Separate Science (Chemistry) Unit 1 Atomic structure and the periodic table

Foundation

Question number	Description	Marks	Page number
4.1.1 Atomic model			
1	Atomic structure multiple choice, completing energy level diagram, explaining why atoms are neutral, matching state of matter with particle diagram	10	5
1	Naming parts of an atom, identify atom group from diagram, atomic number and mass from diagram, isotopes multiple choice	8	8
1	Separation method and name matching, suggesting improvement to separation apparatus, separation gap fill, percentage calculation from alloy diagram (4.2.2 alloys multiple choice), calculating volume of a cube	11	11
2	Completing table on sub atomic particles, determining number of sub atomic particles from a diagram, matching atomic model with stage in atomic model development	8	15
3	Atomic structure gap fill, A_r of isotope calculation, using periodic table to identify element calculated, calculating radius of nucleus when given radius of atom.	10	17
3	Identifying compounds, mixture etc from diagrams, matching separation methods and what is separated, drawing apparatus for separating sand and water, describing distillation to produce pure water from salt solution	13	19
6	Describing method to measure mass of dissolved salt in $25cm^3$ of seawater	5	24
4.1.2 The periodic table			
2	Naming group 1 elements, suggesting safety precaution for lithium and water, giving two observations to describe trend in reactivity from a table of observation on group one reacting water, balancing sodium and water symbol equation, naming sodium hydroxide from symbol equation, predicting diameter of atom in a table, converting measurement in nanometres into standard form, describing trends in a graph	13	25

2	Describing trend in group one melting points from a graph, determining values from a graph, matching substances with description, balancing symbol equation, **calculating M_r**	9	30
2	Number of electrons in bromine outer shell, (4.2.1 bonding in hydrogen bromide), formula of fluorine gas, explaining reactivity of halogens in group 7 using results from table, **calculating M_r of a compound, calculating percentage yield after converting units in the question**	9	33
2	Group number of halogens, (4.2.1 drawing dot and cross diagram for fluorine molecule), complete word equation for halogen displacement reaction, displacement reaction gap fill, balancing symbol equation (4.2.2 explain why fluorine is a gas at room temperature)	13	36
3	Development of periodic table multiple choice and gap fill, (4.1.1 atomic structure recall and electron structure)	8	39
4	Balancing symbol equation, group one and seven gap fill, comparing size of potassium and sodium atoms	11	42
7	Completing word equation for sodium and oxygen, naming substance from symbol formula, **calculating mass of compound in volume of concentration in g/dm^3**, plotting data from results table on graph, using graph to make a prediction	10	44
4.1.3 Properties of transition metals			
9	(4.1.1 number of subatomic particles for an atom), two differences between properties of group one and transition metal (4.4.1 explaining why carbon used to extract nickel from oxide), **calculating percentage atom economy to three significant figures**	11	48

Common content

Question number	Description	Marks	Page number
4.1.2 The periodic table			
1	Why Mendeleev reversed position of elements, explaining why Mendeleev periodic table was accepted over previous versions, arrangement of elements in periodic table, formula and state of	10	50

	astatine at room temperature, describing reaction between sodium and chlorine		

Higher

Question number	Description	Marks	Page number
4.1.1 Atomic model			
4	Completing table on sub atomic particles, define mass number, why mass is different in isotopes, explaining how alpha particle scattering experiment changed the plum pudding model of the atom	8	53
4	Multiple choice questions on model of the atom diagrams, define mass number, estimate A_r when given isotope abundances, explain how Chadwick's work led to a better understanding of the atom	8	55
4.1.2 The periodic table			
4	Order of elements in early periodic table, how Mendeleev overcame elements in wrong group, (4.2.2 explaining why halogens have low boiling points and trend in boiling points in group 7), electron structure of neon to explain why neon is unreactive, **calculating how many atoms of argon are in 1g**	11	57
4	(4.2.1 dot and cross diagram for fluorine), number of electrons in a fluorine atom, balancing symbol equation, explaining why chlorine is more reactive than bromine	9	60
4	(4.1.1 electron structure of sodium atom), safety precautions when reacting sodium with water, explaining how diameter of group one elements from a table affects reactivity	8	62
6	Balanced symbol equation for sodium reacting with chlorine, describing observations before, during and after reaction between sodium and chlorine, explain why sodium is less reactive than potassium (4.2 compare structure and bonding in NaCl and HCl – 6 marks)	14	65
4.1.3 Properties of transition metals			

8	Titanium as transition metal is context, question very mixed. Hazard from a symbol equation of industrial reaction, reason why hazard if water comes into contact with sodium, suggesting reason argon used as atmosphere for reaction not air, (4.2.2 explaining why would not expect $TiCl_4$ to be liquid at room temperature), (4.2.1 describe oxidation and oxidation half equation) **Explain using calculations limiting reactant in a given symbol equation, calculate actual mass from a percentage yield**	15	68

Do not write outside the box

0 1 An argon atom can be represented as $^{40}_{18}Ar$

0 1 . 1 What does the number 40 represent in $^{40}_{18}Ar$?

[1 mark]

0 1 . 2 How many protons does this atom of argon have?

[1 mark]

Tick **one** box.

18 ☐

22 ☐

40 ☐

58 ☐

0 1 . 3 How many neutrons does this atom of argon have?

[1 mark]

Tick **one** box.

18 ☐

22 ☐

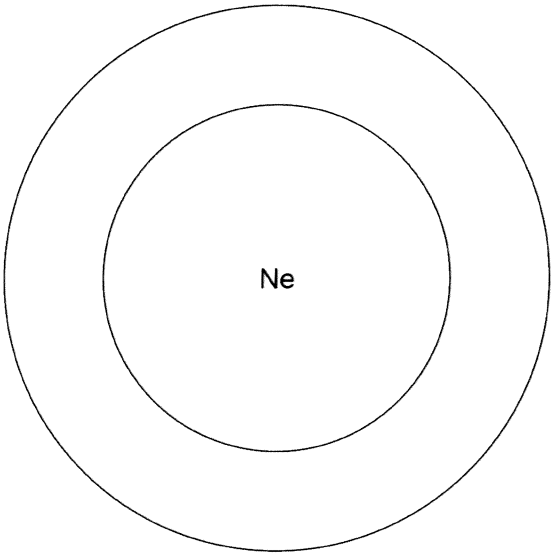
40 ☐

58 ☐

Do not write outside the box

Figure 1 shows the energy levels (shells) in a neon atom.

Figure 1



0 1 . 4 A neon atom has 10 electrons.

Complete **Figure 1** to show the electronic structure of a neon atom.

Use **x** to represent an electron.

[1 mark]

0 1 . 5 The nucleus of a neon atom has a charge.

What is the charge?

[1 mark]

Tick **one** box.

Negative ☐

Neutral ☐

Positive ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 6 A neon atom has 10 protons, 10 electrons and 10 neutrons.

Explain why there is no overall charge on a neon atom.

[2 marks]

0 1 . 7 There are two different types of neon atom.

What are these different types of atom called?

[1 mark]

Tick **one** box.

Compounds ☐

Ions ☐

Isotopes ☐

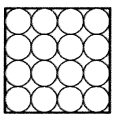
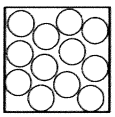
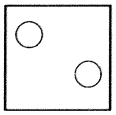
Molecules ☐

0 1 . 8 Neon is a gas.

The states of matter can be shown by a simple particle model.

Draw **one** line from each state of matter to the correct particle model.

[2 marks]

State of matter	Particle model
Gas	
Liquid	
Solid	

10

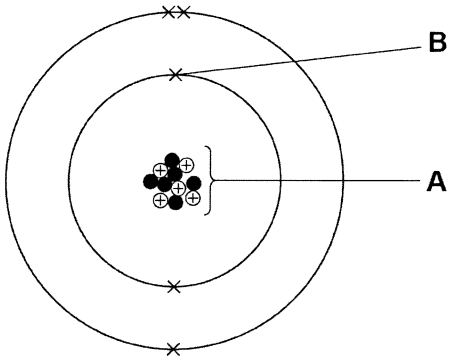
Answer **all** questions in the spaces provided.

Do not write outside the box

0 1 This question is about atomic structure.

Figure 1 represents an atom of element **Z**.

Figure 1



0 1 . 1 Name the parts of the atom labelled **A** and **B**.

Choose answers from the box.

[2 marks]

electron	**neutron**	**nucleus**	**proton**

A _____

B _____

Do not write outside the box

0 1 . 2 Which particle has the lowest mass?

Choose the answer from the box.

[1 mark]

electron	**neutron**	**nucleus**	**proton**

0 1 . 3 Which group of the periodic table contains element **Z**?

Use **Figure 1**.

[1 mark]

Group _____

0 1 . 4 Give the atomic number and the mass number of element **Z**.

Use **Figure 1**.

Choose answers from the box.

[2 marks]

1	**5**	**6**	**11**	**16**

Atomic number _____

Mass number _____

Question 1 continues on the next page

Do not write outside the box

Bromine has two different types of atom.

The atoms have a different number of neutrons but the same number of protons.

0 1 . 5 What is the name for this type of atom?

[1 mark]

Tick (✓) **one** box.

Compound ☐

Ion ☐

Isotope ☐

Molecule ☐

0 1 . 6 The different types of bromine atom can be represented as $^{79}_{35}Br$ and $^{81}_{35}Br$

The relative atomic mass (A_r) of bromine is 80

Which statement is true about the number of each type of atom in bromine?

[1 mark]

Tick (✓) **one** box.

There are fewer $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are more $^{79}_{35}Br$ atoms than $^{81}_{35}Br$ atoms. ☐

There are the same number of $^{79}_{35}Br$ atoms and $^{81}_{35}Br$ atoms. ☐

8

Do not write outside the box

0 1 This question is about mixtures.

0 1 . 1 Substances are separated from a mixture using different methods.

Draw **one** line from each substance and mixture to the best method of separation.

[3 marks]

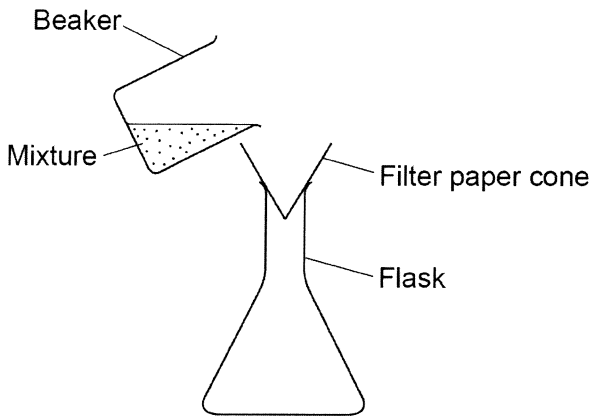
Substance and mixture	Method of separation
Ethanol from ethanol and water	Chromatography
Salt from sea water	Crystallisation
The different colours in black ink	Electrolysis
	Filtration
	Fractional distillation

Do not write outside the box

0 1 . 2 A student filters a mixture.

Figure 1 shows the apparatus.

Figure 1



Suggest **one** improvement to the apparatus.

[1 mark]

_____

_____

0 1 . 3 Complete the sentences.

Choose answers from the box.

[2 marks]

condense	evaporate	freeze	melt	solidify

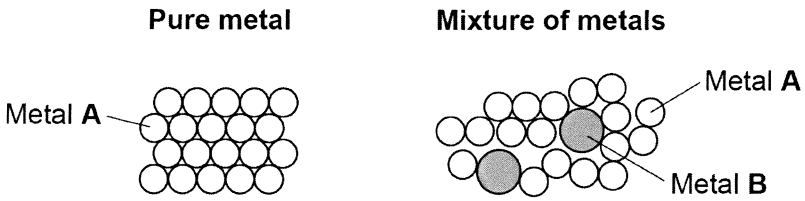
In simple distillation, the mixture is heated to make the liquid _____.

The vapour is then cooled to make it _____.

Do not write outside the box

Figure 2 shows the arrangement of atoms in a pure metal and in a mixture of metals.

Figure 2



0 1 . 4 Calculate the percentage of metal **B** atoms in the mixture of metals shown in **Figure 2**.

[2 marks]

Percentage of metal **B** atoms = _____ %

0 1 . 5 What is a mixture of metals called?

[1 mark]

Tick **one** box.

- An alloy ☐
- A compound ☐
- A molecule ☐
- A polymer ☐

Do not write outside the box

0 1 . 6 Why is the mixture of metals in **Figure 2** harder than the pure metal?

[1 mark]

Tick **one** box.

The atoms in the mixture are different shapes. ☐

The layers in the mixture are distorted. ☐

The layers in the mixture slide more easily. ☐

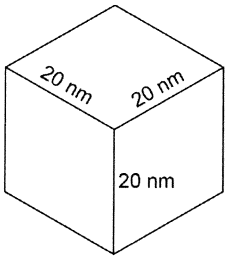
The mixture has a giant structure. ☐

0 1 . 7 A nanoparticle of pure metal **A** is a cube.

Each side of the cube has a length of 20 nm.

Figure 3 shows the cube.

Figure 3



What is the volume of the nanoparticle?

[1 mark]

Tick **one** box.

20 nm^3 ☐

60 nm^3 ☐

400 nm^3 ☐

8000 nm^3 ☐

11

Do not write outside the box

0 2 **Table 1** shows the relative mass and charge of the particles in an atom.

Table 1

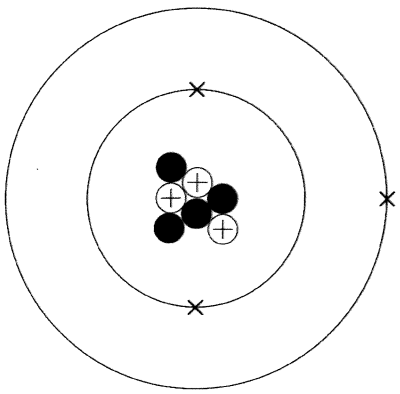
Name of particle	Relative mass	Charge
proton	1	+1
neutron		
electron	very small	

0 2 . 1 Complete **Table 1**.

[3 marks]

0 2 . 2 **Figure 2** represents a lithium atom.

Figure 2



Give the number of protons, neutrons and electrons in the lithium atom shown in **Figure 2**.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

Do not write outside the box

0 2 . 3 Scientific models of the atom have changed over time.

Draw **one** line from each description of the atomic model to the stage in the development of the atomic model.

[2 marks]

Description of atomic model	Stage in the development of the atomic model
	Dalton atoms
A ball of positive charge with electrons embedded in it	Neutrons discovered
Spherical atoms	Nucleus of atoms discovered
	Plum pudding model

8

Turn over for the next question

Do not write outside the box

0 3 This question is about the structure of the atom.

0 3 . 1 Complete the sentences.

Choose answers from the box.

Each word may be used once, more than once, or not at all.

[5 marks]

electron	**ion**	**neutron**
nucleus	**proton**	

The centre of the atom is the _____.

The two types of particle in the centre of the atom are the proton and the _____.

James Chadwick proved the existence of the _____.

Niels Bohr suggested particles orbit the centre of the atom. This type of particle is the _____.

The two types of particle with the same mass are the neutron and the _____.

Table 2 shows information about two isotopes of element **X**.

Table 2

	Mass number	**Percentage (%) abundance**
Isotope 1	63	70
Isotope 2	65	30

Do not write outside the box

0 3 . 2 Calculate the relative atomic mass (A_r) of element **X** using the equation:

$$A_r = \frac{\text{(mass number} \times \text{percentage) of isotope 1 + (mass number} \times \text{percentage) of isotope 2}}{100}$$

Use **Table 2**.

Give your answer to 1 decimal place.

[2 marks]

A_r = _____

0 3 . 3 Suggest the identity of element **X**.

Use the periodic table.

[1 mark]

Element **X** is _____

0 3 . 4 The radius of an atom of element **X** is 1.2×10^{-10} m

The radius of the centre of the atom is $\frac{1}{10\,000}$ the radius of the atom.

Calculate the radius of the centre of an atom of element **X**.

Give your answer in standard form.

[2 marks]

Radius = _____ m

10

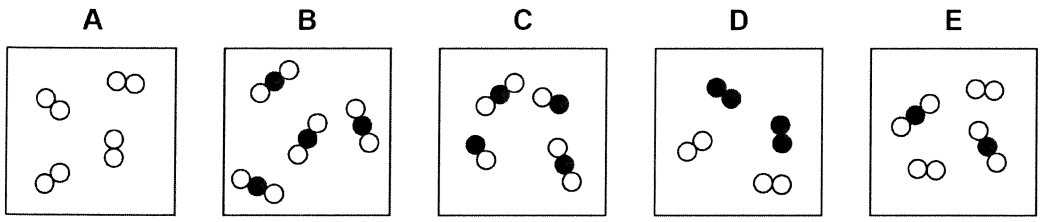
Do not write outside the box

0 3 This question is about elements, compounds and mixtures.

Figure 5 shows five different substances, **A**, **B**, **C**, **D** and **E**.

○ and ● represent atoms of different elements.

Figure 5



Use **Figure 5** to answer Questions **03.1** to **03.3**

0 3 . 1 Which substance is only one compound?

[1 mark]

Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

0 3 . 2 Which substance is a mixture of elements?

[1 mark]

Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

0 3 . 3 Which substance is a mixture of an element and a compound?

[1 mark]

Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

Do not write outside the box

Substances are separated from a mixture using different methods.

0 3 . 4 Draw **one** line from each method of separation to the substance and mixture it would separate.

[2 marks]

Method of separation	**Substance and mixture**
chromatography	blue food colour from a mixture of food colours
	copper from an alloy of copper and zinc
crystallisation	copper sulfate from copper sulfate solution
	ethanol from a mixture of ethanol and water

Do not write outside the box

0 3 . 5 Sand does not dissolve in water. A student separates a mixture of sand and water by filtration.

Draw a diagram of the apparatus the student could use.

You should label:

- where the sand is collected
- where the water is collected.

[3 marks]

Diagram

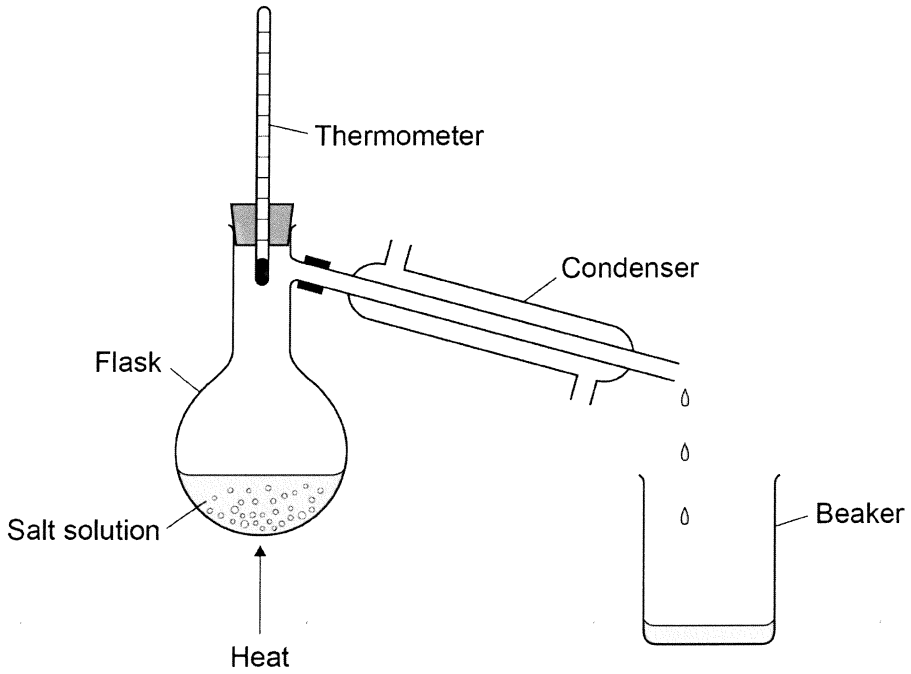
Question 3 continues on the next page

Do not write outside the box

0 3 . 6 A student distils a sample of salt solution to produce pure water.

Figure 6 shows the apparatus.

Figure 6



What temperature would you expect the thermometer to show?

[1 mark]

Tick (✓) **one** box.

0 °C ☐

10 °C ☐

50 °C ☐

100 °C ☐

Do not write outside the box

0 3 . 7 Describe how the process of distillation shown in **Figure 6** produces pure water from salt solution.

[4 marks]

13

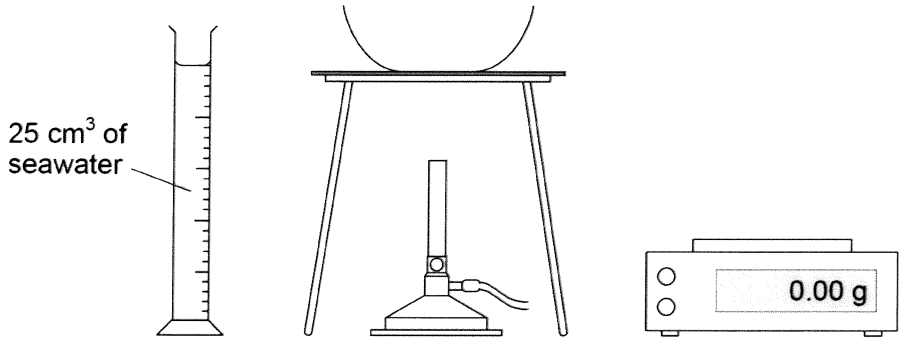
Turn over for the next question

Do not write outside the box

0 6 . 4 Students separated the dissolved solids from a sample of seawater.

Figure 7 shows some of the equipment used.

Figure 7



Describe a method to measure the mass of dissolved solids in a 25 cm^3 sample of seawater.

[5 marks]

5

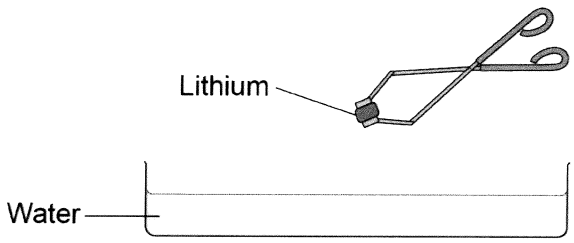
Do not write outside the box

0 2 This question is about Group 1 elements.

A teacher demonstrated the reaction of Group 1 elements with water.

Figure 3 shows the apparatus.

Figure 3



0 2 . 1 What name is given to Group 1 elements?

[1 mark]

Tick **one** box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

Non-metals ☐

0 2 . 2 The teacher wore safety glasses and used tongs to handle the elements.

Suggest **one** other safety precaution the teacher should take.

[1 mark]

_____

_____

Do not write outside the box

Table 2 shows the teacher's results.

Table 2

Element	Observations
Lithium	• bubbles form • lithium moves slowly on surface
Sodium	• bubbles form • sodium moves quickly on surface • sodium melts to form a ball
Potassium	• bubbles form • potassium moves very quickly on surface • potassium melts to form a ball • a lilac flame is seen

0 2 . 3 Describe the trend in reactivity in Group 1.

Give **two** observations from **Table 2** which provide evidence for the trend.

[3 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 4 Rubidium is a Group 1 element.

Rubidium is below potassium in the periodic table.

Suggest why the teacher did **not** demonstrate the reaction between rubidium and water.

[1 mark]

0 2 . 5 Complete the balanced equation for the reaction between sodium and water.

[1 mark]

$$\_\_\_\_\ Na + \_\_\_\_\ H_2O \rightarrow \_\_\_\_\ NaOH + H_2$$

0 2 . 6 What is the name of the compound with the formula NaOH?

[1 mark]

Tick **one** box.

- Sodium dioxide ☐
- Sodium hydrate ☐
- Sodium hydroxide ☐
- Sodium oxide ☐

Do not write outside the box

Table 3 shows the diameter of atoms of Group 1 elements.

Table 3

Element	Diameter of atom in nanometres
Lithium	0.304
Sodium	0.372
Potassium	**X**
Rubidium	0.496
Caesium	0.530

0 2 . 7 Predict value **X** in **Table 3**.

[1 mark]

X = _____ nanometres

0 2 . 8 1 nanometre is 10^{-9} metres.

What is the diameter of a lithium atom in metres?

[1 mark]

Tick **one** box.

3.04×10^{-8} m ☐

3.04×10^{-9} m ☐

3.04×10^{-10} m ☐

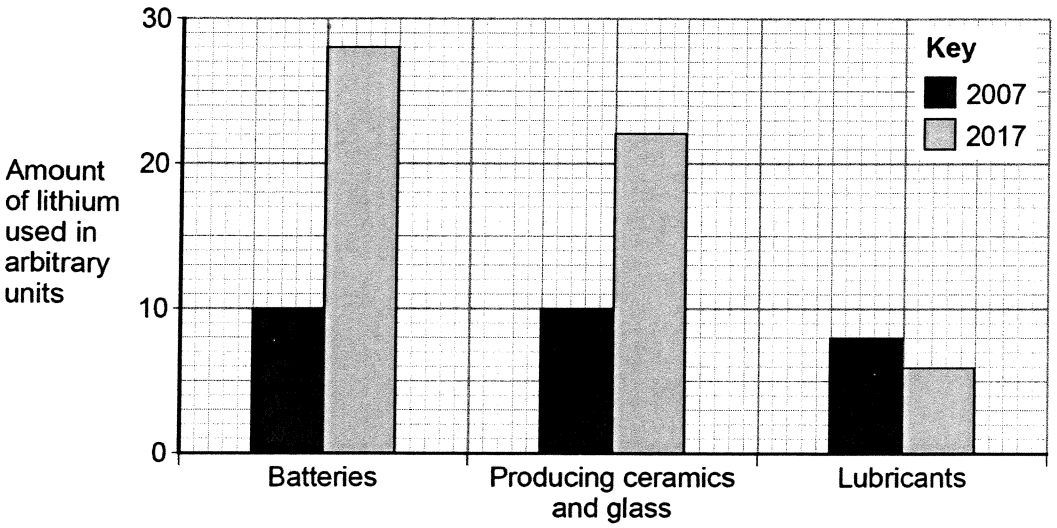
3.04×10^{-11} m ☐

Question 2 continues on the next page

Do not write outside the box

Figure 4 shows the use of lithium and lithium compounds in 2007 and 2017.

Figure 4



Use of lithium and lithium compounds

0 2 . 9 Describe how the use of lithium and lithium compounds changed between 2007 and 2017.

You must include data from **Figure 4** in your answer.

[3 marks]

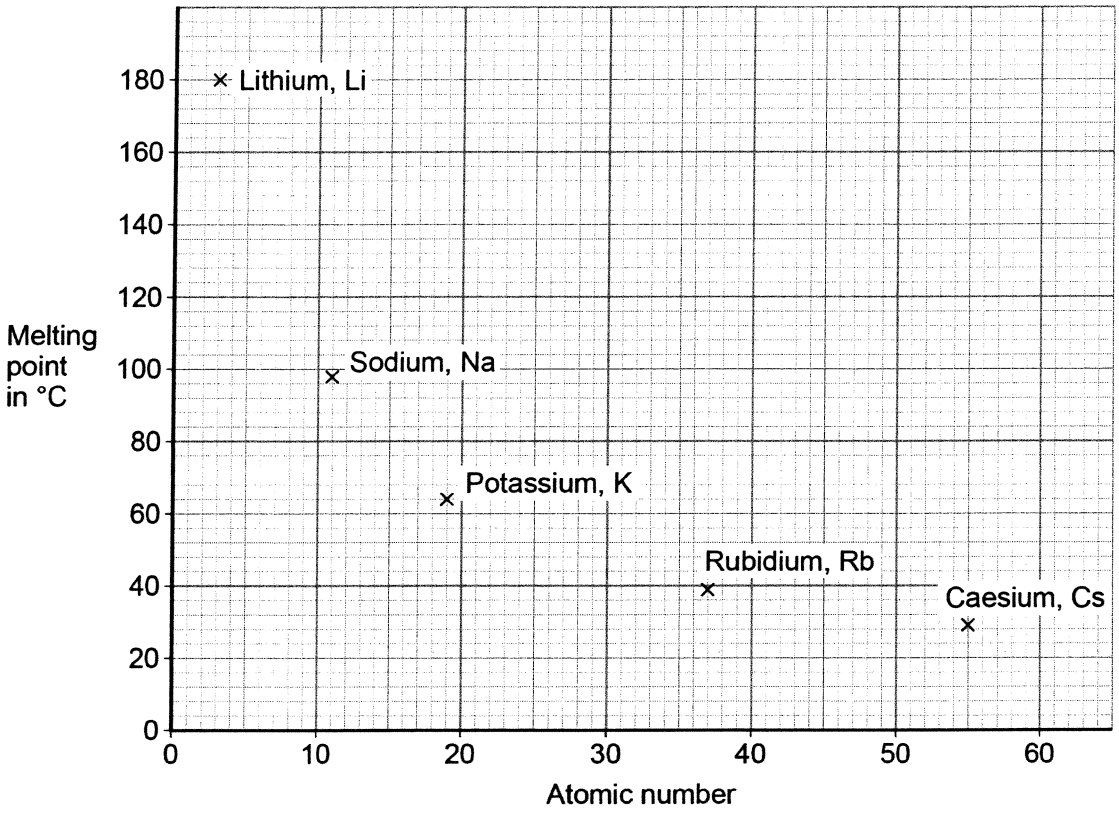
13

Do not write outside the box

0 2 This question is about Group 1 metals.

Figure 1 shows the melting points of Group 1 metals plotted against their atomic number.

Figure 1



0 2 . 1 Describe the trend shown by the melting points of Group 1 metals as the atomic number increases.

[1 mark]

_____

_____

0 2 . 2 Determine the atomic number and melting point of caesium.

Use **Figure 1**.

[1 mark]

Atomic number of caesium = _____

Melting point of caesium = _____ °C

Turn over ▶

Do not write outside the box

Lithium is a Group 1 metal.

0 2 . 3 A lithium atom can be shown as $^{7}_{3}Li$.

How many electrons does the **outer shell** of a lithium atom contain?

[1 mark]

Tick **one** box.

1 ☐

3 ☐

4 ☐

7 ☐

0 2 . 4 Lithium reacts with oxygen to produce lithium oxide.

Draw **one** line from each substance to the correct description of the substance.

[2 marks]

Substance	**Description**
	compound
Lithium oxide	element
	metal
Oxygen	mixture
	polymer

Do not write outside the box

0 2 . 5 Balance the equation for the reaction of lithium with oxygen.

[1 mark]

$$\_\_\_\_Li + O_2 \longrightarrow 2Li_2O$$

0 2 . 6 What type of bonding is present in lithium oxide?

[1 mark]

Tick **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

0 2 . 7 Calculate the relative formula mass (M_r) of lithium oxide (Li_2O).

Relative atomic masses (A_r): Li = 7 O = 16

[2 marks]

Relative formula mass = _____

9

Turn over for the next question

Do not write outside the box

0 2 The halogens are elements in Group 7.

0 2 . 1 Bromine is in Group 7.

Give the number of electrons in the outer shell of a bromine atom.

[1 mark]

_____

0 2 . 2 Bromine reacts with hydrogen. The gas hydrogen bromide is produced.

What is the structure of hydrogen bromide?

[1 mark]

Tick **one** box.

- Giant covalent ☐
- Ionic lattice ☐
- Metallic structure ☐
- Small molecule ☐

0 2 . 3 What is the formula for fluorine gas?

[1 mark]

Tick **one** box.

- F ☐
- F_2 ☐
- F^2 ☐
- 2F ☐

Do not write outside the box

A student mixes solutions of halogens with solutions of their salts.

Table 1 shows the student's observations.

Table 1

	Potassium chloride (colourless)	**Potassium bromide (colourless)**	**Potassium iodide (colourless)**
Chlorine (colourless)		Solution turns orange	Solution turns brown
Bromine (orange)	No change		Solution turns brown
Iodine (brown)	No change	No change	

0 2 . 4 Explain how the reactivity of the halogens changes going down Group 7.

Use the results in **Table 1**.

[3 marks]

Question 2 continues on the next page

Do not write outside the box

A company uses chlorine to produce titanium chloride from titanium dioxide.

0 2 . 5 What is the relative formula mass (M_r) of titanium dioxide, TiO_2?

Relative atomic masses (A_r): O = 16 Ti = 48

[1 mark]

Tick **one** box.

64 ☐

80 ☐

128 ☐

768 ☐

0 2 . 6 The company calculates that 500 g of titanium dioxide should produce 1.2 kg of titanium chloride.

However, the company finds that 500 g of titanium dioxide only produces 900 g of titanium chloride.

Calculate the percentage yield.

[2 marks]

Percentage yield = _____ %

9

0 2 This question is about the halogens.

0 2 . 1 Which group in the periodic table is known as the halogens?

[1 mark]

Tick **one** box.

Group 1 ☐

Group 2 ☐

Group 7 ☐

Group 0 ☐

0 2 . 2 A fluorine atom has 7 electrons in the outer shell.

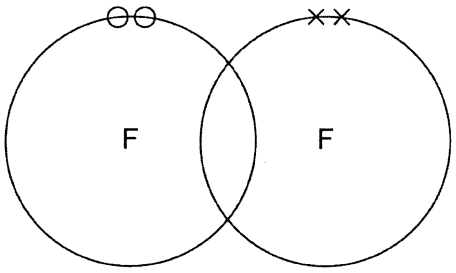
Figure 8 shows part of a dot and cross diagram to represent a molecule of fluorine (F_2).

Complete the dot and cross diagram.

You should show only the electrons in the outer shells.

[2 marks]

Figure 8



0 2 . 3 Chlorine reacts with potassium bromide solution.

Complete the word equation.

[2 marks]

chlorine + potassium bromide → _____ + _____

Do not write outside the box

0 2 . 4 What type of reaction happens when chlorine reacts with potassium bromide solution?

[1 mark]

Tick **one** box.

decomposition ☐

displacement ☐

neutralisation ☐

precipitation ☐

0 2 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

an atom	**an electron**	**a neutron**	**a proton**

Chlorine is more reactive than bromine.

This is because chlorine gains _____ more easily.

0 2 . 6 How does the size of a chlorine atom compare with the size of a bromine atom?

Complete the sentence.

Choose the answer from the box.

[1 mark]

bigger than	**the same size as**	**smaller than**

A chlorine atom is _____ a bromine atom.

Do not write outside the box

0 2 . 7 Give a reason for your answer to question **02.6**

[1 mark]

Reason _____

_____

0 2 . 8 Fluorine reacts with chlorine to produce ClF_3

Balance the chemical equation for the reaction.

[1 mark]

$Cl_2 +$ _____ $F_2 \rightarrow 2\ ClF_3$

0 2 . 9 Explain why fluorine is a gas at room temperature.

Use the following words in your answer:

energy **forces** **molecules** **weak**

[3 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

13

Do not write outside the box

0 3 This question is about the periodic table and argon.

0 3 . 1 What order did scientists use to arrange elements in early periodic tables?

[1 mark]

Tick (✓) **one** box.

Atomic weight of element ☐

Number of neutrons in an atom of element ☐

Size of atoms of element ☐

Year element was discovered ☐

0 3 . 2 In early periodic tables some elements were placed in the wrong groups.

Mendeleev overcame some of these problems in his periodic table.

Complete the sentence.

[1 mark]

Mendeleev did this by leaving _____ for elements that had not been discovered.

Question 3 continues on the next page

Do not write outside the box

0 3 . 3 What is the name of the group that contains argon?

[1 mark]

Tick (✓) **one** box.

Alkali metals ☐

Halogens ☐

Noble gases ☐

0 3 . 4 An atom of argon is represented as $^{40}_{18}Ar$

Determine the number of protons and the number of neutrons in one atom of argon.

[2 marks]

Number of protons _____

Number of neutrons _____

0 3 . 5 Different atoms of argon are, $^{39}_{18}Ar$ and $^{38}_{18}Ar$

What is the name given to these different atoms of argon?

[1 mark]

Tick (✓) **one** box.

Fullerenes ☐

Ions ☐

Isotopes ☐

Molecules ☐

Do not write outside the box

0 3 . 6 What is the electronic structure of an argon atom, $^{40}_{18}Ar$?

[1 mark]

Tick (✓) **one** box.

2 ☐ 2, 8 ☐ 2, 8, 2 ☐ 2, 8, 8 ☐

0 3 . 7 Why is argon unreactive?

[1 mark]

_____

_____

8

Turn over for the next question

Do not write outside the box

0 4 This question is about Group 1 elements.

0 4 . 1 Sodium reacts with chlorine to produce sodium chloride.

Balance the equation for the reaction.

[1 mark]

$$\_\_\_\_ Na + Cl_2 \rightarrow \_\_\_\_ NaCl$$

0 4 . 2 4.6 g of sodium reacts with chlorine to produce 11.7 g of sodium chloride.

What mass of chlorine reacted?

[1 mark]

Mass of chlorine = _____ g

0 4 . 3 A teacher puts hot sodium into a gas jar of chlorine.

The changes seen before, during and after this reaction were observed.

Complete the sentences.

Choose the answers from the box.

[4 marks]

colourless	**green**	**lilac**	**silver**	**white**	**yellow**

Sodium is a _____ solid.

Chlorine is a _____ gas.

The hot sodium burns with a _____ flame.

The product sodium chloride is a _____ solid.

Do not write outside the box

0 4 . 4 Sodium chloride (NaCl) is an ionic compound.

Write the formulae of the ions in sodium chloride.

[2 marks]

Sodium ion _____

Chloride ion _____

0 4 . 5 Complete the sentence.

Choose the answer from the box.

[1 mark]

an atom	an electron	a neutron	a proton

Potassium is more reactive than sodium.

This is because potassium loses _____ more easily than sodium.

0 4 . 6 How does the size of a potassium atom compare with the size of a sodium atom?

Give a reason for your answer.

[2 marks]

_____

Reason _____

_____

_____

11

Turn over for the next question

Do not write outside the box

0 7 This question is about elements in Group 1.

A teacher burns sodium in oxygen.

0 7 . 1 Complete the word equation for the reaction.

[1 mark]

sodium + oxygen → _____

0 7 . 2 What is the name of this type of reaction?

[1 mark]

Tick **one** box.

Decomposition ☐

Electrolysis ☐

Oxidation ☐

Precipitation ☐

0 7 . 3 The teacher dissolves the product of the reaction in water and adds universal indicator.

The universal indicator turns purple.

What is the pH value of the solution?

[1 mark]

Tick **one** box.

1 ☐ 4 ☐ 7 ☐ 13 ☐

Do not write outside the box

0 7 . 4 The solution contains a substance with the formula NaOH

Give the name of the substance.

[1 mark]

_____

0 7 . 5 All alkalis contain the same ion.

What is the formula of this ion?

[1 mark]

Tick **one** box.

H^+ ☐

Na^+ ☐

OH^- ☐

O^{2-} ☐

0 7 . 6 A solution of NaOH had a concentration of 40 g/dm^3

What mass of NaOH would there be in 250 cm^3 of the solution?

[2 marks]

_____

_____

_____

_____

Mass = _____ g

Do not write outside the box

0 7 . 7 The melting points of the elements in Group 1 show a trend.

Table 6 shows the atomic numbers and melting points of the Group 1 elements.

Table 6

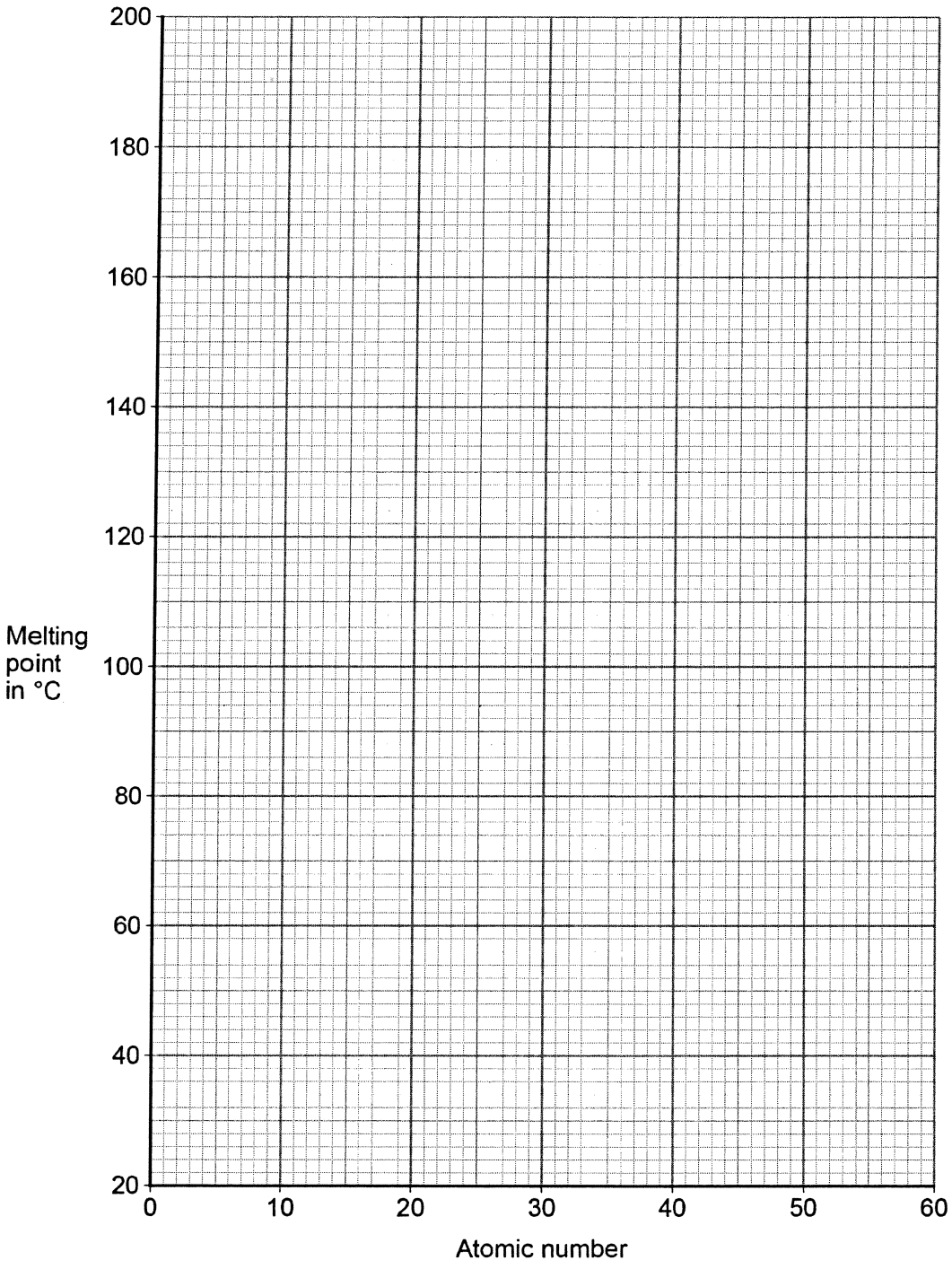
Element	Atomic number	Melting point in °C
Lithium	3	181
Sodium	11	98
Potassium	19	63
Rubidium	37	**X**
Caesium	55	29

Plot the data from **Table 6** on **Figure 11**.

[2 marks]

Do not write outside the box

Figure 11



0 7 . 8 Predict the melting point, **X**, of rubidium, atomic number 37

Use **Figure 11**.

[1 mark]

Melting point = _____ °C

10

Turn over ▶

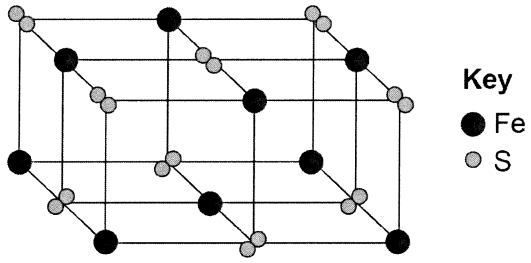
Do not write outside the box

0 9 This question is about metals and metal compounds.

0 9 . 1 Iron pyrites is an ionic compound.

Figure 12 shows a structure for iron pyrites.

Figure 12



Determine the formula of iron pyrites.

Use **Figure 12**.

[1 mark]

_____

0 9 . 2 An atom of iron is represented as $^{56}_{26}Fe$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

0 9 . 3 Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

Nickel is extracted from nickel oxide by reduction with carbon.

0 9 . 4 Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 9 . 5 An equation for the reaction is:

$$NiO + C \rightarrow Ni + CO$$

Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

Percentage atom economy = _____ %

11

Do not write outside the box

Answer **all** questions in the spaces provided.

0 1 This question is about the periodic table.

In the 19th century, some scientists tried to classify the elements by arranging them in order of their atomic weights.

Figure 1 shows the periodic table Mendeleev produced in 1869.

His periodic table was more widely accepted than previous versions.

Figure 1

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
Period 1	H						
Period 2	Li	Be	B	C	N	O	F
Period 3	Na	Mg	Al	Si	P	S	Cl
Period 4	K Cu	Ca Zn	* *	Ti *	V As	Cr Se	Mn Br
Period 5	Rb Ag	Sr Cd	Y In	Zr Sn	Nb Sb	Mo Te	* I

0 1 . 1 The atomic weight of tellurium (Te) is 128 and that of iodine (I) is 127

Why did Mendeleev reverse the order of these two elements?

[1 mark]

Do not write outside the box

0 1 . 2 Mendeleev left spaces marked with an asterisk *

He left these spaces because he thought missing elements belonged there.

Why did Mendeleev's periodic table become more widely accepted than previous versions?

[3 marks]

0 1 . 3 Mendeleev arranged the elements in order of their atomic weight.

What is the modern name for atomic weight?

[1 mark]

Tick (✓) **one** box.

- Atomic number ☐
- Mass number ☐
- Relative atomic mass ☐
- Relative formula mass ☐

0 1 . 4 Complete the sentence.

[1 mark]

In the modern periodic table, the elements are arranged in order of

_____.

Do not write outside the box

Chlorine, iodine and astatine are in Group 7 of the modern periodic table.

0 1 . 5 Astatine (At) is below iodine in Group 7.

Predict:

- the formula of an astatine molecule
- the state of astatine at room temperature.

[2 marks]

Formula of astatine molecule _____

State at room temperature _____

0 1 . 6 Sodium is in Group 1 of the modern periodic table.

Describe what you would see when sodium reacts with chlorine.

[2 marks]

_____

_____

_____

_____

10

Do not write outside the box

0 4 This question is about atomic structure.

0 4 . 1 Atoms contain subatomic particles.

Table 2 shows properties of two subatomic particles.

Complete **Table 2**.

[2 marks]

Table 2

Name of particle	Relative mass	Relative charge
neutron		
		+1

An element **X** has two isotopes.

The isotopes have different mass numbers.

0 4 . 2 Define mass number.

[1 mark]

0 4 . 3 Why is the mass number different in the two isotopes?

[1 mark]

Question 4 continues on the next page

Do not write outside the box

0 4 . 4 The model of the atom changed as new evidence was discovered.

The plum pudding model suggested that the atom was a ball of positive charge with electrons embedded in it.

Evidence from the alpha particle scattering experiment led to a change in the model of the atom from the plum pudding model.

Explain how.

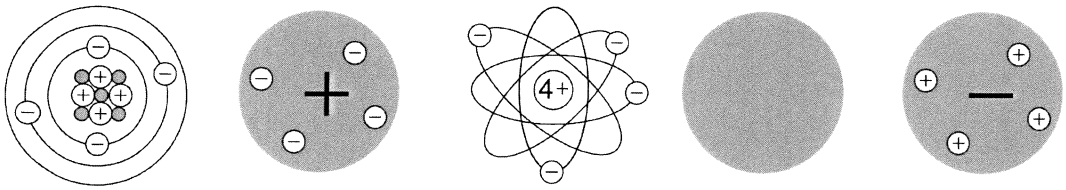
[4 marks]

8

Do not write outside the box

0 4 **Figure 3** represents different models of the atom.

Figure 3



A B C D E

0 4 . 1 Which diagram shows the plum pudding model of the atom?

[1 mark]

Tick **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

0 4 . 2 Which diagram shows the model of the atom developed from the alpha particle scattering experiment?

[1 mark]

Tick **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

0 4 . 3 Which diagram shows the model of the atom resulting from Bohr's work?

[1 mark]

Tick **one** box.

A ☐ B ☐ C ☐ D ☐ E ☐

Do not write outside the box

0 4 . 4 Define the mass number of an atom.

[1 mark]

0 4 . 5 Element **X** has two isotopes. Their mass numbers are 69 and 71

The percentage abundance of each isotope is:

- 60% of $^{69}\mathbf{X}$
- 40% of $^{71}\mathbf{X}$

Estimate the relative atomic mass of element **X**.

[1 mark]

Tick **one** box.

< 69.5 ☐

Between 69.5 and 70.0 ☐

Between 70.0 and 70.5 ☐

> 70.5 ☐

0 4 . 6 Chadwick's experimental work on the atom led to a better understanding of isotopes.

Explain how his work led to this understanding.

[3 marks]

8

Do not write outside the box

0 4 This question is about elements in the periodic table.

0 4 . 1 What order did scientists use to arrange elements in early periodic tables?

[1 mark]

0 4 . 2 In the early periodic tables some elements were placed in the wrong groups.

Mendeleev overcame this in his periodic table.

Give **one** way Mendeleev did this.

[1 mark]

Question 4 continues on the next page

Do not write outside the box

Table 2 shows the boiling points of fluorine, chlorine and bromine.

Table 2

Element	Boiling point in °C
Fluorine	–186
Chlorine	–34
Bromine	+59

0 4 . 3 Explain why the boiling points in **Table 2** are low.

[2 marks]

0 4 . 4 Explain the trend in the boiling points in **Table 2**.

[3 marks]

Do not write outside the box

0 4 . 5 Explain why neon is unreactive.

Give the electronic structure of neon in your answer.

[2 marks]

0 4 . 6 How many atoms are there in 1 g of argon?

The Avogadro constant is 6.02×10^{23} per mole.

Relative atomic mass (A_r): Ar = 40

[2 marks]

Number of atoms in 1 g = _____

11

Turn over for the next question

0 4 This question is about the halogens.

0 4 . 1 Write the state symbol for chlorine at room temperature.

[1 mark]

Cl_2 (_____)

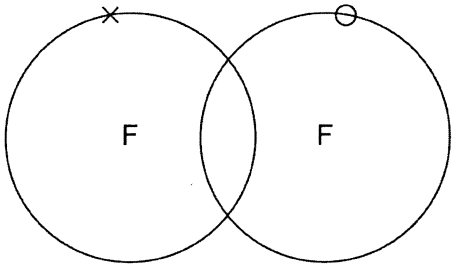
0 4 . 2 **Figure 4** represents one molecule of fluorine.

Complete the dot and cross diagram on **Figure 4**

You should show only the electrons in the outer shells.

[2 marks]

Figure 4



0 4 . 3 A fluorine atom can be represented as $^{19}_{9}F$

What is the total number of electrons in a fluorine molecule (F_2)?

[1 mark]

Tick **one** box.

9 ☐ 14 ☐ 18 ☐ 38 ☐

0 4 . 4 Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.

[2 marks]

_____Al + _____Br_2 → 2 _____

Do not write outside the box

0 4 . 5 When chlorine reacts with potassium bromide, chlorine displaces bromine.

$$Cl_2 + 2\,KBr \rightarrow Br_2 + 2\,KCl$$

Explain why chlorine is more reactive than bromine.

[3 marks]

9

Turn over for the next question

Do not write outside the box

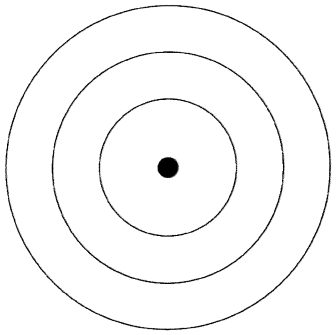
0 4 This question is about Group 1 elements.

0 4 . 1 A sodium atom is represented as $^{23}_{11}Na$

Complete **Figure 6** to show the electronic structure of a sodium atom.

[1 mark]

Figure 6



A teacher demonstrated the reaction between lithium and water.

The teacher repeated the demonstration using sodium and then potassium with water.

0 4 . 2 The teacher wore eye protection.

Suggest **two** other safety precautions the teacher should take.

[2 marks]

1 _____

_____

2 _____

_____

Do not write outside the box

0 4 . 3 Universal indicator is added to the solution formed in the reaction between potassium and water. The universal indicator becomes purple in colour.

Which ion causes universal indicator to turn purple?

[1 mark]

Tick **one** box.

H^+ ☐

K^+ ☐

OH^- ☐

O^{2-} ☐

Question 4 continues on the next page

Do not write outside the box

0 4 . 4 **Table 3** gives the diameter of atoms of Group 1 elements.

Table 3

Element	Diameter of atom in nm
Lithium	0.304
Sodium	0.372
Potassium	0.454
Rubidium	0.496
Caesium	0.530

Explain how the diameter of the atom affects the reactivity of Group 1 elements.

[4 marks]

8

Do not write outside the box

0 6 This question is about sodium.

0 6 . 1 Sodium reacts with chlorine.

What is the balanced equation for the reaction?

[1 mark]

Tick (✓) **one** box.

$Na + Cl \rightarrow NaCl$ ☐

$Na + Cl_2 \rightarrow NaCl_2$ ☐

$2\ Na + Cl_2 \rightarrow 2\ NaCl$ ☐

$2\ Na + Cl \rightarrow Na_2Cl$ ☐

0 6 . 2 Hot sodium is put in a gas jar of chlorine.

Describe the observations made before, during and after the reaction.

[3 marks]

Before reaction _____

_____

During reaction _____

_____

After reaction _____

_____

Do not write outside the box

0 6 . 3 Explain why sodium is less reactive than potassium.

[4 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Chlorine reacts with sodium and with hydrogen.

Compare the structure and bonding in sodium chloride and hydrogen chloride.

[6 marks]

END OF QUESTIONS

14

Do not write outside the box

0 8 Titanium is a transition metal.

Titanium is extracted from titanium dioxide in a two stage industrial process.

Stage 1 $TiO_2 + 2\,C + 2\,Cl_2 \rightarrow TiCl_4 + 2\,CO$

Stage 2 $TiCl_4 + 4\,Na \rightarrow Ti + 4\,NaCl$

0 8 . 1 Suggest **one** hazard associated with **Stage 1**.

[1 mark]

0 8 . 2 Water must be kept away from the reaction in **Stage 2**.

Give **one** reason why it would be hazardous if water came into contact with sodium.

[1 mark]

0 8 . 3 Suggest why the reaction in **Stage 2** is carried out in an atmosphere of argon and **not** in air.

[2 marks]

Do not write outside the box

0 8 . 4 Titanium chloride is a liquid at room temperature.

Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

[3 marks]

In **Stage 2**, sodium displaces titanium from titanium chloride.

0 8 . 5 Sodium atoms are oxidised to sodium ions in this reaction.

Why is this an oxidation reaction?

[1 mark]

0 8 . 6 Complete the half equation for the oxidation reaction.

[1 mark]

Na → _____ + _____

Do not write outside the box

0 8 . 7 In **Stage 2**, 40 kg of titanium chloride was added to 20 kg of sodium.

The equation for the reaction is:

$$TiCl_4 + 4\,Na \rightarrow Ti + 4\,NaCl$$

Relative atomic masses (A_r): Na = 23 Cl = 35.5 Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

[4 marks]

0 8 . 8 For a **Stage 2** reaction the percentage yield was 92.3%

The theoretical maximum mass of titanium produced in this batch was 13.5 kg.

Calculate the actual mass of titanium produced.

[2 marks]

Mass of titanium = _____ kg

15