero marks for linkages).</td>
<td>(6)</td>
</tr>
</table>

	The following table shows how the marks should be awarded for structure and lines of reasoning **Number of marks awarded for structure of answer and sustained lines of reasoning** **Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout** — 2 **Answer is partially structured with some linkages and lines of reasoning** — 1 **Answer has no linkages between points and is unstructured** — 0	In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning. Reasoning marks may be reduced for extra incorrect chemistry	

	Indicative content • the sum of the first two ionisation energies for barium is lower / barium loses (its outer) electrons more easily • barium is a bigger atom/barium has a larger atomic radius/barium has more shells of electrons • barium has more shielding • these outweigh/exert a greater influence than • barium has more proton/greater nuclear charge • barium reacts faster/barium is more reactive	Allow reverse argument for strontium Allow max 5 IPs for reference to general trends only down group 2 Allow any reference to single ionisation Do not award for barium 'molecule'	

Q9.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following points: • Al below Mg but above /equal to Na **(1)** • rise from Al to Si and then to P **and** rise from S to Cl to Ar **(1)** • S below P but above / equal to Si **(1)**	Example of chart  Allow use of dots (·) or other alternatives to X Ignore any lines connecting the crosses (X)	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following points: • big increase/jump between 1st and 2nd electrons removed and between 9th and 10th electrons removed **(1)** • one / first electron in the outer most / third shell **and** eight electrons / electron 2 - 9 in the next / second shell **and** two electrons / electrons 10 & 11 in the inner most/ first shell **(1)**	Allow answers in terms of energy levels Allow Na is a group 1 element Allow electronic configuration of Na is 2, 8, 1 Allow an answer that relates jump in energy to existence of (new) shells Allow there are three shells of electrons	**(2)**

Q10.

Question Number	Answer	Mark
(i)	The only correct answer is **C** ($S(g) \rightarrow S^{+}(g) + e^{-}$) *A is not correct because the sulfur must be in the gas phase* *B is not correct because the sulfur must be individual atoms and in the gas phase* *D is not correct because the sulfur must be individual atoms*	(1)

Question Number	Answer		Additional Guidance	Mark
(ii)	An explanation that makes reference to the following points: • first ionisation energy decreases down the group because although the number of protons is increasing	(1)		(3)
	• the electron being removed is (one shell of electrons) further from the nucleus	(1)	Allow greater repulsion between inner electron shells	
	• (with one shell of electrons) giving more shielding from the nucleus	(1)		

Question Number	Answer		Additional Guidance	Mark
(iii)	An explanation that makes reference to the following points: • because in sulfur the nuclear charge / atomic number / proton number / number of protons has is less (by 1)	(1)	Do not award just 'the charge has decreased (by 1) in sulfur' Allow effective nuclear charge has decreased by 1 in sulfur	(2)
	• and the electron being removed is from the same sub-shell / a (3)p electron / has similar shielding / is further from the nucleus /	(1)	Allow has the same shielding Allow atomic radius is larger Do not award ionic radius is larger Ignore same shell Allow reverse arguments for chlorine	

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Question Number	Answer	Additional Guidance	Mark
(iv)	An explanation that makes reference to the following points: • because in sulfur (spin) pairing has occurred (for the first time in the 3p sub-shell) **or** electron being removed from an orbital containing two electrons **(1)** • (resulting in an increase in) repulsion between electrons (so the electron is lost more easily) **(1)**	Ignore half-filled (sub-) shell is more stable in phosphorus Ignore reference to shielding and distance to the nucleus	(2)

Q11.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • equation **(1)** • state symbol, (g), on both H and H^+ **(1)**	$H(g) \rightarrow H^+(g) + e^{(-)}$ or $H(g) - e^{(-)} \rightarrow H^+(g)$ Ignore state symbol for electron $H_2(g) \rightarrow H_2^+(g) + e^{(-)}$ scores only M2 $H_2(g) - e^{(-)} \rightarrow H_2^+(g)$ scores only M2 $H_2(g) \rightarrow 2H^+(g) + 2e^{(-)}$ scores 0 $X(g) \rightarrow X^+(g) + e^{(-)}$ scores only M2	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following points: H < He: • He more protons than H / He greater nuclear charge than H **(1)** • in helium the outer electron is in the same shell as hydrogen **(1)** H > Li: • in lithium the outer electron is in a higher energy level / a new shell / further from the nucleus / in a 2s orbital **(1)** • (and) is shielded by inner electrons / $1s^2$ electrons **(1)**	Ignore references to shielding for H and He Ignore references to atomic radius or electrons being closer to or the same distance from the nucleus in helium Allow lithium has more shells of electrons Allow (outer electron of) lithium has more shielding than hydrogen / is shielded	**(4)**

Q12.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following points • the outer electron in a sodium atom is closer to the nucleus (than that in potassium) (1) • (and) less shielding from inner electron shells (1) • these outweigh the greater nuclear charge / number of protons in potassium (1)	Accept reverse arguments throughout Allow sodium atoms are smaller (than potassium) Allow sodium has electron in 3s whereas potassium has electron in 4s Allow diagram to illustrate Do not award reference to ionic radius Do not award if reference given to both have a +1 charge/ same nuclear charge	(3)

Q13.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• any 2 correct (1) • all 3 correct (2)	Example of table 1st IE: (590) 4s; 2nd IE: (1145) 4s; 3rd IE: (4912) 3p Accept $3p_x$ / $3p_y$ / $3p_z$ for 3rd IE Ignore any superscript numbers by 4s and 3p Allow (1) for just 's, s, p' or 's, s, p' with one or more incorrect numbers in front	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	• correct equation	Examples of equations $Ca^{2+}(g) \rightarrow Ca^{3+}(g) + e^{(-)}$ **or** $Ca^{2+}(g) - e^{(-)} \rightarrow Ca^{3+}(g)$ Correct state symbols are required Ignore any state symbol for the electron	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following points: • (there is a much larger difference between the 2nd and 3rd ionisation energies because the) 3rd electron is lost from a shell / energy level / sub- shell / (3p) orbital closer to the nucleus **or** the 3rd electron is lost from a shell / energy level / sub-shell / (3p) orbital of lower energy **(1)** • (there is a smaller difference between the 1st and 2nd ionisation energies because the) 1st and 2nd electrons removed from the same shell / energy level / sub- level / orbital **or** the first two electrons experience similar shielding (from the inner electrons) **or** there is only a small change in electron-electron repulsion as the first two electrons are removed **(1)**	Ignore electron is lost from a full (sub-)shell / a full (sub-)shell is more stable Ignore just '3rd electron lost is more strongly attracted to the nucleus' Allow the same amount of shielding Allow the 3rd electron (to be lost) experiences less shielding (from inner electrons)	**(2)**

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	• completed table	4.26 and 5.28	(1)

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Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that includes • the range of numbers / 738 to 189 371 is too large (to fit on a graph / axis) **or** logarithms make it easier to plot the numbers	Allow: a (very) long y axis would be needed (some of) the numbers are too large the difference between the ionisation energies is too large so the numbers will fit on the graph logs give smaller (range of) numbers Ignore simpler to read Do not award reference to averages	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that includes one of the following points • the same number of protons is attracting a decreasing number of electrons **or** electron is removed from an increasingly positively charged ion **or** electron removed is closer to the nucleus **or** the electron removed is experiencing less electron-electron repulsion	Do not award each electron is removed from shells closer to the nucleus	(1)

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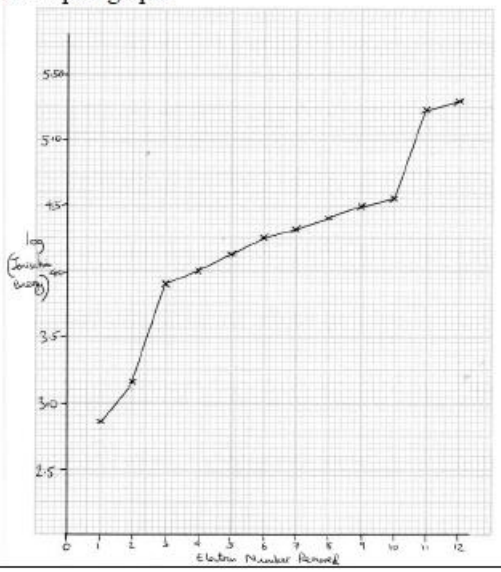
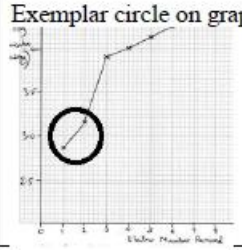
Question Number	Answer	Additional Guidance	Mark
(iv)	An answer that includes a suitable graph • labelled axes (1) • suitable scale (1) • plotting of points and lines joining points (1)	Do not award if any units given on y axis Plotted points must cover at least ½ the graph paper on each axis Allow ±½ square Do not award line going from point 1 to the origin Ignore plotting of electron 6 and 12 Exemplar graph 	(3)

Question Number	Answer	Additional Guidance	Mark
(v)	An answer that includes • circle around the first two points/circles around individual points	Exemplar circle on graph 	(1)

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Q15.

Question Number	Answer	Additional Guidance	Mark
	An answer that includes • species in suitable equation (1) • state symbols (1)	Example of equation $O^+(g) \rightarrow O^{2+}(g) + e^-$ ALLOW $O^+(g) - e^- \rightarrow O^{2+}(g)$ Ignore state symbols on electron Do not allow multiples for M1 M2 dependent on M1 or near miss	(2)

Q16.

Question Number	Acceptable Answer		Additional Guidance	Mark
	• 1s orbital – 2 electrons • 2p subshell – 6 electrons • third quantum shell – 18 electrons	(1) (1) (1)	Example of table | Region	Maximum number of electrons
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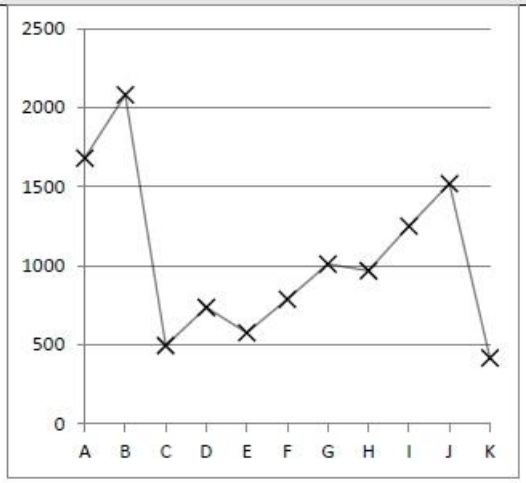
the 1s orbital	2
the 2p subshell	6
the third quantam shell	18	 Allow $1s^2$ for 2 Allow $2p^6$ for 6 Ignore $3s^23p^63d^{10}$ for the third number Do not award more than one number written in the box e.g. 8 or 18 in the third box	(3)

Q17.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An answer that makes reference to the following points: • makes mention of energy/enthalpy/(heat) energy/heat (change/required) AND to remove an electron **(1)** • one mole/1 mol **(1)** • makes mention of **gaseous atom(s)** (but not as the product of ionisation) **(1)** **ALTERNATIVE ANSWER** • energy change per mole / kJ mol^{-1} for **(1)** $X(g) \rightarrow X^{+}(g) + e^{(-)}$ • one mark for species **(1)** • one mark for correct state symbols **(1)**	IGNORE any references to standard conditions Do not award "Energy **given out**..." Do not award **Just** 'gaseous element'/ 'gaseous substance' Max 2 for $X(g) + e^{(-)} \rightarrow X^{+}(g) + 2\ e^{(-)}$	**(3)**

Q18.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	 G above F AND H between G and F **(1)** I above H and below A AND J above I and below B **(1)** K below C **(1)**	Points which are not joined with lines are perfectly acceptable. Do not penalise I below G if MP1 not awarded	**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following points: • D has one more proton / has a higher nuclear charge **(1)** • the electron being removed in C and D are from the same subshell / s-subshell / (s) orbital **(1)**	 Allow same shell / energy level Allow the electron in D is closer to the nucleus than C / atomic radius decreases Ignore references to shielding, and full s-orbital which is more stable.	**(2)**

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Question Number	Acceptable Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following points: • (the electron being removed from E) is from a new subshell / p-subshell / p-orbital **(1)** • which is more shielded from the nucleus than the s-subshell (from which the electron is removed in D) OR • which is further from the nucleus than the s-subshell / orbital (in E) **(1)**	Do not award 'in a new quantum shell' Allow electron removed from a higher energy level. Do not award clear reference to the outer electron in E being further from the nucleus than outer electron in D/atomic radius increasing from D to E Do not award clear reference to the outer electron in E being further from the nucleus than outer electron in D/atomic radius increasing from D to E	**(2)**