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

$$1s^2 2s^2 2p^6 3s^2 3p^3$$
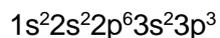
An alternative way to express the electronic configuration is
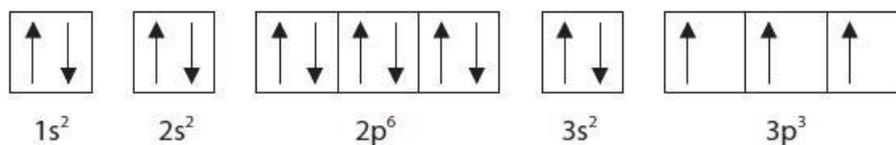
(i) State what is meant by the two arrows in the first box.

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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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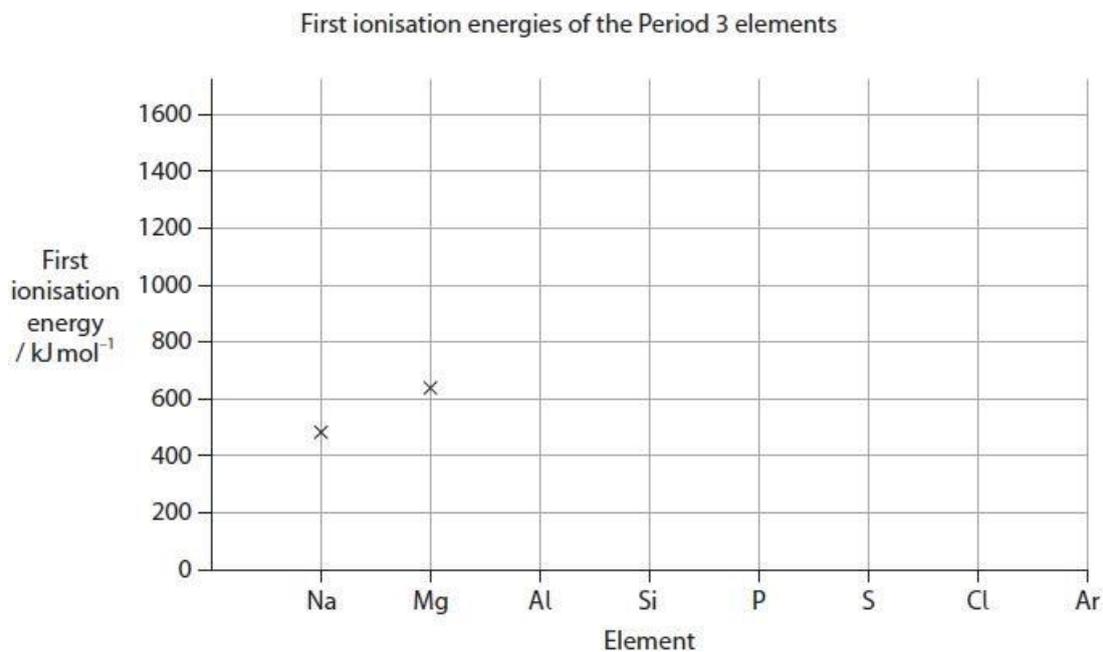
(Total for question = 6 marks)

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)

First ionisation energies of the Period 3 elements

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

Successive ionisation energies of sodium

State what deductions can be made from this graph.

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(Total for question = 5 marks)

Q10.

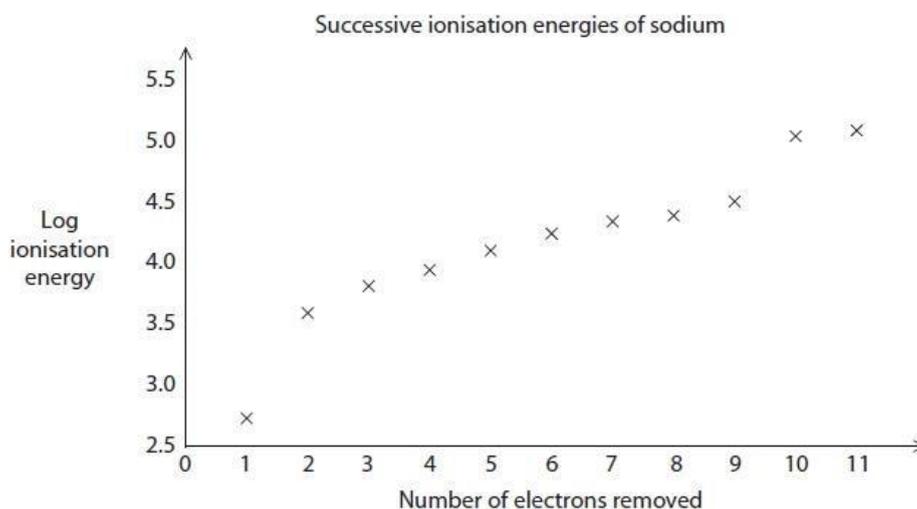**Answer the question with a cross in the box you think is correct ☒ . If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒ .**

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

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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 / kJmol^{-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.

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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 / kJmol^{-1}	738	1451	7733	10541	13629	17995	21704	25657	31644	35463	169996	189371
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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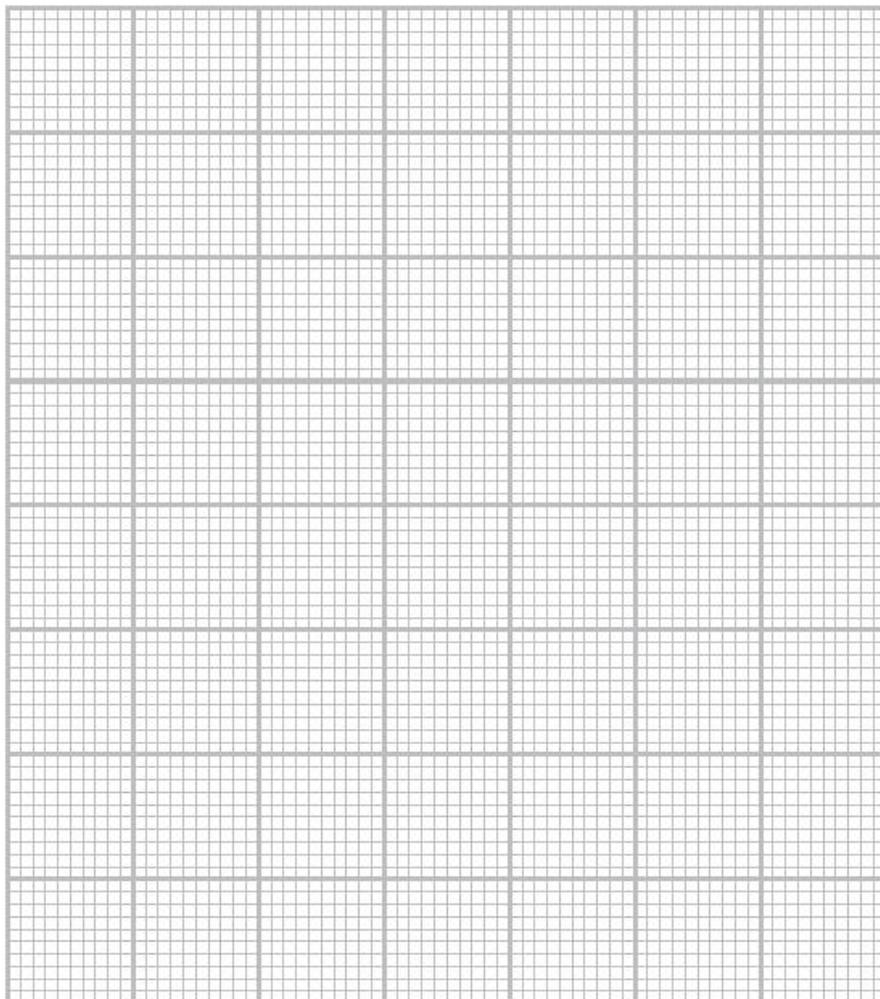...

(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)

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)