Atomic Structure and The Periodic Table

Question Paper

Level	A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Atomic Structure and The Periodic Table
Sub Topic	
Booklet	Question Paper
Paper Type	Open-Response 1

Time Allowed: **70 minutes**

Score: **/58**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

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

(a) Write the equation, including state symbols, which represents the first ionization energy of magnesium.

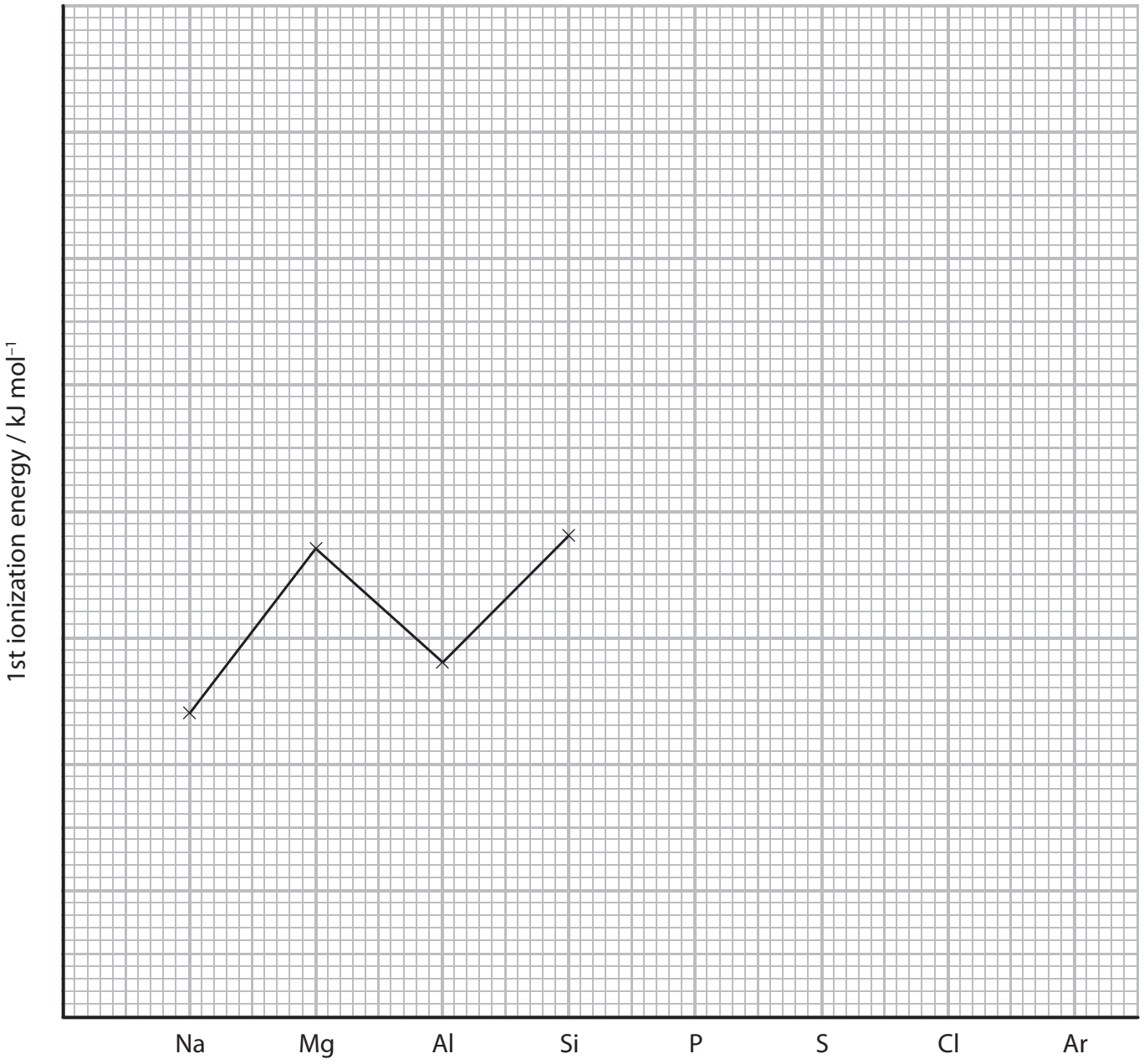
(2)

(b) Complete the electronic configuration for aluminium using s, p notation.

(1)

$1s^2$.....

(c) The sketch graph below shows the first ionization energies of some of the elements in Period 3.



*(i) Explain why the values shown on the graph go down from magnesium to aluminium, and then rise again going from aluminium to silicon.

(3)

(ii) Complete the sketch graph for the elements from phosphorus to argon. Explain why one of these elements does not follow the general trend.

(3)

(d) Draw a dot and cross diagram for silicon tetrachloride, $SiCl_4$, showing outer shell electrons only. Use a cross (×) for silicon electrons and a dot (●) for chlorine electrons.

(2)

(e) Sodium and magnesium are both in Period 3. In sodium iodide, the ions are not polarized but in magnesium iodide some polarization occurs.

*(i) Explain the term **polarization** as it applies to magnesium iodide, and state how it arises.

(3)

(ii) State how thermochemical data could be used to show that there is polarization in magnesium iodide.

(1)

(Total for Question = 15 marks)

2 This question concerns the Periodic Table.

(a) An atom of argon has mass number 40. Complete the table below showing the numbers of sub-atomic particles in this atom of argon. Use the Periodic Table as a source of data.

(1)

Sub-atomic particles present in one atom of ^{40}Ar	Number
protons	
electrons	
neutrons	

(b) An atom of potassium has mass number 39. Explain why argon is placed before potassium in the modern Periodic Table.

(1)

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(c) In the context of the Periodic Table, explain what is meant by the term **periodicity**.

(2)

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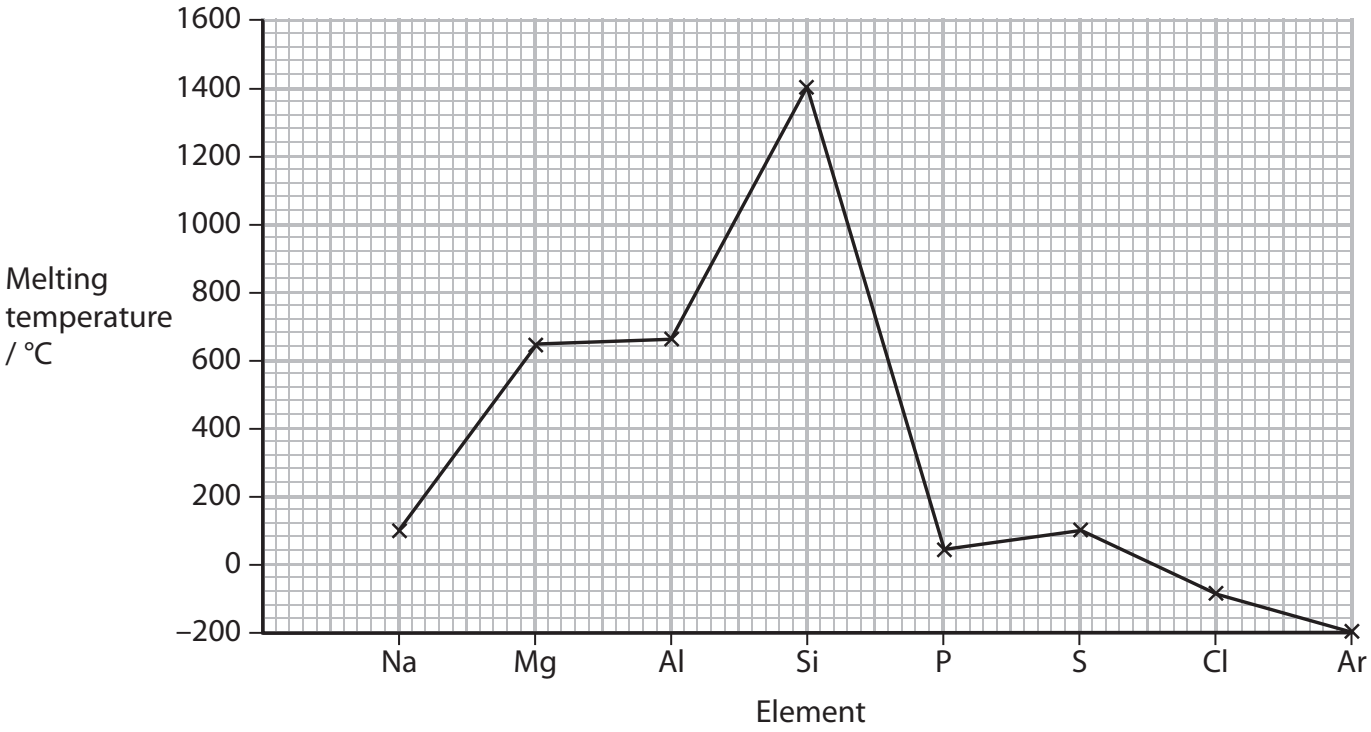
(d) The graph shows the variation in melting temperatures of the elements across Period 3 (Na to Ar) of the Periodic Table.



(i) Name **one** of the elements above that is composed of **simple molecules** at room temperature and pressure.

(1)

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(ii) Silicon has a giant atomic structure. Explain how this structure results in the high melting temperature shown on the graph.

(2)

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(iii) Explain why the melting temperature of magnesium is higher than that of sodium.

(3)

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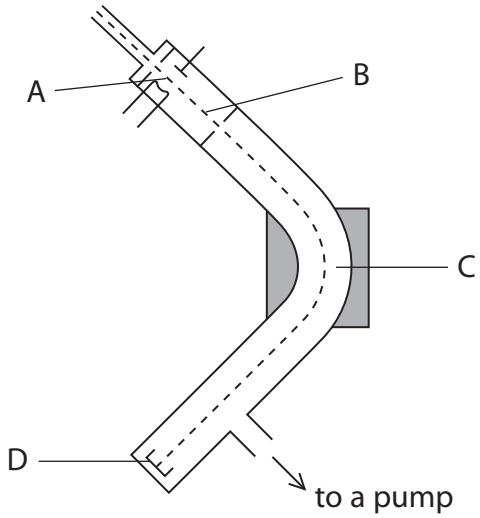
(Total for Question = 10 marks)

3 Naturally occurring samples of potassium contain three isotopes, ^{39}K, ^{40}K and ^{41}K.

(a) The isotopes can be separated in a mass spectrometer.

(i) In the diagram below, particles are ionized at A and detected at D.



Name the **processes** occurring in the mass spectrometer at B and C.

(2)

B .....

C .....

(ii) A sample of potassium has the following composition.

Isotope	^{39}K	^{40}K	^{41}K
% abundance	93.22	0.12	6.66

Calculate the relative atomic mass of this sample of potassium, giving your answer to **two** decimal places.

(2)

(iii) Complete the table below to show the numbers of sub-atomic particles in an atom of each of the isotopes ^{39}K and ^{41}K.

(1)

Isotope	Electrons	Protons	Neutrons
^{39}K			
^{41}K			

(iv) Complete the electronic configuration for an atom of ^{39}K.

(1)

$1s^2$ .....

(v) Why is potassium placed after argon in the Periodic Table, even though it has a smaller relative atomic mass?

(1)

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*(vi) Explain why a potassium ion is smaller than a potassium atom.

(2)

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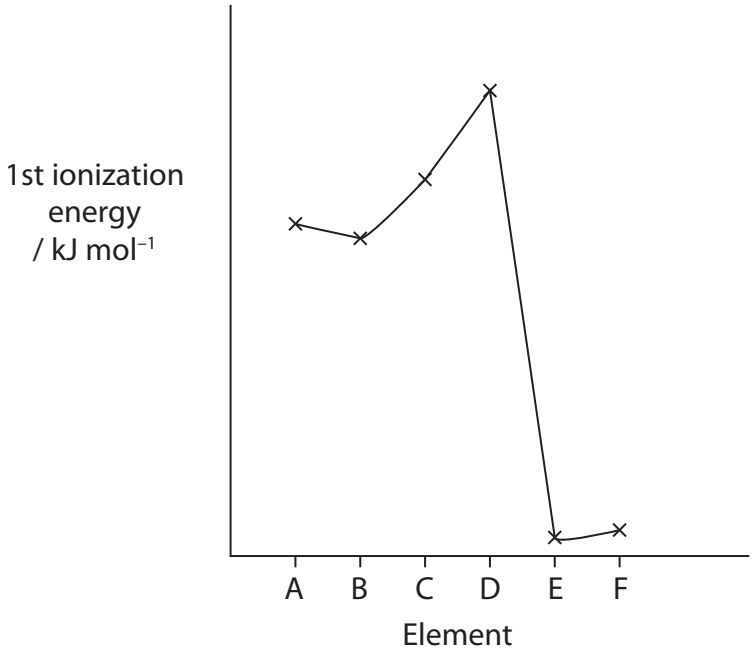
(b) The type of bonding in potassium is metallic.

Draw a labelled diagram to illustrate the metallic bonding in potassium.

(2)

(c) The graph shows the variation of first ionization energy with atomic number for six successive elements in the Periodic Table, including potassium. The letters used to label the elements are not their symbols.



(i) Define the term **first ionization energy**.

(3)

(ii) Identify, with a reason, which element is potassium.

(2)

(Total for Question = 16 marks)

4 The radioactive isotope iodine-131, $^{131}_{53}I$, is formed in nuclear reactors providing nuclear power. Naturally occurring iodine contains only the isotope, $^{127}_{53}I$.

(a) Complete the table to show the number of protons and neutrons in these two isotopes.

(2)

Isotope	$^{131}_{53}I$	$^{127}_{53}I$
Number of protons		
Number of neutrons		

(b) When iodine-131 decays, one of its neutrons emits an electron and forms a proton. Identify the new element formed by name or symbol.

(1)

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(c) The problem with radioactive iodine is that it accumulates in humans in the thyroid gland. Its absorption can be reduced by taking an appropriate daily dose of a soluble iodine compound.

Suggest a suitable iodine compound which could be used.

(1)

Total for Question = 4 Marks

5 This question is about the elements arsenic to rubidium which have atomic numbers 33 to 37.

The first ionization energies, E_{m1}, of these elements are given in the table.

Element	As	Se	Br	Kr	Rb
E_{m1} / kJ mol^{-1}	947	941	1140	1351	403

(a) Write the equation, with state symbols, which represents the first ionization energy of arsenic.

(2)

(b) Suggest the formulae of the hydrides of arsenic and selenium.

(2)

(c) (i) Complete the electronic configuration for an arsenic and a selenium atom using the electrons-in-boxes notation.

(2)

		4s	4p		
As	[Ar] 3d^{10}	↑↓			
Se	[Ar] 3d^{10}	↑↓			

*(ii) Explain why the first ionization energy of selenium is lower than that of arsenic.

(2)

*(d) Explain why the first ionization energy of krypton is higher than that of selenium.

(2)

*(e) Explain why the first ionization energy of rubidium is lower than that of krypton.

(2)

(f) Which of the elements, arsenic to rubidium, is likely to have atoms with the smallest atomic radius?

(1)

(Total for Question = 13 marks)