A-Level Chemistry

Periodicity

Question Paper

Time available: 54 minutes
Marks available: 49 marks

1. This question is about atomic structure.

(a) There is a general trend for an increase in ionisation energy across Period 3. Give **one** example of an element that deviates from this trend.

Explain why this deviation occurs.

Element _____

Explanation _____

_____

_____

_____

_____

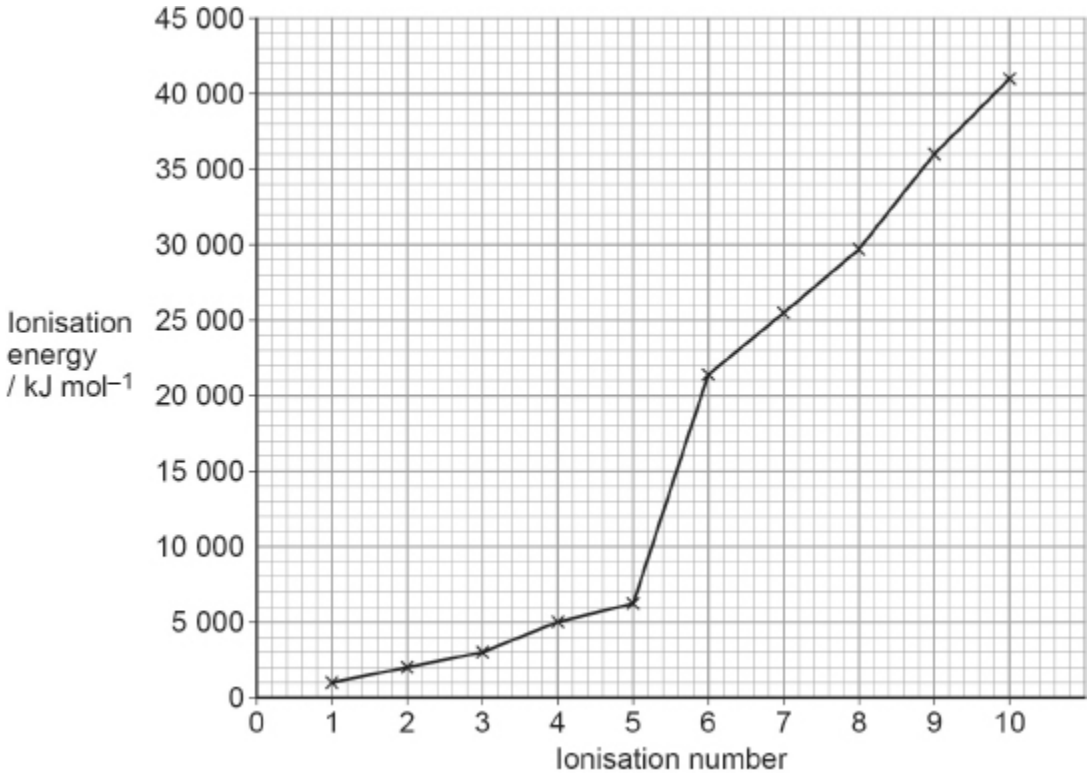
(3)

(b) Give an equation, including state symbols, to represent the process that occurs when the **third** ionisation energy of sodium is measured.

_____

(1)

(c) The graph shows the successive ionisation energies of a Period 3 element, **X**.



Identify element **X**.
Explain your choice.

Element _____

Explanation _____

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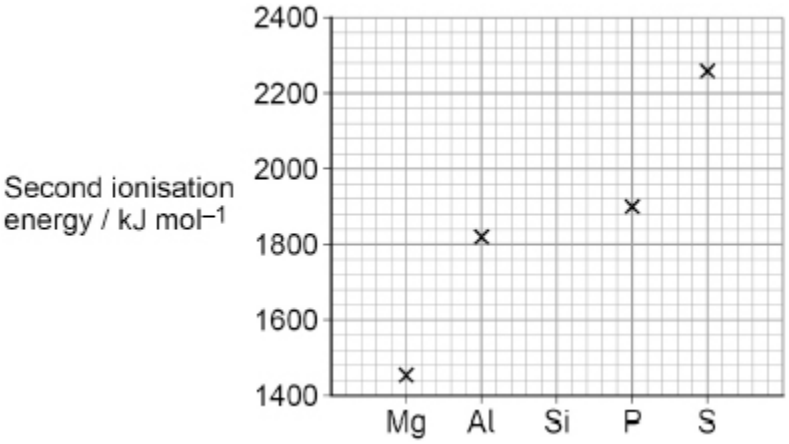
(3)

(Total 7 marks)

2. This question is about Period 3 elements.

The graph shows the **second** ionisation energies of some elements in Period 3.



(a) Draw a cross (x) on the graph above to show the **second** ionisation energy of silicon.

(1)

(b) Identify the element in Period 3, from sodium to argon, that has the highest **second** ionisation energy.

Give an equation, including state symbols, to show the process that occurs when the **second** ionisation energy of this element is measured.

If you were unable to identify the element you may use the symbol **Q** in your equation.

Element _____

Equation

_____

(2)

(c) Explain why the atomic radius decreases across Period 3, from sodium to chlorine.

_____

_____

_____

_____

(2)

(d) Identify the element in Period 3, from sodium to chlorine, that has the highest electronegativity.

_____

(1)

(e) Phosphorus burns in air to form phosphorus(V) oxide.
Give an equation for this reaction.

_____

(1)

(Total 7 marks)

3. This question is about periodicity, the Period 4 elements and their compounds.

(a) State the meaning of the term periodicity.

_____

_____

_____

(1)

(b) Identify the element in Period 4 with the highest electronegativity value.

_____

(1)

(c) Identify the element in Period 4 with the largest atomic radius.

Explain your answer.

Element _____

Explanation _____

_____

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_____

(3)

(d) The equations for two reactions of arsenic(III) oxide are shown.

$$As_2O_3 + 6\ HCl \rightarrow 2\ AsCl_3 + 3\ H_2O$$

$$As_2O_3 + 6\ NaOH \rightarrow 2\ Na_3AsO_3 + 3\ H_2O$$

Name the property of arsenic(III) oxide that describes its ability to react in these two ways.

_____

(1)

(e) Complete the equation for the formation of arsenic hydride.

As_2O_3 + Zn + $HNO_3 \rightarrow$ AsH_3 + $Zn(NO_3)_2$ + H_2O

(1)

(Total 7 marks)

4. This question is about Period 3 of the Periodic Table.

(a) Deduce which of Na^+ and Mg^{2+} is the smaller ion.
Explain your answer.

Smaller ion _____

Explanation _____

_____

_____

_____

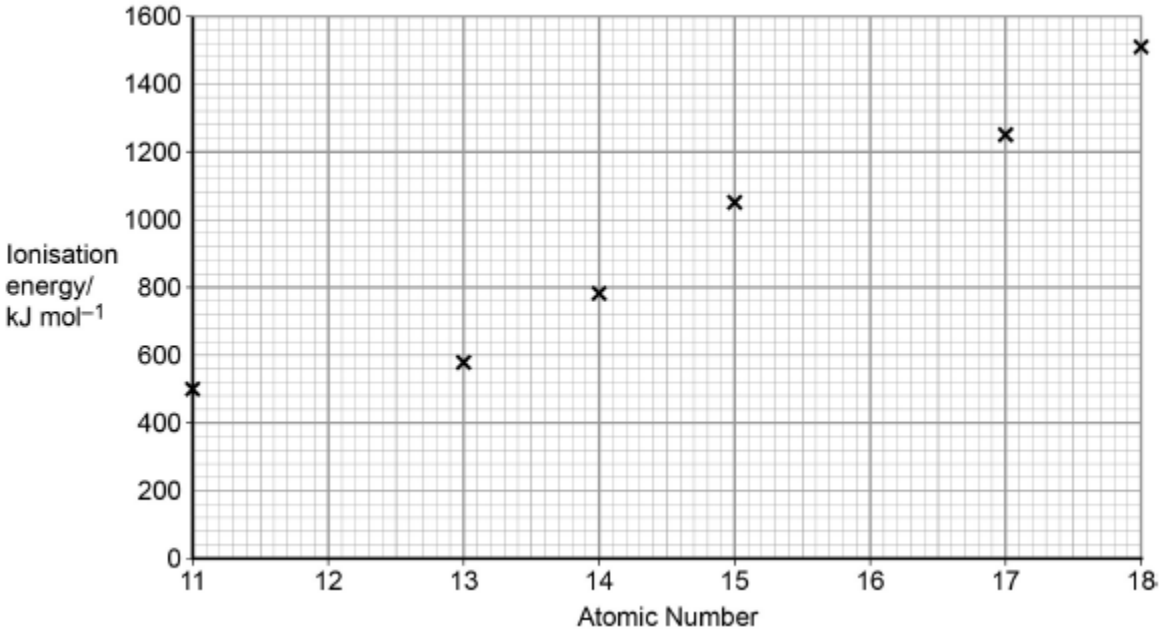
(2)

(b) Write an equation to represent the process that occurs when the first ionisation energy for sodium is measured.

_____

(1)

(c) The first ionisation energies of some Period 3 elements are shown in the following graph.



Complete the graph by plotting the approximate first ionisation energy values for magnesium and sulfur.

Explain why the first ionisation energy of sulfur is different from that of phosphorus.

(4)

(Total 7 marks)

5. This question is about the elements in Period 3 of the Periodic Table.

(a) State the element in Period 3 that has the highest melting point.
Explain your answer.

Element _____

Explanation _____

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_____

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(3)

(b) State the element in Period 3 that has the highest first ionisation energy.
Explain your answer.

Element _____

Explanation _____

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(3)

(c) Suggest the element in Period 3 that has the highest electronegativity value.

_____

(1)

(d) Chlorine is a Period 3 element.
Chlorine forms the molecules ClF_3 and CCl_2

(i) Use your understanding of electron pair repulsion to draw the shape of ClF_3 and the shape of CCl_2
Include any lone pairs of electrons that influence the shape.

Shape of ClF_3 Shape of CCl_2

(2)

(ii) Name the shape of CCl_2

_____

(1)

(iii) Write an equation to show the formation of one mole of ClF_3 from its elements.

_____

(1)

(Total 11 marks)

6. Trends in physical properties occur across all Periods in the Periodic Table.
This question is about trends in the Period 2 elements from lithium to nitrogen.

(a) Identify, from the Period 2 elements lithium to nitrogen, the element that has the largest atomic radius.

_____

(1)

(b) (i) State the general trend in first ionisation energies for the Period 2 elements lithium to nitrogen.

_____

(1)

(ii) Identify the element that deviates from this general trend, from lithium to nitrogen, and explain your answer.

Element _____

Explanation _____

_____

_____

(3)

(c) Identify the Period 2 element that has the following successive ionisation energies.

	First	Second	Third	Fourth	Fifth	Sixth
Ionisation energy / kJ mol^{-1}	1090	2350	4610	6220	37 800	47 000

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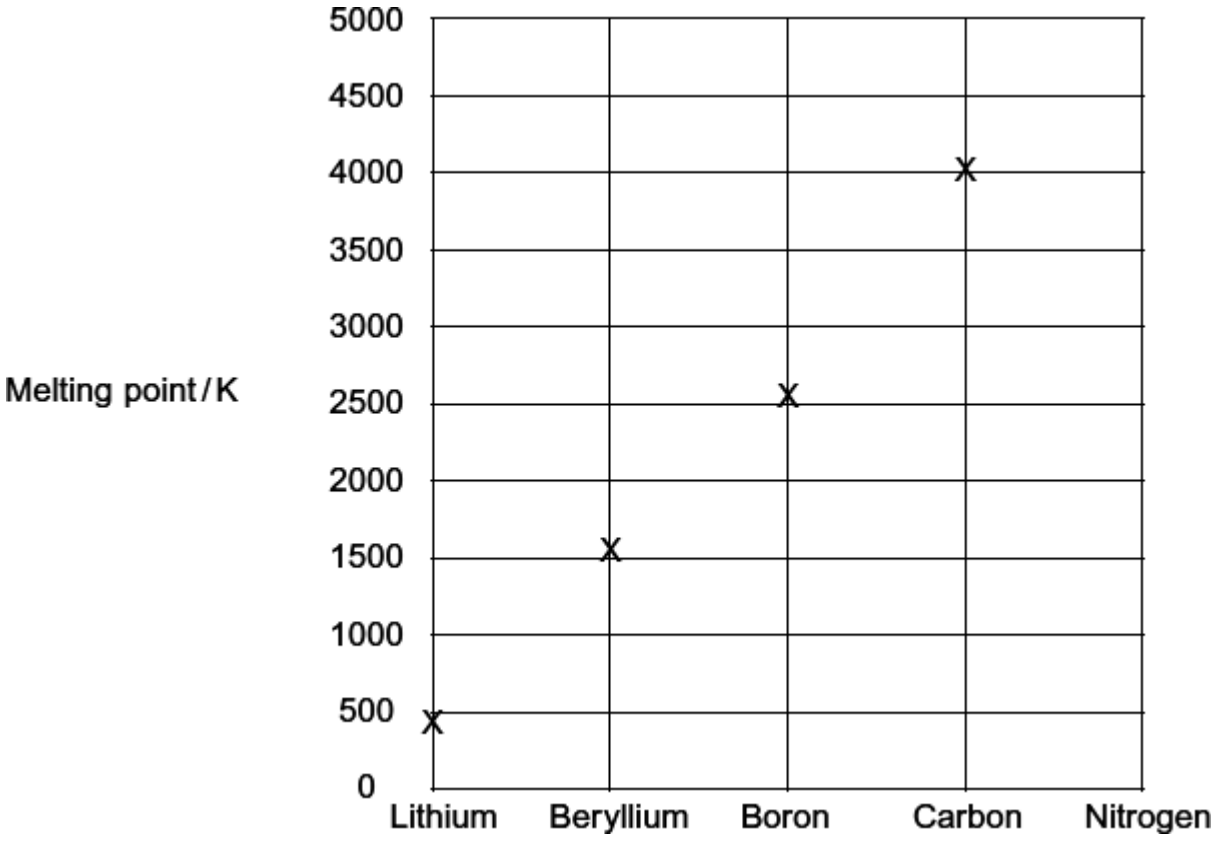
(1)

(d) Draw a cross on the diagram to show the melting point of nitrogen.



(1)

(e) Explain, in terms of structure and bonding, why the melting point of carbon is high.

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(3)

(Total 10 marks)