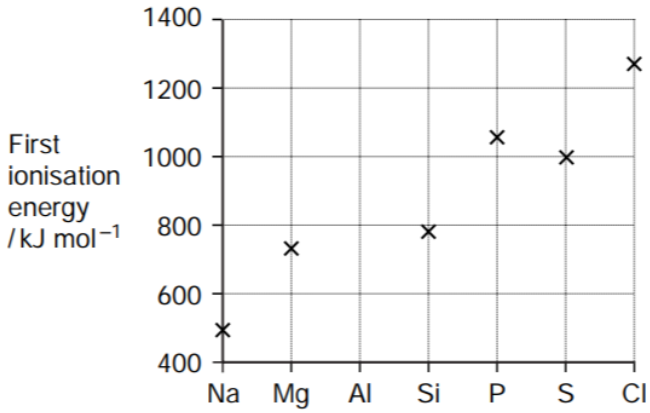
CHAPTER 1 ATOMIC STRUCTURE

1 The following diagram shows the first ionisation energies of some Period 3 elements.



(a) Draw a cross on the diagram to show the first ionisation energy of aluminium.

(1 mark)

(b) Write an equation to show the process that occurs when the first ionisation energy of aluminium is measured.

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(2 marks)

(c) State which of the first, second or third ionisations of aluminium would produce an ion with the electron configuration $1s^2\ 2s^2\ 2p^6\ 3s^1$

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(1 mark)

(d) Explain why the value of the first ionisation energy of sulfur is less than the value of the first ionisation energy of phosphorus.

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(2 marks)

(e) Identify the element in Period 2 that has the highest first ionisation energy and give its electron configuration.

Element .....

Electron configuration .....

(2 marks)

(f) State the trend in first ionisation energies in Group 2 from beryllium to barium. Explain your answer in terms of a suitable model of atomic structure.

Trend.....

Explanation .....

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(3 marks)

2 (a) One isotope of sodium has a relative mass of 23.

(i) Define, in terms of the fundamental particles present, the meaning of the term *isotopes*.

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(ii) Explain why isotopes of the same element have the same chemical properties.

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(iii) Calculate the mass, in grams, of a single atom of this isotope of sodium. (The Avogadro constant, L, is 6.023×10^{23} mol^{-1})

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(5 marks)

(b) Give the electronic configuration, showing all sub-levels, for a sodium atom.

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(1 mark)

(c) An atom has half as many protons as an atom of ^{28}Si and also has six fewer neutrons than an atom of ^{28}Si. Give the symbol, including the mass number and the atomic number, of this atom.

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(2 marks)

3 The values of the first ionisation energies of neon, sodium and magnesium are 2080, 494 and 736 kJ mol^{-1}, respectively.

(a) Explain the meaning of the term *first ionisation energy* of an atom.

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(2 marks)

(b) Write an equation to illustrate the process occurring when the **second** ionisation energy of magnesium is measured.

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(2 marks)

(c) Explain why the value of the first ionisation energy of magnesium is higher than that of sodium.

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(2 marks)

(d) Explain why the value of the first ionisation energy of neon is higher than that of sodium.

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(2 marks)

4 A sample of iron from a meteorite was found to contain the isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe.

(a) The relative abundances of these isotopes can be determined using a mass spectrometer. In the mass spectrometer, the sample is first vaporised and then ionised.

(i) State what is meant by the term *isotopes*.

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(ii) Explain how, in a mass spectrometer, ions are detected and how their abundance is measured.

How ions are detected .....

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How abundance is measured .....

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(5 marks)

(b) (i) Define the term *relative atomic mass* of an element.

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(ii) The relative abundances of the isotopes in this sample of iron were found to be as follows.

m/z	54	56	57
Relative abundance (%)	5.8	91.6	2.6

Use the data above to calculate the relative atomic mass of iron in this sample. Give your answer to one decimal place.

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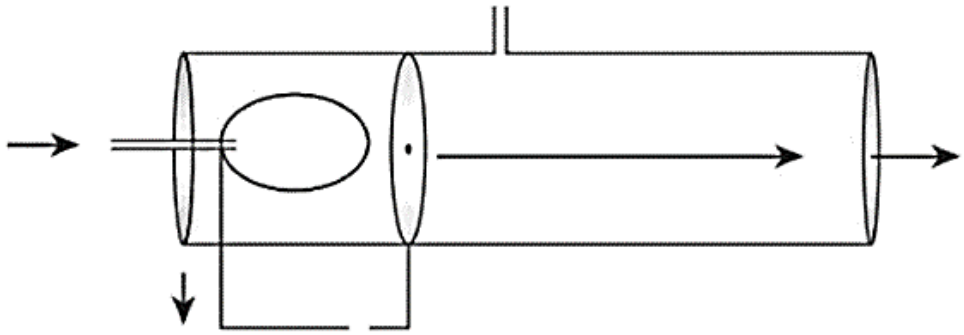
(4 marks)

5 The diagram shows the layout of a time of flight mass spectrometer.



(a) Explain how positive ions are formed from the sample.

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(1 mark)

(b) Explain why the instrument is kept under vacuum.

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(1 mark)

(c) Explain how the ions are accelerated and separated by mass in the instrument.

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(3 marks)

(d) Explain how an electric current is produced when an ion arrives at the detector.

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(1 mark)

(e) The low-resolution mass spectrum of magnesium shows three peaks.

Mass/ charge	Relative abundance / %
24	79.0
25	10.0
26	11.0

(i) Give the number of protons and neutrons in the nuclei of each isotope.

Mass/ charge	Number of protons	Number of neutrons
24		
25		
26		

(1 mark)

(ii) Calculate the relative atomic mass of a sample of magnesium.
Give your answer to the appropriate number of significant figures.

(2 marks)