Name ..... Class: .....

Start Time ..... End Time ..... Time Taken .....

Time allowed: 60 minutes

INSTRUCTIONS TO CANDIDATES

Write your name in the space above.
Fill in the time you start and the time you finish the test.
Answer all the questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part of a question.
The marks allocated and the spaces provided for your answers are a good indication of the length of answers required.

Success Criteria	Questions in Paper	Mark	Out of	%	Rank Order
Fundamental particles	1a, 1b, 2d, 4a		3, 2, 2, 2		
Electron configurations	1c, 2b, 6a, 6b		2, 1, 2, 1		
Periodicity	1d, 2c, 6c		2, 1, 1		
Bonding	1ei, ii, iii,		6		
Equation writing	1eiv		1		
Isotopes	2a		5		
Mass Spectrometry	3, 5a-d		9, 8		
Relative Atomic Mass	3b, 53		2, 4		
Ionisation energies	3c, 3d, 3e		3		
Total			**57**		

Q1.

(a) Complete the following table.

Particle	Relative charge	Relative mass
Proton		
Neutron		
Electron		

(3)

(b) An atom of element **Z** has two more protons and two more neutrons than an atom of $^{34}_{16}S$. Give the symbol, including mass number and atomic number, for this atom of **Z**.

_____

(2)

(c) Complete the electronic configurations for the sulphur atom, S, and the sulphide ion, S^{2-}.

S $1s^2$ _____

S^{2-} $1s^2$ _____

(2)

(d) State the block in the Periodic Table in which sulphur is placed and explain your answer.

Block _____

Explanation _____

(2)

(e) Sodium sulphide, Na_2S, is a high melting point solid which conducts electricity when molten. Carbon disulphide, CS_2, is a liquid which does not conduct electricity.

(i) Deduce the type of bonding present in Na_2S and that present in CS_2

Bonding in Na_2S _____

Bonding in CS_2 _____

(ii) By reference to all the atoms involved explain, in terms of electrons, how Na_2S is formed from its atoms.

_____

_____

(iii) Draw a diagram, including all the outer electrons, to represent the bonding present in CS_2

(iv) When heated with steam, CS_2 reacts to form hydrogen sulphide, H_2S, and carbon dioxide.
Write an equation for this reaction.

_____

(7)

(Total 16 narks)

Q2.

(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*.

_____

_____

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

_____

_____

(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})

_____

_____

_____

(5)

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

_____

(1)

(c) Explain why chromium is placed in the d block in the Periodic Table.

_____

_____

(1)

(d) 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.

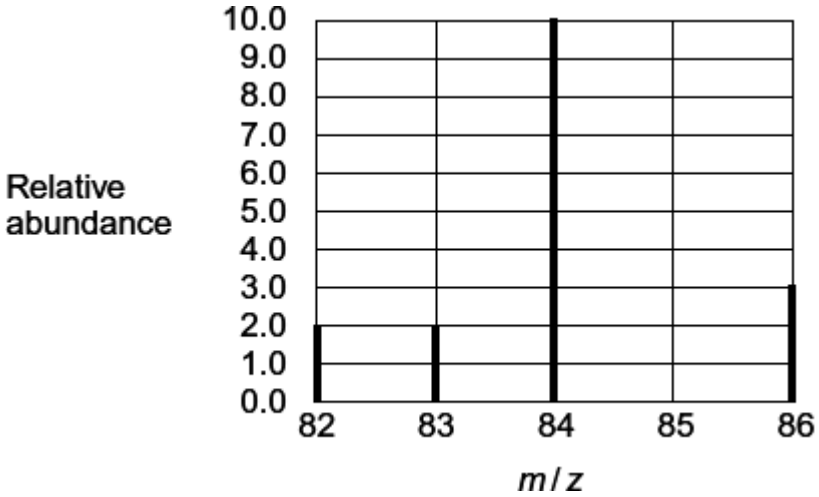
_____

(2)

(Total 9 marks)

Q3.

The mass spectrum of a sample of krypton taken from a meteorite is shown below.



(a) Use this spectrum to calculate the relative atomic mass of this sample of krypton. Give your answer to one decimal place.

Explain why the value you have calculated is slightly different from the relative atomic mass given in the Periodic Table.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) State how krypton is ionised in the mass spectrometer.

Write an equation, including state symbols, to show the reaction that occurs when the **first** ionisation energy of Kr is measured.

Sometimes the mass spectrum of Kr has a very small peak with an *m/z* value of 42. Explain the occurrence of this peak.

(5)

(Total 9 marks)

Q4.

(a) **Table 1** shows some data about fundamental particles in an atom.

Table 1

Particle	proton	neutron	electron
Mass / g	1.6725×10^{-24}	1.6748×10^{-24}	0.0009×10^{-24}

(i) An atom of hydrogen can be represented as ^{1}H

Use data from **Table 1** to calculate the mass of this hydrogen atom.

_____

(1)

(ii) Which **one** of the following is a fundamental particle that would **not** be deflected by an electric field?

A electron

B neutron

C proton

Write the correct letter, **A**, **B** or **C**, in the box.

☐

(1)

(b) A naturally occurring sample of the element boron has a relative atomic mass of 10.8. In this sample, boron exists as two isotopes, ^{10}B and ^{11}B

(i) Calculate the percentage abundance of ^{10}B in this naturally occurring sample of boron.

_____

_____

_____

_____

_____

(2)

(c) Complete **Table 2** by suggesting a value for the third ionisation energy of boron.

Table 2

	First	Second	Third	Fourth	Fifth
Ionisation energy / kJ mol^{-1}	799	2420		25 000	32 800

(1)

(d) Write an equation to show the process that occurs when the **second** ionisation energy of boron is measured. Include state symbols in your equation.

_____

(1)

(e) Explain why the second ionisation energy of boron is higher than the first ionisation energy of boron.

_____

_____

(1)

(Total 8 marks)

Q5.

(a) Explain how ions are accelerated, detected and have their abundance determined in a time of flight (TOF) mass spectrometer.

_____

_____

_____

_____

_____

(3)

(b) Calculate the mass, in kg, of a single $^{52}Cr^{+}$ ion.
Assume that the mass of a $^{52}Cr^{+}$ ion is the same as that of a ^{52}Cr atom.

(The Avogadro constant L = 6.022×10^{23} mol^{-1})

_____

_____

(1)

(c) In a TOF mass spectrometer the kinetic energy (KE) of a $^{52}Cr^{+}$ ion was 1.269×10^{-13} J

Calculate the velocity of the ion using the equation.

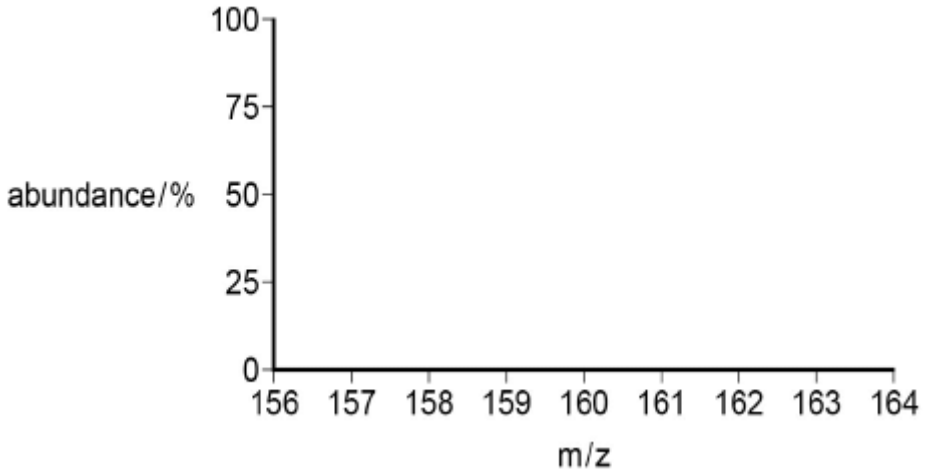
$$KE = \frac{1}{2}mv^2$$

(m = mass/kg and v = velocity/ms^{-1})

(2)

(d) Bromine has two isotopes, ^{79}Br and ^{81}Br, in approximately equal abundance. In a TOF mass spectrometer bromine forms ions with formula $[Br_2]^+$

Sketch the pattern of peaks you would expect to see in the mass spectrum of a sample of bromine.



(2)

(e) A sample of xenon has A_r = 131.31. The sample consists of four isotopes. The abundances of three of the isotopes are shown in the table below. The data for one of the isotopes, ^{m}Xe, is missing.

Isotope	^{129}Xe	^{131}Xe	^{132}Xe	^{m}Xe
% abundance	28.0	25.0	27.0	To be calculated

Use the data to calculate the abundance of isotope ^{m}Xe and calculate m, the mass number of ^{m}Xe. Show your working.

(4)

(Total 12 marks)

Q6.

This question is about electron configuration.

(a) Give the full electron configuration of an Al atom and of a Cr^{3+} ion.

Al atom _____

Cr^{3+} ion _____

(2)

(b) Deduce the formula of the ion that has a charge of 2+ with the same electron configuration as krypton.

(1)

(c) Deduce the formula of the compound that contains 2+ ions and 3− ions that both have the same electron configuration as argon.

(1)

(Total 4 marks)