

Structured Questions: Paper 2

3.1 The Periodic Table & Periodic Trends

3.1.1 The Periodic Table / 3.1.2 Periodic Trends: Physical - Atomic & Ionic Radius / 3.1.3 Periodic Trends: Physical - Ionisation Energy / 3.1.4 Periodic Trends: Physical - Electron Affinity / 3.1.5 Periodic Trends: Physical - Electronegativity / 3.1.6 Periodic Trends: Chemical

Easy (5 questions)	/30
Medium (5 questions)	/51
Hard (4 questions)	/43
Total Marks	/124

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Easy Questions

1 (a) Define the term *first ionisation energy* and state what is meant by the term *periodicity*.

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(1 mark)

(b) Distinguish between the terms *group* and *period*.

.....
(1 mark)

(c) State the property that determines the order in which elements are arranged in the periodic table.

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(1 mark)

State the relationship between the electron arrangement of an element and its group and period in the periodic table.

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(d) (2 marks)

2 (a) Explain the following statement.

The first ionisation energy of potassium is smaller than the first ionisation energy of calcium.

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(2 marks)

(b) Explain the following statement.

The first ionisation energy of potassium is larger in value than rubidium

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(2 marks)

(c) Using section 8 of the data booklet, explain the trend of decreasing electronegativity values of the Group 17 elements from F to I.

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(3 marks)

(d) Define the term *electronegativity*.

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(1 mark)

3 (a) Define what is meant by the term *electron affinity*.

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(1 mark)

(b) State whether first electron affinity is an exothermic or endothermic process.

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(1 mark)

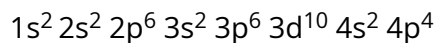
(c) Write an equation, including state symbols, for the first electron affinity of bromine.

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(2 marks)

(d) State whether the first electron affinity of I is more or less exothermic than Br.

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(1 mark)

4 (a) An element has the following electron configuration.



- i) State which block of the periodic table the element is in.
- ii) State how many electrons it has in its outer shell.

(2 marks)

(b) Magnesium can be ionised to form a cation, Mg^+ .

- i) Write the electron configuration of an Mg^+
- ii) Define the term '*first ionisation energy*' in relation to magnesium.

(3 marks)

(c) The periodic table can be divided into blocks.

State why are silicon, carbon, oxygen and chlorine all classified as p-block elements.

(1 mark)

(d) This question is about the periodicity of period 3 elements.

- i) State the trend in atomic radius across period 3.
- ii) State the general trend in first ionisation energies across period 3.

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(2 marks)

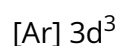
5 (a) Antimony, Sb, has atomic number 51.

Using section 6 of the data booklet, complete the table to show where antimony is found in the periodic table.

Period	Block

(1 mark)

(b) Identify the element that is in the d-block of the periodic table which forms a 3+ ion with the following electron configuration.



(1 mark)

(c) Ionisation energies can provide evidence for electron structure.

Write an equation, including state symbols, for the first ionisation energy of chlorine.

(1 mark)

(d) An element Y has the following six first ionisation energies in kJ mol^{-1} . These are shown in the table below.

	1 st	2 nd	3 rd	4 th	5 th	6 th
Ionisation energy (kJ mol^{-1})	577	1820	2740	11 600	14 800	18 400

State what group of the periodic table this element belongs to.

(1 mark)

Medium Questions

- 1 (a) The periodic table displays the chemical elements, arranged in order of increasing atomic number. It is made up of groups and periods of elements.

State and explain the general trend in first ionisation energy across a period of the periodic table.

(4 marks)

- (b) The general trend in first ionisation energies stated in part (a) is seen across period 2 of the periodic table. However, boron and one other period 2 element deviate from this trend.

Identify this element and explain why it deviates from the general trend.

(3 marks)

- (c) State why nitrogen is classed as a p block element and give its full electron configuration.

(2 marks)

(d) Identify the period 3 element that has the lowest melting point.

Explain your answer with reference to bonding and structure.

(3 marks)

2 (a) The first ionisation energy for all the elements is found in Section 8 of the IB data booklet.

- i) Define the term *first ionisation energy* of an element.
- ii) Write the equation for the first ionisation energy of aluminium.

(3 marks)

(b) The table below shows successive ionisation energies of an element **A**, found in period 3 of the periodic table.

Table 1

Number of electrons	1	2	3	4	5	6	7	8
Ionisation Energy (kJ mol ⁻¹)	1012	1907	2914	4964	6274	21268	25431	29872

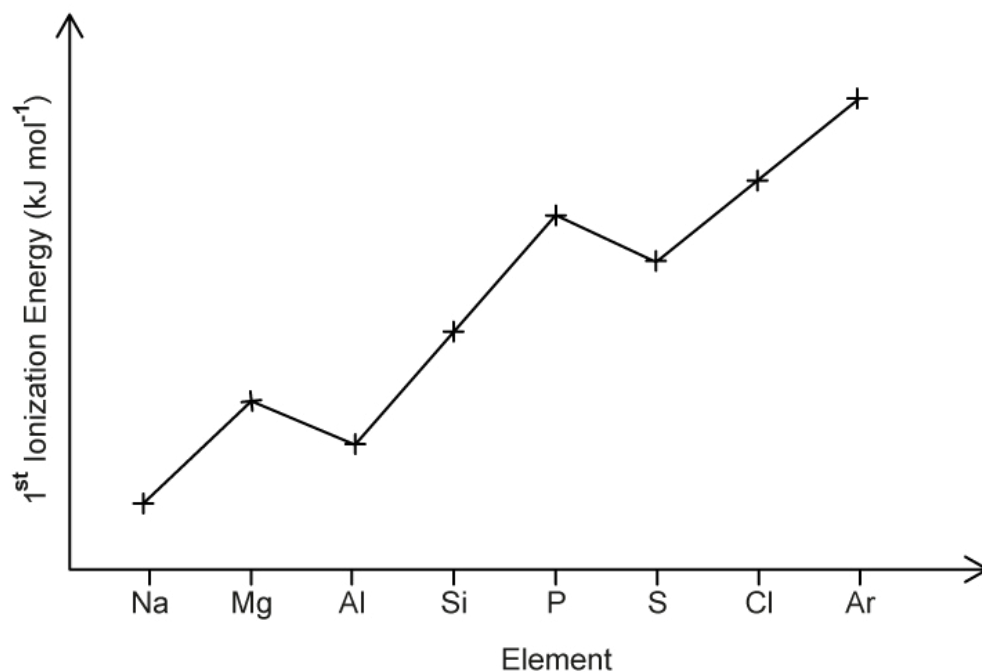
Identify element **A**.

Explain your answer using data from **Table 1**.

(2 marks)

(c) The graph below in **Figure 1** shows some information on the elements of period 3 of the periodic table.

Figure 1



State and explain the trend that this graph shows, including why there are values that deviate from the trend.

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(5 marks)

(d) Explain why the second ionisation energy of aluminium is a larger value than the first ionisation energy.

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(1 mark)

3 (a) This question is about the structure of the periodic table.

Throughout the early history of the periodic table scientists have attempted to order the elements according to different properties.

State the property that is used to order the elements in the modern periodic table.

Outline how the electron configuration of elements is related to their group and period in the periodic table.

(3 marks)

(b) This question is about the element phosphorus.

i) State the group number, period number, and block in which you would find the element phosphorus.

ii) State the full electron configuration of the phosphide ion, P^{3-} .

(2 marks)

(c) Outline why the atomic radius is seen to decrease across period 2 (from lithium to fluorine).

(2 marks)

(d) Gallium forms an ion smaller than its element, whereas arsenic forms an ion larger than its element.

Explain these differences in ionic radius.

(3 marks)

4 (a) Bromine and selenium are both found in period 4 of the periodic table.

State and explain which of the two has a higher electronegativity.

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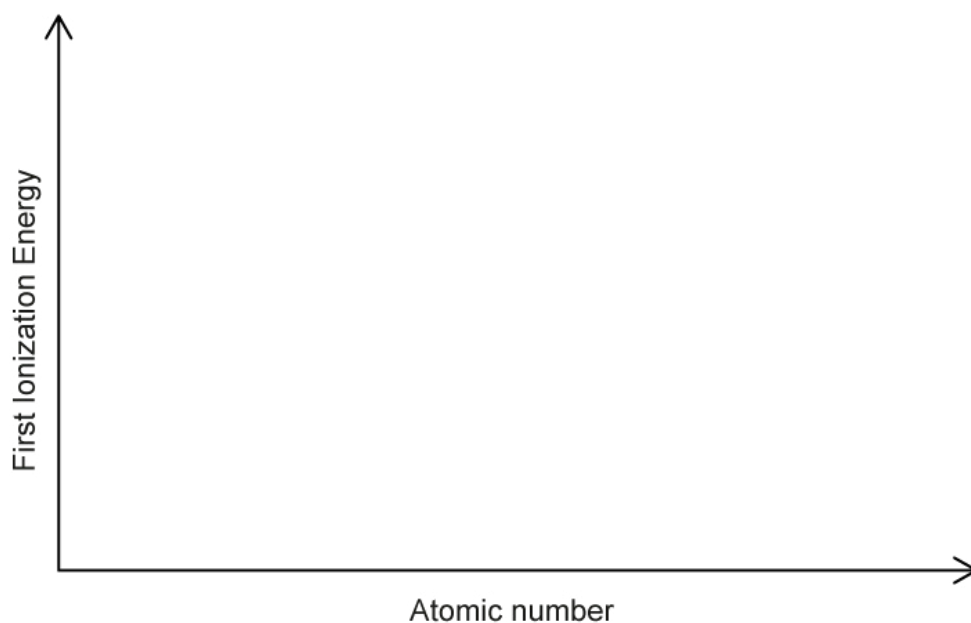
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(3 marks)

(b) Sketch on the axes shown below in **Figure 1**, a graph of the first ionisation energy against atomic number for the elements of group 1.

Figure 1



Explain the trend in ionisation energy down group 1.

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(2 marks)

(c) Discuss the similarities and differences between the trends in atomic radius and ionic radius down group 1 and group 17.

(3 marks)

(d) State how the first ionisation energy of potassium differs from that of:

- i) Calcium
- ii) Rubidium

(2 marks)

5 (a) Group 17 elements are known as highly electronegative non-metal elements.

- i) Define the term *electronegativity*.
- ii) State and explain the trend in *electronegativity* in group 17.

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(2 marks)

(b) Define the term *electron affinity* and write an equation to show the first *electron affinity* of bromine.

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(2 marks)

(c) State, with reasons, whether the first electron affinity of iodine is more or less exothermic than bromine.

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(2 marks)

(d) Suggest why the second electron affinity of oxygen is endothermic.

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(2 marks)

Hard Questions

1 (a) This question refers to the elements in the first three periods of the Periodic Table.

Select an element from the first three periods that fits each of the following descriptions.

i) The element with the highest first ionisation energy [1]

ii) The element that forms a $1-$ ion with the same electron configuration as helium [1]

iii) An element which forms a compound with hydrogen in which the element has an oxidation number of -4 [1]

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(3 marks)

(b) This question is about the elements which have atomic numbers 33 to 37.

The first ionisation energies of these elements are shown in the table below.

Element	As	Se	Br	Kr	Rb
Ionisation energy value in kJ mol^{-1}	947	941	1340	1351	403

i) Suggest the formulae of the hydrides of arsenic and selenium [2]

ii) Explain why the first ionisation energy of rubidium is lower than that of krypton [2]

iii)

State which of the elements, arsenic to rubidium, has atoms with the smallest atomic radius

[1]

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(5 marks)

(c) The first 3 elements of Period 3 show a general increase in melting point.

Explain this trend in melting point across these Period 3 elements.

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(3 marks)

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

Hydrogen can be placed in several different positions in periodic tables. One is immediately above lithium in Group 1 as shown in section 6 of the data booklet. Another is in the centre of the first row.

Evaluate the position of hydrogen when it is placed immediately above lithium and state **one** reason in favour and **two** against.

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(3 marks)

2 (a) This question is about Period 4 of the Periodic Table.

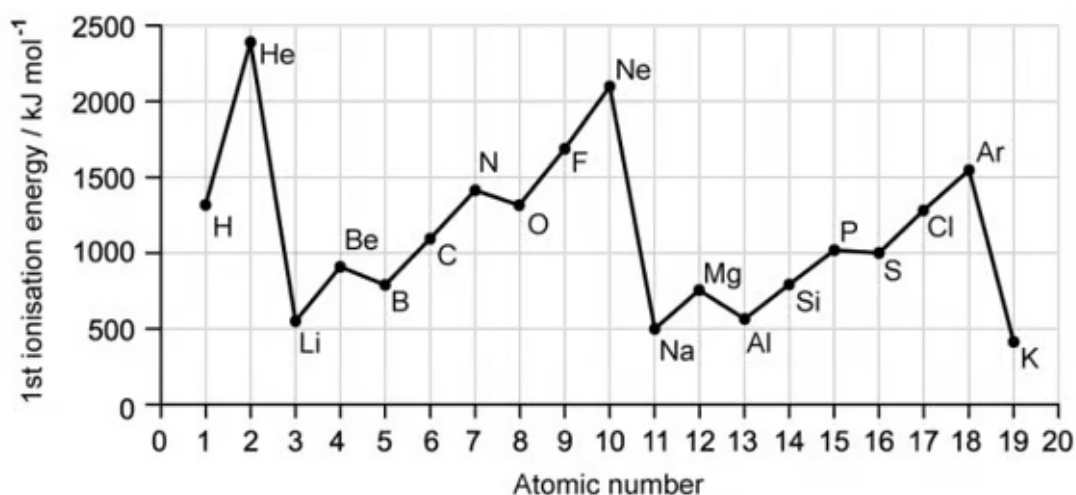
State and explain which of K^+ and Ca^{2+} is the smaller ion.

(2 marks)

(b) Write the electron configuration for a Ca^+ ion.

(1 mark)

(c) The first ionisation energies of the elements H to K are shown below.

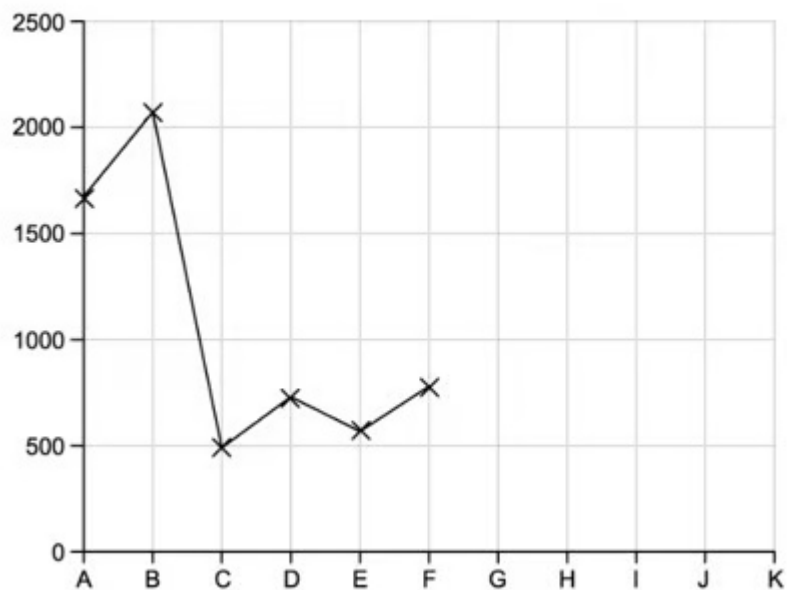


State and explain the trend in first ionisation energies shown by the elements with the atomic numbers 2, 10 and 18.

(4 marks)

3 (a) Electrons in atoms occupy orbitals.

The figure below shows the first ionisation energies for six consecutive elements labelled A–F.



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

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(3 marks)

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

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(2 marks)

(c) 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.

(4 marks)

4 (a) First ionisation energies decrease down groups in the Periodic Table.

Explain this trend and the effect on the reactivity of groups containing metals.

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(3 marks)

(b) The ionisation energy values show a general increase across period 4 from gallium to krypton.

State and explain how selenium deviates from this trend.

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(3 marks)

(c) Give one other element from period 2 or 3 which also deviates from this general trend, similar to selenium.

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(1 mark)

(d) State and explain the trends in electronegativity down group 2 and across period 3.

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(6 marks)