

Atomic Structure

Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Atomic Structure
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 1

Time Allowed: 68 minutes

Score: /56

Percentage: /100

Grade Boundaries:

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

- 1 (a) Chemists recognise that atoms are made of three types of particle.

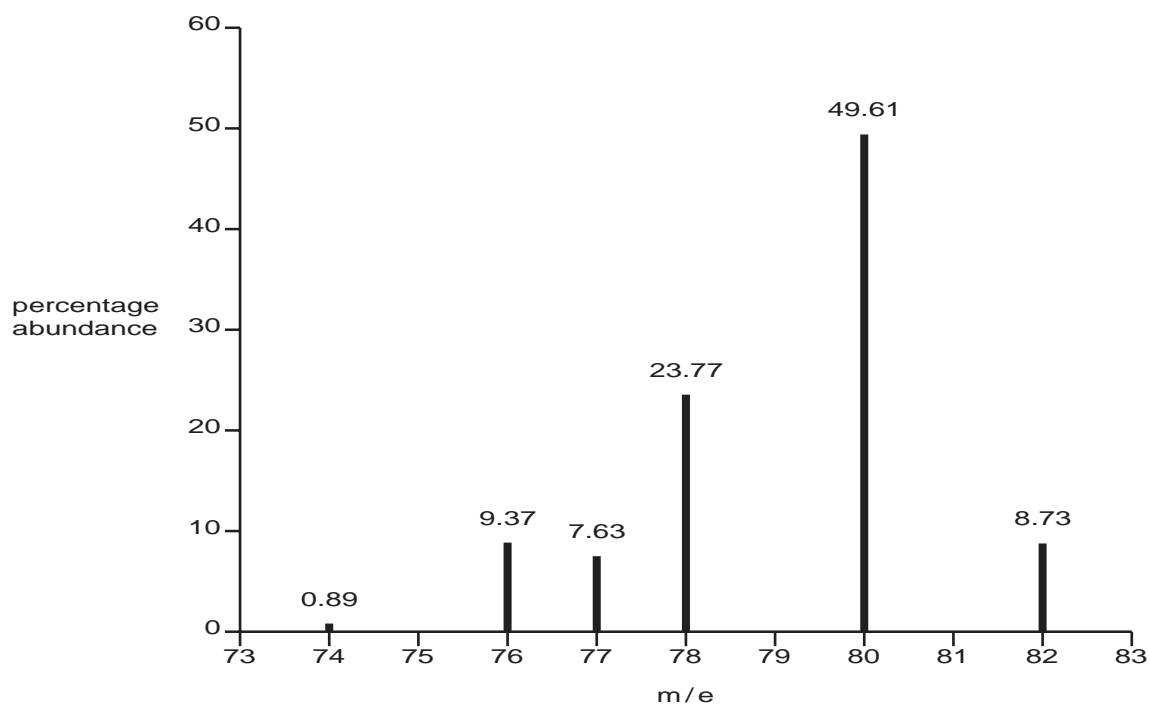
Complete the following table with their names and properties.

name of particle	relative mass	relative charge
		0
	1/1836	

[3]

- (b) The relative atomic mass of an element can be determined using data from its mass spectrum.

The mass spectrum of element X is shown, with the percentage abundance of each isotope labelled.



- (i) Define the terms *relative atomic mass* and *isotope*.

relative atomic mass

.....

.....

isotope

.....

[3]

- (ii) Use the data in the mass spectrum to calculate the relative atomic mass, A_r , of **X**. Give your answer to **two** decimal places and suggest the identity of **X**.

A_r of **X**

- (c) The element tellurium, Te, reacts with chlorine to form a single solid product, with a relative formula mass of 270. The product contains 52.6% chlorine by mass. [2]

- (i) Calculate the molecular formula of this chloride.

molecular formula [3]

- (ii) This chloride melts at 224 °C and reacts vigorously with water.

State the type of bonding **and** structure present in this chloride and explain your reasoning.

.....
.....
.....
..... [2]

- (iii) Suggest an equation for the reaction of this chloride with water.

..... [1]

(d) Sodium and silicon also react directly with chlorine to produce the chlorides shown.

chloride	melting point/°C	difference between the electronegativities of the elements
NaCl	801	2.2
SiCl ₄	-69	1.3

(i) Describe what you would **see** during the reaction between sodium and chlorine.

.....

.....

..... [2]

(ii) Explain the differences between the melting points of these two chlorides in terms of their structure **and** bonding. You should refer to the difference between the electronegativities of the elements in your answer.

NaCl structure **and** bonding

.....

SiCl₄ structure **and** bonding

.....

explanation

.....

.....

.....

..... [4]

[Total: 20]

- 2 (a) Chemists recognise that atoms are made of three types of particle.

Complete the following table with their names and properties.

name of particle	relative mass	relative charge
		+1
	1/1836	

[3]

- (b) Most elements exist naturally as a mixture of isotopes, each with their own relative isotopic mass. The mass spectrum of an element reveals the abundances of these isotopes, which can be used to calculate the relative atomic mass of the element.

Magnesium has three stable isotopes. Information about two of these isotopes is given.

isotope	relative isotopic mass	percentage abundance
²⁴ Mg	24.0	79.0
²⁶ Mg	26.0	11.0

- (i) Define the term *relative isotopic mass*.

.....

 [2]

- (ii) The relative atomic mass of magnesium is 24.3.

Calculate the percentage abundance and hence the relative isotopic mass of the third isotope of magnesium. Give your answer to **three** significant figures

percentage abundance =

isotopic mass =

[3]

(c) Magnesium can be produced by electrolysis of magnesium chloride in a molten mixture of salts.

(i) Give equations for the anode and cathode reactions during the electrolysis of molten magnesium chloride, $MgCl_2$.

anode

cathode

[2]

The electrolysis is carried out under an atmosphere of hydrogen chloride gas to convert any magnesium oxide impurity into magnesium chloride.

(ii) An investigation of the reaction between magnesium oxide and hydrogen chloride gas showed that an intermediate product was formed with the composition by mass Mg, 31.65%; O, 20.84%; H, 1.31% and Cl, 46.20%.

Calculate the empirical formula of this intermediate compound.

empirical formula [2]

(d) The acid/base behaviour of the oxides in the third period varies across the period.

(i) Describe this behaviour and explain it with reference to the structure and bonding of sodium oxide, Na_2O , aluminium oxide, Al_2O_3 , and sulfur trioxide, SO_3 .

.....

.....

..... [2]

(ii) Write equations for reactions of these three oxides with hydrochloric acid and/or sodium hydroxide as appropriate.

.....

.....

.....

..... [4]

[Total: 18]

3 Neon is a noble gas.

(a) Complete the full electronic configuration of neon.

1s² [1]

(b) (i) Explain what is meant by the term *first ionisation energy*.

.....
.....
..... [3]

(ii) Explain why the first ionisation energy of neon is greater than that of fluorine.

.....
..... [2]

(c) Neon has three stable isotopes.

isotope	mass number	percentage abundance
1		9.25
2	20	90.48
3	21	0.27

(i) Define the term *relative atomic mass*.

.....
..... [2]

(ii) Use the relative atomic mass of neon, 20.2, to calculate the mass number of isotope 1.

mass number = [2]

(d) A mixture of neon and argon has a mass of 0.275 g. The mixture was placed in a gas syringe at a temperature of 25 °C and a pressure of 100 kPa. Under these conditions the mixture was found to occupy a volume of 200 cm³.

(i) Calculate the average M_r of the mixture.

average M_r = [2]

(ii) Use your answer to (i) to calculate the percentage of neon in the mixture. Give your answer to **three** significant figures.

percentage of neon = % [1]

(e) Neon and argon can both be obtained by fractional distillation of liquid air as they have different boiling points.

Neon has a boiling point of 27.3 K. The boiling point of argon is 87.4 K.

(i) Name the force that has to be overcome in order to boil neon or argon and explain what causes it.

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.....
..... [3]

(ii) Explain why argon has a higher boiling point than neon.

.....
.....
..... [2]

[Total: 18]