

Atomic Structure and the periodic table

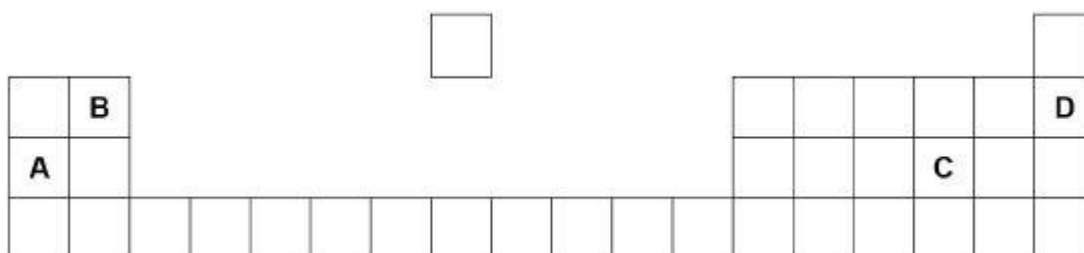
<https://TOSIQAG.exampro.net>

Q1.

This question is about the elements in Group 2 of the periodic table.

- (a) **Figure 1** shows the positions of four elements, **A**, **B**, **C**, and **D**, in the periodic table.

Figure 1



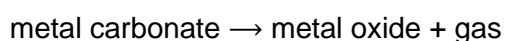
Which element is in Group 2?

Tick **one** box.

A **B** **C** **D**

(1)

Group 2 metal carbonates break down when heated to produce a metal oxide and a gas.



- (b) Name the two products when calcium carbonate (CaCO_3) is heated.

_____ and _____

(2)

- (c) What type of reaction happens when a compound breaks down?

Tick **one** box.

burning

decomposition

neutralisation

reduction

(1)

(d) The metal carbonate takes in energy from the surroundings to break down.

What type of reaction takes in energy from the surroundings?

Tick **one** box.

combustion

electrolysis

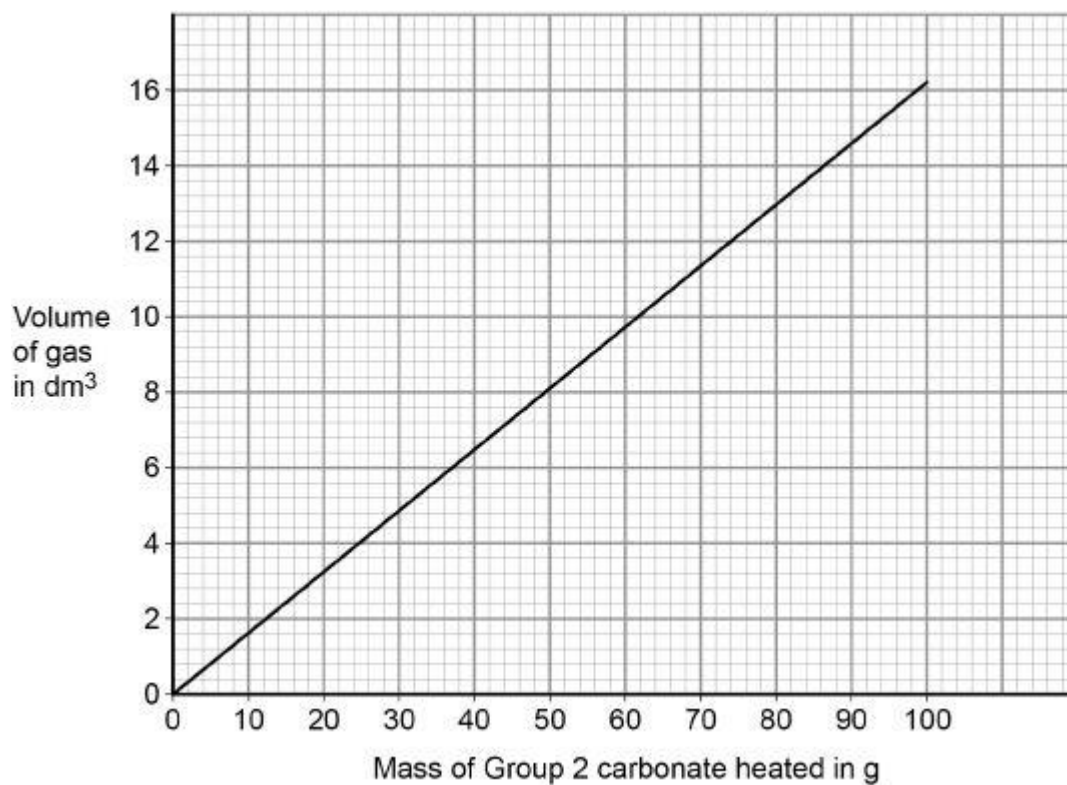
endothermic

exothermic

(1)

(e) **Figure 2** shows the volume of gas produced when a Group 2 metal carbonate is heated.

Figure 2



The student collected 5.2 dm³ of gas.

What mass of the Group 2 metal carbonate is heated?

Mass = _____ g

(1)

- (f) Calculate the mass of the Group 2 carbonate needed to produce 24 dm³ of gas.

Use your answer from part (e) to help you.

Mass = _____ g

(2)

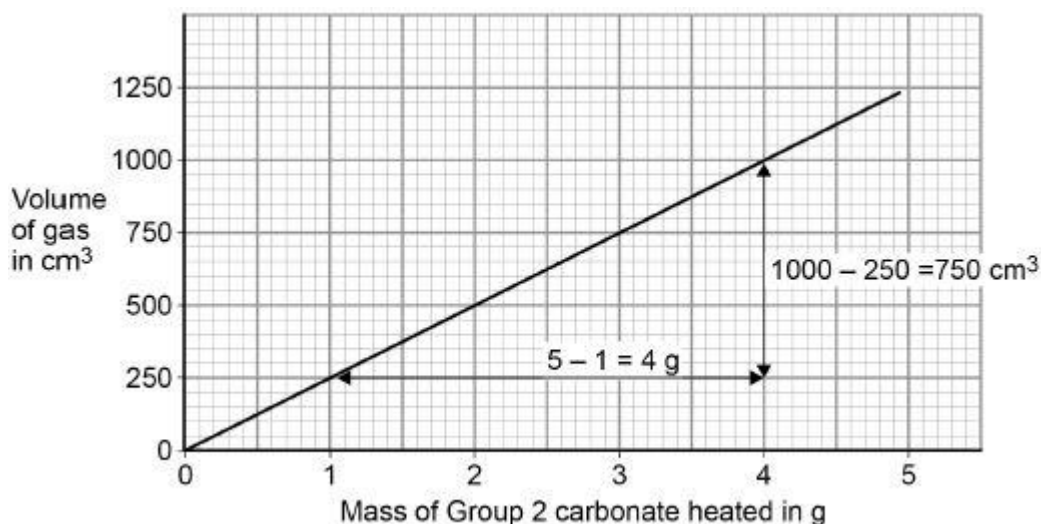
- (g) A student heated different masses of a Group 2 carbonate. The student measured the volume of gas produced.

Figure 3 shows a graph of the student's results.

The student calculates the gradient of the line in **Figure 3**

The student makes **two** mistakes.

Figure 3



Correct formula for gradient = $\frac{\text{Increase in volume of gas}}{\text{Increase in mass of Group 2 metal carbonate heated}}$

Student's calculation = $\frac{4}{750} = 0.00533 \text{ cm}^3 \text{ per g}$

Identify the **two** mistakes the student makes.

Calculate the correct gradient of the line.

Mistake 1 _____

Mistake 2 _____

Calculation _____

Gradient = _____ cm³ per g

(4)

(h) A student repeated the experiment with a different Group 2 metal carbonate (XCO_3).

The relative formula mass (M_r) of XCO_3 is 84

Relative atomic masses (A_r): C = 12 O = 16

Calculate the relative atomic mass (A_r) of X.

Name metal X.

Use the periodic table.

Relative atomic mass (A_r) = _____

Metal X is _____

(4)

(Total 16 marks)

Q2.

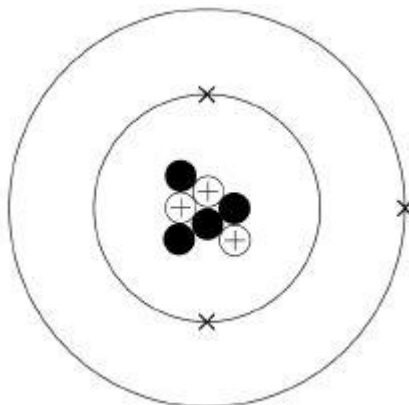
The table below shows the relative mass and charge of the particles in an atom.

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

(a) Complete the table above.

(3)

(b) The diagram below represents a lithium atom.



Give the number of protons, neutrons and electrons in the lithium atom shown in the diagram above.

Number of protons _____

Number of neutrons _____

Number of electrons _____

(3)

(c) 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.

Description of atomic model

Stage in the development of the atomic model

A ball of positive charge with electrons embedded in it

Dalton atoms

Neutrons discovered

Nucleus of atoms discovered

Spherical atoms

Plum pudding model

(2)

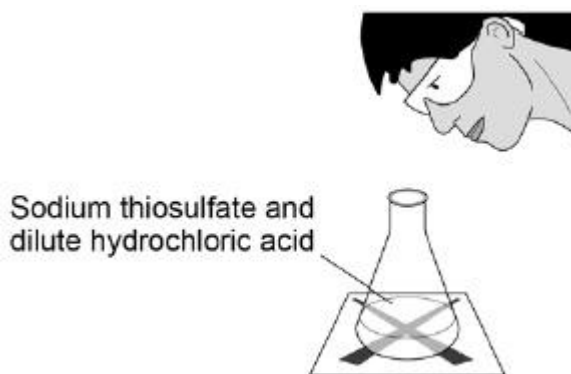
(Total 8 marks)

Q3.

A student investigated the effect of concentration on the rate of the reaction between sodium thiosulfate and dilute hydrochloric acid.

Figure 1 shows the apparatus the student used.

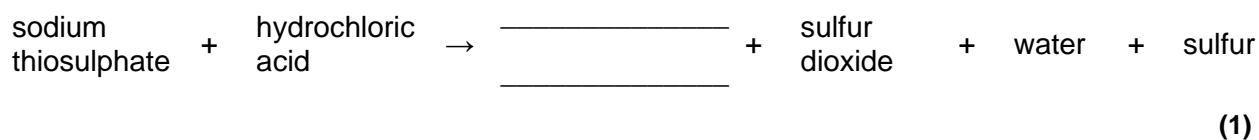
Figure 1



(a) The symbol equation for the reaction is:



Complete the word equation for the reaction.



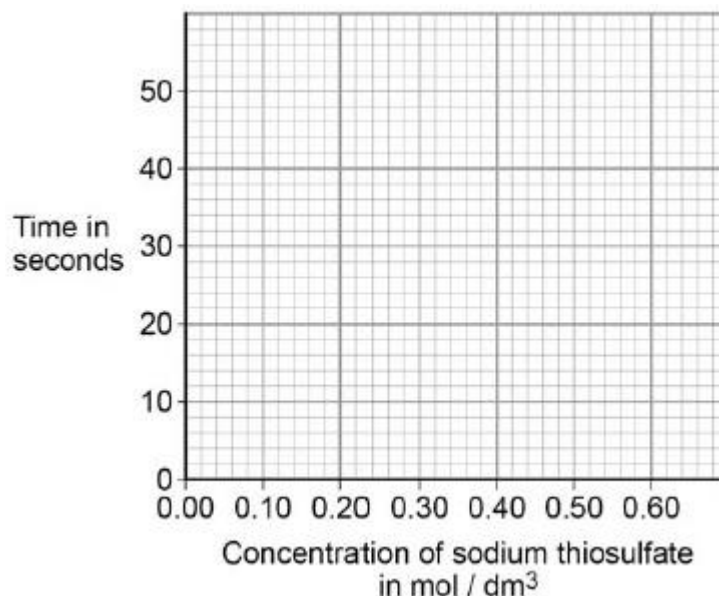
(b) The table shows the results.

| Concentration of sodium thiosulfate in mol/dm ³ | Time for student to no longer see the cross in seconds |
|--|--|
| 0.10 | 41 |
| 0.20 | 21 |
| 0.30 | 20 |
| 0.40 | 10 |
| 0.50 | 8 |

Plot the data from the table on **Figure 2**.

Draw a line of best fit.

Figure 2



(3)

- (c) The student determined the time for a concentration of 0.15 mol/dm^3

What is the concentration when the reaction is 20 seconds faster?

You should show your working on **Figure 2**.

Concentration = _____ mol/dm^3

(2)

- (d) Estimate the time taken for the reaction when the concentration of sodium thiosulfate is 0.60 mol/dm^3

Time taken = _____ s

(1)

(Total 7 marks)

Q4.

This question is about atoms and chemical elements.

Mendeleev's periodic table has groups of elements with similar properties.

Figure 1 shows part of Mendeleev's periodic table.

Figure 1

| | | | | | | | | |
|----------|----------|-----------|------------|----------|---------|----------|------------|-------------------------------|
| 1 | 1 H | | | | | | | |
| 2 | 7 Li | 9.4 Be | 11 B | 12 C | 14 N | 16 O | 19 F | |
| 3 | 23 Na | 24 Mg | 27.3 Al | 28 Si | 31 P | 32 S | 35.5 Cl | |
| 4 | 39 K | 40 Ca | 44 | 48 Ti | 51 V | 52 Cr | 55 Mn | 56 59 59 63 Fe, Co, Ni, Cu |

(a) Compare Mendeleev's periodic table with the modern periodic table.

Which group is missing from Mendeleev's periodic table?

Tick **one** box.

- Group 1
- Group 2
- Group 7
- Group 0

(1)

(b) In the early periodic tables some elements were placed in the wrong groups.

Mendeleev overcame some of these problems in his periodic table.

Give **two** ways Mendeleev did this.

1. _____

2. _____

(2)

Atoms were thought to be tiny spheres that could not be divided.

(c) Draw **one** line from each scientist to the discovery the scientist made.

Scientist

**Discovery the
scientist made**

Discovered electrons

Neils Bohr

Electrons orbit the nucleus

Existence of neutrons

James Chadwick

Mass of atom concentrated at centre

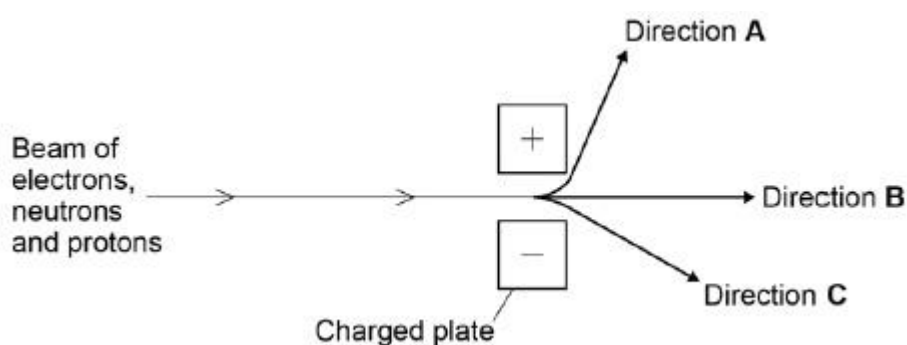
Proton found in nucleus

(2)

- (d) A beam of electrons, neutrons and protons can be separated by passing them through an electric field.

Figure 2 shows the directions of the three particles after entering the electric field.

Figure 2



Charged particles are attracted to the oppositely charged plate in the electric field.

Which direction, **A**, **B** or **C**, does each particle follow?

Complete the table.

| Particle | Direction |
|----------|-----------|
| Electron | |
| Neutron | |
| Proton | |

(2)

- (e) Calculate the mass of one atom of sodium.

Use the equation:

$$\text{mass of one atom of sodium} = \frac{\text{relative atomic mass}}{\text{Avogadro constant}}$$

Avogadro constant = 6.02×10^{23}

Give your answer to 2 significant figures.

Mass = _____ g

(3)

(f) The radius of a sodium atom is 227 picometres.

1 picometre = 10^{-12} metres (m)

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

Which calculation shows the radius of a sodium atom's nucleus?

Tick **one** box.

$227 \times 10\,000$ m

$227 \times \frac{1}{10\,000}$ m

$227 \times 10^{-12} \times 10\,000$ m

$227 \times 10^{-12} \times \frac{1}{10\,000}$ m

(1)

(Total 11 marks)

Mark schemes

Q1.

- (a) B 1
- (b) calcium oxide **or** CaO 1
carbon dioxide **or** CO₂ 1
either order
- (c) decomposition 1
- (d) endothermic 1
- (e) 32 (g) 1
allow 31–33 (g)
- (f) $\frac{32}{5.2} \times 24$ 1
148 (g) 1
allow a range 143–153 (g)
- or**
- uses graph e.g. 12 dm³ gives 74 (g) (1)
(then factors up so that 24 dm³ gives) 148 (g) (1)
allow a range 143–153 (g) 1
an answer of 148 (g) scores 2 marks
allow ecf from part (e)
- (g) (mistakes) 1
increase in mass = 3 (not 4)
allow mistakes in either order
- inserted numbers inversely into formula 1
allow numbers wrong way round
- (calculation) 1
an answer of 250 scores the 2 calculation marks

$$\text{gradient} = \frac{750}{3}$$

allow $\frac{1000}{4}$

250 (cm³ per g)

if no calculation marks awarded

allow $\frac{750}{4}$ **or** 187.5 **or** $\frac{3}{750}$

or 0.004 for 1 mark

1

(h) 3 × 16 or 48

1

(48) + 12 or 60

allow their mass of oxygen + 12

1

84 – (60) **or** 24

allow 84 – their mass of carbonate

1

magnesium **or** Mg

*magnesium **or** Mg without working scores this mark*

1

an answer of 24 scores the 3 calculation marks

[16]

Q2.

(a)

| name of particle | relative mass | charge |
|------------------|---------------|--------|
| proton | (1) | (+1) |
| neutron | 1 | 0 |
| electron | (very small) | -1 |

1 + 1

1

allow words instead of numbers

*allow neutral **or** no charge for the neutron*

(b) (protons) 3

1

(neutrons) 4

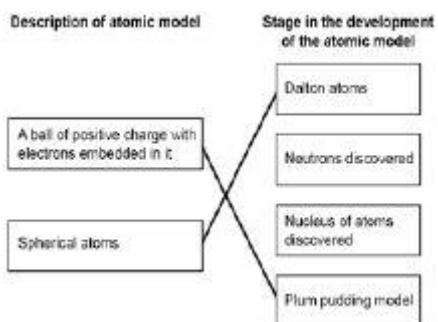
1

(electrons) 3

1

allow words instead of numbers

(c)



1
1

[8]

Q3.

(a) sodium chloride

1

(b) points correctly plotted
allow 1 mark if 4 correct

2

correct line of best fit
do not accept straight line

1

(c) 0.38–0.50
allow for 1 mark for working shown on graph

2

(d) ≥ 5 seconds and < 8 seconds

1

[7]

Q4.

(a) group 0

1

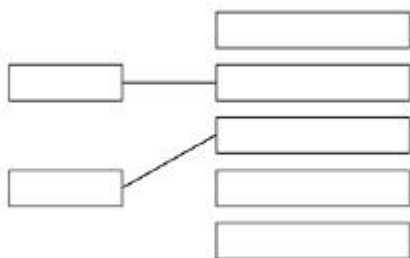
(b) left gaps

1

in some places changed the order based on atomic weights

1

(c)



1
1

(d) (electron) **A**

(neutron) **B**

(proton) **C**

3 correct answers scores 2 marks

1/2 correct answers scores 1 mark

2

(e) $\frac{23}{6.02 \times 10^{23}}$

1

$3.820598... \times 10^{-23}$

1

3.8×10^{-23}

an answer of 3.8×10^{-23} scores 3 marks

1

(f) $227 \times 10^{-12} \times \frac{1}{10\,000} \text{ m}$

1

[11]