Periodicity & Trends

Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	The Core Principles of Chemistry
Sub Topic	Periodicity & Trends
Booklet	Question Paper 1

Time Allowed: **76 minutes**

Score: **/63**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 Which of these elements in Period 3 has the highest melting temperature?

☒ **A** Na

☒ **B** Al

☒ **C** Si

☒ **D** P

(Total for Question 1 = 1 mark)

---

2 The first six ionization energies, in kJ mol^{-1}, of an element are

1086, 2353, 4621, 6223, 37832, 47278

In which group of the Periodic Table is this element?

☒ **A** 2

☒ **B** 3

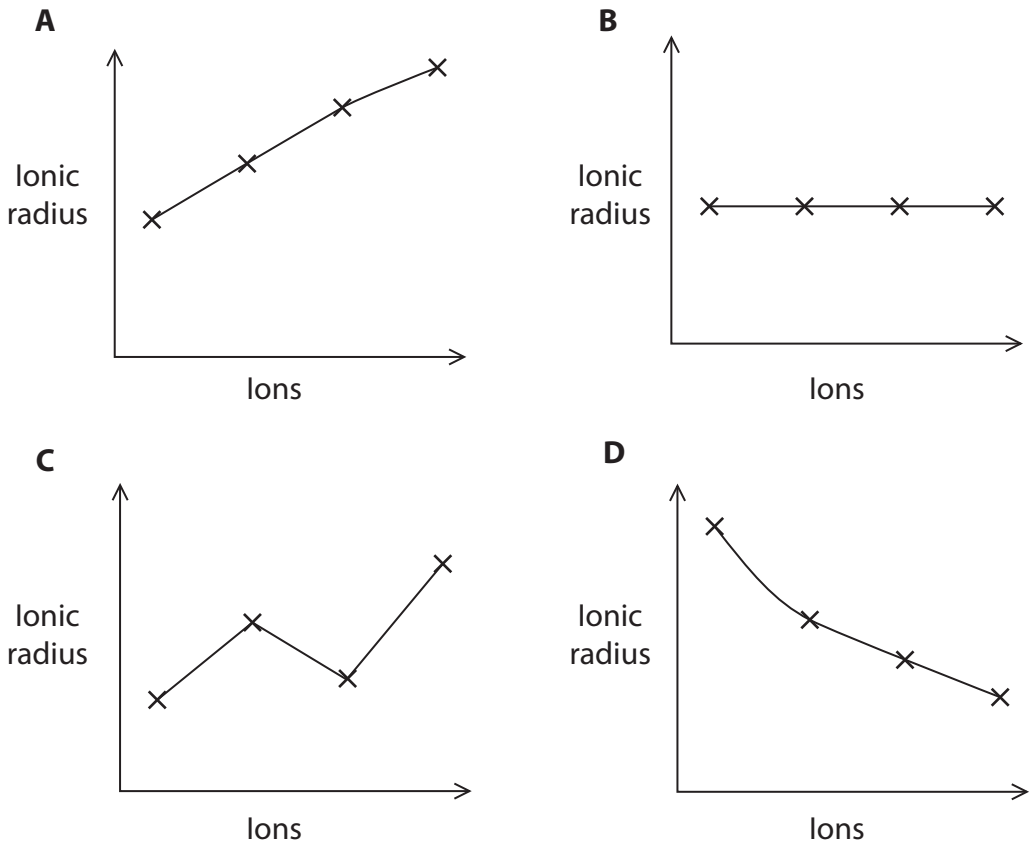
☒ **C** 4

☒ **D** 5

(Total for Question 2 = 1 mark)

---

3 Each diagram shows the trend in the ionic radius for four sequences of ions.
The diagrams are not to scale.



(a) Which diagram shows the trend in the ionic radius for the sequence Li^+, Na^+, K^+, Rb^+?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Which diagram shows the trend in the ionic radius for the sequence Na^+, Mg^{2+}, Al^{3+}, Si^{4+}?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 = 2 marks)

4 The atomic radius of potassium is larger than that of sodium because potassium has

- ☒ **A** a larger nuclear charge.
- ☒ **B** a larger nucleus.
- ☒ **C** more occupied electron shells.
- ☒ **D** a smaller first ionization energy.

(Total for Question 4 = 1 mark)

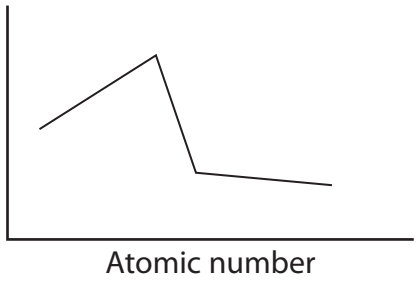
5 Which of the following results in the most polarizing cation?

	Cation radius	Cation charge
☒ **A**	small	small
☒ **B**	small	large
☒ **C**	large	small
☒ **D**	large	large

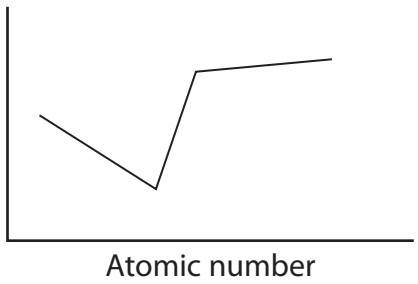
(Total for Question 5 = 1 mark)

6 Which of the following graphs, not drawn to scale, best represents the trend in the melting temperatures of the elements across Period 3, from sodium to argon?

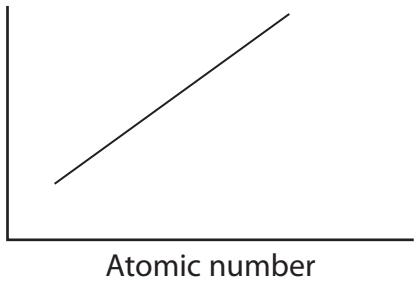
☒ **A**



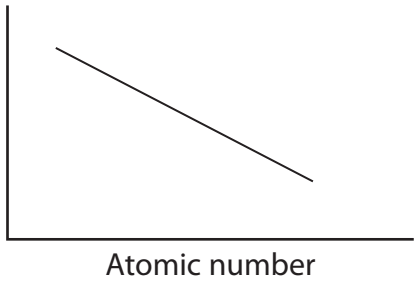
☒ **B**



☒ **C**



☒ **D**



(Total for Question 6 = 1 mark)

7 Which one of the following ions has the smallest radius?

☒ **A** F^-

☒ **B** Mg^{2+}

☒ **C** Na^+

☒ **D** O^{2-}

(Total for Question 7 = 1 mark)

8 In which of the following pairs does the second element have a **lower** 1st ionization energy than the first element?

	First element	Second element
☒ **A**	Si	C
☒ **B**	Na	Mg
☒ **C**	Be	B
☒ **D**	Ar	Ne

(Total for Question 8 = 1 mark)

9 Element X is in Group 3 and element Y is in Group 6 of the Periodic Table.
Which of the following is the most likely formula of the compound formed when X and Y react together?

☒ **A** X_2Y_3

☒ **B** X_3Y_2

☒ **C** X_2Y

☒ **D** XY_2

(Total for Question 9 = 1 mark)

10 Four sequences of ionization energies of elements, in kJ mol^{-1}, are shown below.

A	590	1145	4912	6474	8144
B	520	496	419	403	376
C	1000	1251	1521	419	590
D	631	658	650	653	717

(a) The sequence giving the first ionization energies of elements going down a Group in the Periodic Table is

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) The sequence showing the first five ionization energies of calcium is

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(c) The sequence showing the first ionization energy of successive elements, in which atomic number increases by one each time, starting with an element in Group 6 is

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 10 = 3 marks)

11 Which of the following ions has the **smallest** ionic radius?

☒ **A** Ca^{2+}

☒ **B** K^{+}

☒ **C** S^{2-}

☒ **D** Cl^{-}

(Total for Question 11 = 1 mark)

12 This is a question about ionisation energies.

(a) Define **in words** the term 'first ionisation energy'.

(3)

(b) Write the equation for the **second** ionisation energy of lithium.

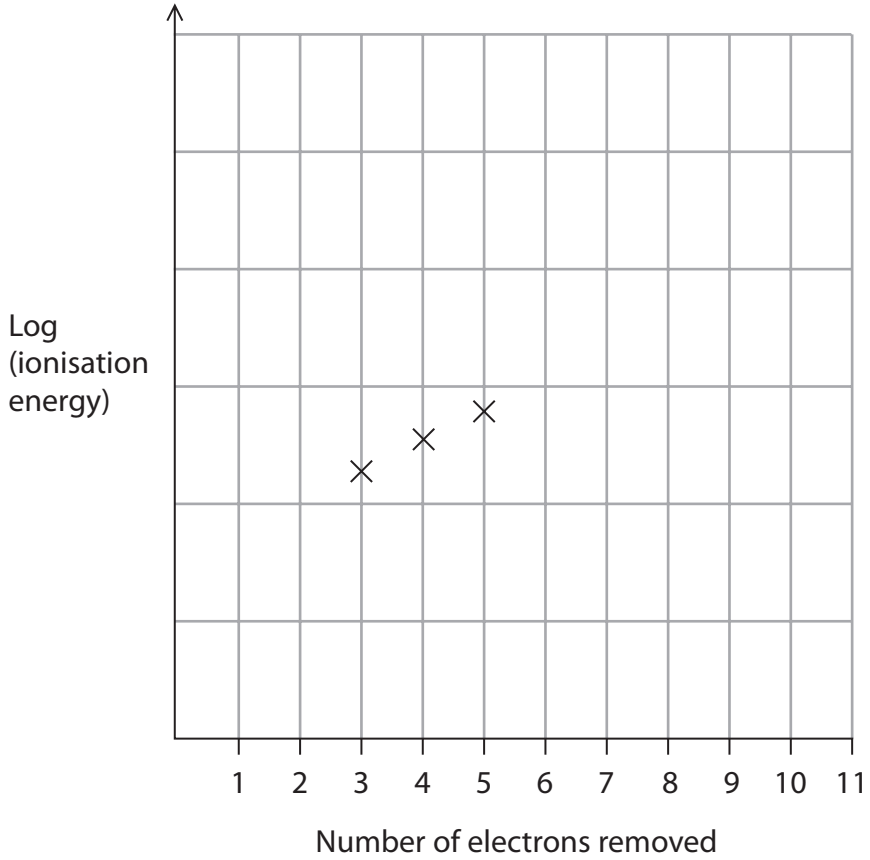
(1)

(c) Why is it not possible to determine the **third** ionisation energy for helium?

(1)

(d) Complete the sketch of the log (ionisation energy) of sodium.

(4)



*(e) Explain why there is a general decrease in the values of the first ionisation energy on descending a group in the Periodic Table.

(3)

*(f) Explain why the first ionisation energy of sulfur is less than that of phosphorus.

(2)

*(g) The first ionisation energy for sodium is +496 kJ mol^{-1} and for magnesium is +738 kJ mol^{-1}. Hence suggest a value for the first ionisation energy of aluminium and justify your choice.

(3)

Ionisation Energy Value: .....

Justification .....

(Total for Question 12 = 17 marks)

13 The first ionization energies for the elements in Period 3 of the Periodic Table are

Element	Na	Mg	Al	Si	P	S	Cl	Ar
First ionization energy / kJ mol^{-1}	496	738	578	789	1012	1000	1251	1521

(a) (i) Complete the electronic configuration of phosphorus, using the electrons-in-boxes notation.

Write the symbols for the sub-shells on the dotted lines.

(2)

1s ....

*(ii) The first ionization energies generally increase from left to right across the period.

Explain why the first ionization energy of sulfur is **lower** than that of phosphorus.

(2)

.....

.....

.....

.....

.....

.....

(iii) Write an equation, with state symbols, to show the **third** ionization energy of phosphorus.

(2)

*(b) (i) Explain why the first ionization energy of nitrogen is greater than the first ionization energy of phosphorus.

(3)

(ii) Draw a dot and cross diagram to show the bonding in a molecule of nitrogen.

Show **outer** electrons only.

(2)

(c) Solid white phosphorus exists as P_4 molecules.

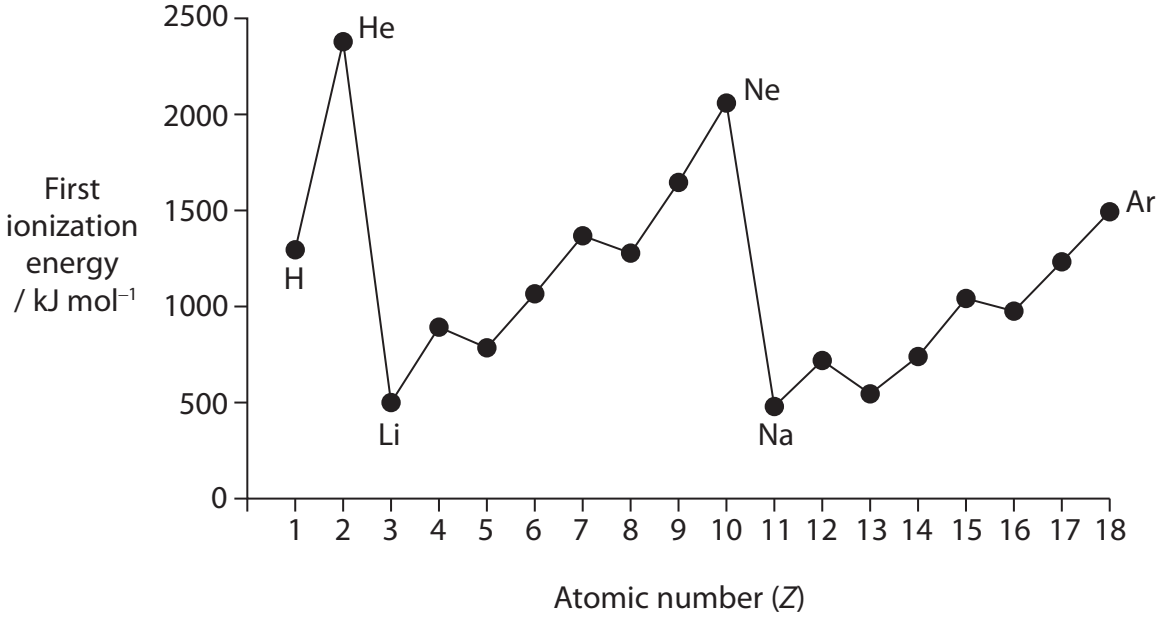
Calculate the number of molecules in 24.8 g of white phosphorus.

[The Avogadro constant, $L = 6.02 \times 10^{23}$ mol^{-1}]

(2)

(Total for Question 13 = 13 marks)

14 The diagram below shows the pattern in the first ionization energies of the first 18 elements.



(a) Give the equation, including state symbols, for the first ionization energy of fluorine.

(2)

*(b) Explain why there is a **general** increase in the first ionization energies from sodium to argon.

(3)

(c) *(i) Explain why the first ionization energy of aluminium ($Z = 13$) is less than that of magnesium ($Z = 12$).

(2)

*(ii) Explain why the first ionization energy of sulfur ($Z = 16$) is less than that of phosphorus ($Z = 15$).

(2)

(d) The table below, which is incomplete, refers to the elements sodium to sulfur.

Element	Na	Mg	Al	Si	P	S
Melting temperature	low	high				
Structure		giant				
Electrical conductivity		high				

(i) Complete the **melting temperature** row by using only the words 'high' or 'low'.

(2)

(ii) Complete the **structure** row by using only the words 'giant' or 'molecular'.

(2)

(iii) Complete the **electrical conductivity** row by using only the words 'high' or 'low'.

(1)

(e) In an experiment, 2.76 g of sodium completely reacted with water to form 500 cm^3 of aqueous sodium hydroxide.

$$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$$

(i) Calculate the number of moles of sodium that reacted.

(1)

(ii) Calculate the maximum volume, in dm^3, of hydrogen that can be formed at room temperature and pressure.

[1 mol of any gas occupies 24 dm^3 at room temperature and pressure.]

(2)

(iii) Calculate the concentration, in mol dm^{-3}, of the sodium hydroxide solution, NaOH(aq), formed in the experiment.

(2)

(Total for Question 14 = 19 marks)