St Mary Redcliffe and Temple 6th Form

Transition Task

Subject: Chemistry

Specification: OCR A Chemistry – this is new for 2023. Here is a link to the specification

Transition Tasks:

1. Complete a report on The History of the Atom (guidance below)
2. Complete a minimum of 4 of the transition tasks below developing the essential skills needed for A-Level Chemistry.
3. Complete this Chemistry based escape room: https://testtuberevise.com/portfolio/escape-the-atom/

Entry Requirements to study A Level Chemistry:

- 65 in Combined Science **and a** 6 in Maths or
- 6 in Separate Chemistry **and a** 6 in Maths
- Any student doing all Biology, Chemistry and Physics would need a minimum of 77 for Combined Science or 777 for Separate Science and a 6 in Maths

What happens if you fall short of this requirement?

You will be able to take an entrance test (approx. 1hr) which you will need to pass.
The questions in the test will be common to all exam boards and will be GCSE exam style questions. There will be a focus on the mathematical elements of the course as well as the higher chemistry concepts.

Support Materials and Further Reading:

Making a head start with Chemistry

This is a resource available to you to give you a Head Start to A-Level Chemistry

Reading around the subject

1. Periodic Tales: The Curious Lives of the Elements by Hugh Aldersley-Williams (ISBN-10: 0141041455)

2. The Disappearing Spoon by Sam Kean (ISBN-10: 0316388270)

3. A Short History of Nearly Everything by Bill Bryson (ISBN-10: 9781784161859)

4. The Periodic Table by Primo Levi (ISBN-10: 0141185147)

5. Bad Science

Videos/TV Programs

1. Chemistry: A Volatile History – found on BBC iPlayer

2. The Modern Alchemist – A Royal Institution Christmas Lecture - https://www.rigb.org/christmaslectures/watch/2012/the-modern-alchemist

3. Subscribe to 'Machemguy' on YouTube who has created a 'Prep for A-level Chemistry' playlist

Expectations

For each lesson, you will need to have the following things:

1. Pens (black, blue and purple)
2. Pencil
3. Scientific calculator
4. Ruler
5. A ring binder
6. Printed version of the data sheet https://www.ocr.org.uk/Images/363792-unit-h032-and-h432-data-sheet.pdf (You can print this off when you get to 6th form if you do not have access to a printer at home)
7. A plastic wallet

Textbook

You will have access to a digital version of the textbook via an online platform called Kerboodle. Logins will be shared when you arrive in September.

Revision guides

In September, we will create an opportunity for you to purchase the revision bundle below for a reduced rate of £17.50 – this is optional.

- A-Level Chemistry: OCR A Year 1 & 2 Complete Revision & Practice with Online Edition
- A-Level Chemistry: OCR A Year 1 & 2 Exam Practice Workbook - includes Answers

Task 1: History of the Atom

Introduction

The idea of an atom was first conceived by the ancient philosophers of Greece. In the fifth century BC, Leucippus and his student Democritus suggested that there were small indivisible particles, which he called atoms – from the Greek *atomos* meaning 'uncuttable'.

This idea of atoms has been built on by many other scientists over hundreds of years. These scientists have drawn conclusions from a variety of different experiments. Some conclusions have been arrived at when scientists were researching other questions, and some ideas have been proven by designing a specific experiment.

A model of the structure of the atom is still evolving today. Particle physicists are working at particle accelerators like CERN, on newly discovered quarks.

In this Webquest you will be researching one of the models to have been developed over the years to describe the structure of an atom.

Your task is to produce a report into the different models of the atom that has been developed by scientists since 1890.

Your research should be done online, using the web links provided below as well as any other credible sources you feel would be useful.

Your report will should be typed and include images and, where appropriate, diagrams of the experiments conducted.

Your report should include:

- Information about the key scientists who developed this model of the atom
- A description of what they believed the atom looked like when they began their work
- The key experiments that they did and what they found out from them
- The conclusions that they drew from their work and the model of the atom that developed from their work
- Information about when their ideas were suggested.

The different models of the atom that you need to research are:

- the plum pudding model of an atom
- the solar system or planetary model of an atom
- electron cloud model of an atom
- the discovery of the neutron
- current developments.

Sources

General websites that are useful:
brief overview of atomic models
early days of atom theory

The plum pudding model of an atom:
What is the plum pudding model?
How did Rutherford's gold foil experiment disprove the plum pudding model?

The solar system or planetary model of an atom:
why Rutherford developed his model - animation
how Rutherford viewed the atom
the planetary model
the nuclear atom

Electron cloud model of an atom:
Modern Atomic Theory: Models
What Is The Electron Cloud Model?
the atomic nucleus

The discovery of the neutron
Discovery of the neutron
the discovery of the neutron

Current developments:
the discovery of the top quark
the Higgs boson
What is the Large Hadron Collider?

Transition task 2: Transition Skills 1-3.

We would like you to print off and complete a minimum of 4 of following transition sheets on these core skills:

Skill 1: Basic Chemistry Competencies

- Balancing Equations
- Constructing ionic formulae
- Writing Equations from texts

Skill 2: Basic Mathematical Competencies

- Rearranging equations
- BODMAS (order of operations)
- Quantity Calculus (unit determination)
- Expressing Large and small numbers
- Significant figures, decimal places and rounding
- Unit conversions – length, mass and time and Unit conversions – volume
- Moles and Mass
- Moles and concentration

Skill 3: Basic Practical Competencies:

- Laboratory equipment
- Recording Results

Answers to these transition tasks can be found <u>here</u>:

Transition Task 2

1. Transition skills

0.1.1 Balancing equations

Balance the equations below.

1. …..C + …..O_2 → …..CO
2. …..Ba + …..H_2O → …..$Ba(OH)_2$ + …..H_2
3. …..C_2H_6 + …..O_2 → …..CO_2 + …..H_2O
4. …..HCl + …..$Mg(OH)_2$ → …..$MgCl_2$ + H_2O
5. …..N_2 + …..O_2 → …..NO
6. …..Fe_2O_3 + …..C → …..Fe + …..CO_2
7. …..CH_3CH_2OH + …..[O] → …..CH_3COOH + …..H_2O
8. …..HNO_3 + …..CuO → …..$Cu(NO_3)_2$ + H_2O
9. …..Al^{3+} + …..e^- → …..Al
10. …..$[Fe(H_2O)_6]^{3+}$ + …..CO_3^{2-} → …..$Fe(OH)_3(H_2O)_3$ + …..CO_2 + …..H_2O

(10 marks)

1. Transition skills

0.1.2 Constructing ionic formulae

1. For each of the following ionic salts, determine the cation and anion present and use these to construct the formula of the salt. (5 marks)

a. Magnesium oxide

b. Sodium sulfate

c. Calcium hydroxide

d. Aluminium oxide

e. Copper(I) oxide

2. When an acid is added to water it dissociates to form H^+ ions (which make it acidic) and an anion. These acidic hydrogen atoms can be used to determine the charge on the anion. Deduce the charge on the anions in the following acids. The acidic H atoms, H^+, have been underlined for you.

(5 marks)

a. $\underline{H_2}SO_3$

b. $\underline{H}NO_3$

c. $\underline{H_3}PO_4$

d. $HCOO\underline{H}$

e. $\underline{H_2}CO_3$

1 Transition skills

0.1.3 Writing equations from text

The following questions contain a written description of a reaction. In some cases the products may be missing as you will be expected to predict the product using your prior knowledge.

For more advanced equations you may be given some of the formulae you need.

For each one, write a balanced symbol equation for the process. (10 marks)

1. The reaction between silicon and nitrogen to form silicon nitride Si_3N_4.

....

2. The neutralisation of sulfuric acid with sodium hydroxide.

....

3. The preparation of boron trichloride from its elements.

....

4. The reaction of nitrogen and oxygen to form nitrogen monoxide.

....

5. The combustion of ethanol (C_2H_5OH) to form carbon dioxide and water only.

....

6. The formation of silicon tetrachloride ($SiCl_4$) from SiO_2 using chlorine gas and carbon.

....

7. The extraction of iron from iron(III) oxide (Fe_2O_3) using carbon monoxide.

....

8. The complete combustion of methane.

....

9. The formation of one molecule of ClF_3 from chlorine and fluorine molecules.

....

10. The reaction of nitrogen dioxide with water and oxygen to form nitric acid.

....

2. Transition skills

0.2.1 Rearranging equations

1. The amount of substance in moles (n) in a solution can be calculated when the concentration given in mol/dm^3 (c) and volume (v) in cm^3 are known by using the equation:

$$n = \frac{cv}{1000}$$

a. Rearrange this equation making c the subject of the equation. (1 mark)

b. Rearrange this equation making v the subject of the equation. (1 mark)

2. The density of a substance can be calculated from its mass (m) and volume (v) using the equation:

$$d = \frac{m}{v}$$

a. Rearrange this equation so that the mass of a substance can be calculated given its density and volume. (1 mark)

Chemists most commonly work with masses expressed in grams and volumes in cm^3. However, the SI unit for density is kg/m^3.

b. Write an expression for the calculation of density in the SI unit of kg/m^3 when the mass (m) of the substance is given in g and the volume (v) of the substance is given in cm^3.
(2 marks)

3. The de Broglie relationship relates the wavelength of a moving particle (λ) with its momentum (p) through Planck's constant (h):

$$\lambda = \frac{h}{p}$$

a. Rearrange this equation to make momentum (p) the subject of the formula. (1 mark)

Momentum can be calculated from mass and velocity using the following equation.

$$p = mv$$

b. Using this equation and the de Broglie relationship, deduce the equation for the velocity of the particle. (2 marks)

4. The kinetic energy (KE) of a particle in a time of flight mass spectrometer can be calculated using the following equation.

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

Rearrange this equation to make v the subject of the equation. (2 marks)

2. Transition skills

0.2.2 BODMAS (order of operations)

The order of operations for a calculation is very important. If operations are carried out in the wrong order then this could lead to the wrong answer. Most modern calculators will anticipate BODMAS issues when operations are entered but human beings can override the calculator's instincts.

1. Do the following calculations in your head.

(a) $3 + 5 \times 5 =$

(b) $6 \times 6 + 4 =$

(c) $20 - 6 \times 2 =$

(d) $48 - 12 \div 4 =$

(e) $4 + 4 \div 2 =$

(f) $100 - (20 \times 3) =$

(6 marks)

2. The molecular formula of glucose is $C_6H_{12}O_6$. Three students entered the following into their calculators to calculate the relative formula mass of glucose. Repeat their calculations as shown.

(a)

12	×	6	+	1	×	12	+	16	×	6	=

(b)

12	×	6	=	+	1	=	×	12	=	+	16
=	×	6	=								

(c)

(	12	×	6	)	+	(	12	×	1	)	+
(	16	×	6	)	=						

(d) Write a sentence summing up why the answers differ.

(4 marks)

2.Transition skills

0.2.3 Quantity calculus (unit determination)

1. Determine the units of density given that

$$density = \frac{mass(g)}{volume\ (cm^3)}$$

(1 mark)

2. Determine the units of concentration given that

$$concentration = \frac{number\ of\ moles\ (mol)}{volume\ (dm^3)}$$

(1 mark)

3. Pharmacists often calculate the concentration of substances for dosages. In this case the volumes are smaller, measured in cm^3, and the amount is given as a mass in grams. Determine the units of concentration when

$$concentration = \frac{mass\ (g)}{volume\ (cm^3)}$$

(1 mark)

4. Rate of reaction is defined as the *'change in concentration per unit time'*. Determine the units for rate when concentration is measured in mol dm^{-3} and time in seconds.

(1 mark)

5. Pressure is commonly quoted in pascals (Pa) and can be calculated using the formula below. The SI unit of force is newtons (N) and area is m^2.

$$pressure = \frac{force}{area}$$

Use this formula to determine the SI unit of pressure that is equivalent to the Pascal.

(1 mark)

6. Determine the units for each of the following constants (K) by substituting the units for each part of the formula into the expression and cancelling when appropriate. For this exercise you will need the following units [ ] = mol dm^{-3}, rate = mol dm^{-3} s^{-1}, p = kPa.

a. $K_c = \frac{[A][B]^2}{[C]}$

b. $K = \frac{rate}{[A][B]}$

c. $K_p \frac{(pA)^{0.5}}{(pB)}$

d. $K_w = [H^+][OH^-]$

e. $K_a = \frac{[H^+]\,[X^-]}{[HX]}$

2. Transition skills

0.2.4 Expressing large and small numbers

Standard form and scientific form

Large and small numbers are often expressed using powers of ten to show their magnitude. This saves us from writing lots of zeros, expresses the numbers more concisely and helps us to compare them.

In standard form a number is expressed as;

$\boldsymbol{a \times 10^{n}}$

where ***a*** is a number between 1 and 10 and ***n*** is an integer.

Eg, 160 000 would be expressed as 1.6×10^{5}

Sometimes scientists want to express numbers using the same power of ten. This is especially useful when putting results onto a graph axis. This isn't true standard form as the number could be smaller than 1 or larger than 10. This is more correctly called **scientific form**.

Eg, 0.9×10^{-2}, 2.6×10^{-2}, 25.1×10^{-2} and 101.6×10^{-2} are all in the same scientific form.

1. Express the following numbers using standard form.

a. 1 060 000
b. 0.001 06
c. 222.2

(3 marks)

2. The following numbers were obtained in rate experiments and the students would like to express them all on the same graph axes. Adjust the numbers to a suitable scientific form.

0.1000	0.0943	0.03984	0.00163

(3 marks)

3. Calculate the following without using a calculator. Express all values in standard form.

a. $\frac{10^9}{10^5}$

b. $\frac{10^7}{10^{-7}}$

c. $\frac{1.2 \times 10^6}{2.4 \times 10^{17}}$

d. $(2.0 \times 10^7) \times (1.2 \times 10^{-5})$

(4 marks)

2.Transition skills

0.2.5 Significant figures, decimal places and rounding

For each of the numbers in questions 1–6, state the number of significant figures and the number of decimal places.

		Significant figures	Decimal places
1	3.131 88		
2	1000		
3	0.000 65		
4	1006		
5	560.0		
6	0.000 480		

(6 marks)

7. Round the following numbers to (i) 3 significant figures and (ii) 2 decimal places.

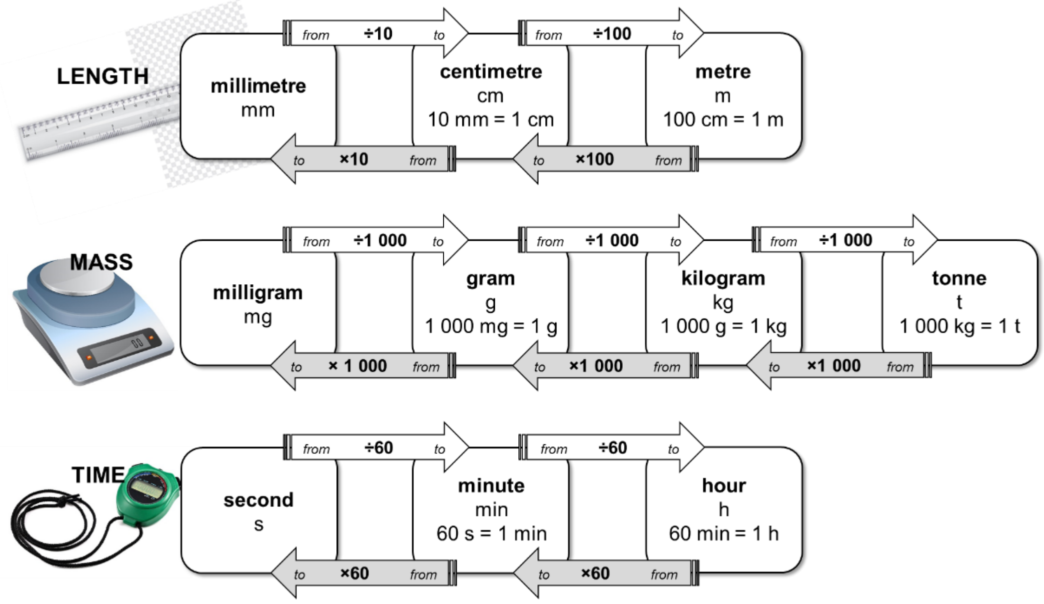
a. 0.075 84
b. 231.456

(4 marks)

2. Transition skills

0.2.6 Unit conversions 1 – Length, mass and time

Mo's teacher has drawn a diagram on the board to help him with converting quantities from one unit into another.



For example, to convert a length in millimetres into units of centimetres, divide by 10, eg 10 mm = 1 cm.

Use the diagram to help with the following unit conversions. (10 marks)

1. A block of iron has a length of 1.2 cm. Calculate its length in millimetres.

2. The width of the classroom is 7200 cm. Calculate its length in metres.

3. A reaction reaches completion after 4½ minutes. Convert this time into seconds.

4. The stop clock reads 2 min 34 s. Convert this time into seconds.

5. A method states that a reaction needs to be heated under reflux for 145 min. Calculate this time in hours and minutes.

6. A factory produces 15 500 kg of ammonia a day. Calculate the mass of ammonia in tonnes.

7. A paper reports that 0.0265 kg of copper oxide was added to an excess of sulfuric acid. Convert this mass of copper oxide into grams.

8. A packet of aspirin tablets states that each tablet contains 75 mg of aspirin. Calculate the minimum number of tablets that contain a total of 1 g of aspirin.

9. A student measures a reaction rate to be 0.5 g/s. Convert the rate into units of g/min.

10. A factory reports that it produces fertiliser at a rate of 10.44 kg/h. Calculate the rate in units of g/s.

2.Transition skills

0.2.7 Unit conversions 2 – Volume

The SI unit for volume is **metre cubed, m³**. However as volumes in chemistry are often smaller than 1 m³, fractions of this unit are used as an alternative.

centimetre cubed, cm³	**decimetre cubed, dm³**
centi- *prefix* one hundredth	**deci-** *prefix* one tenth
1 cm = $\frac{1}{100}$ m so,	1 dm = $\frac{1}{10}$ m so,
1 cm³ = $\left(\frac{1}{100}\right)^3$ m³ = $\left(\frac{1}{1\,000\,000}\right)$ m³	1 dm³ = $\left(\frac{1}{10}\right)^3$ m³ = $\left(\frac{1}{1\,000}\right)$ m³

1. Complete the table by choosing the approximate volume from the options in bold for each of the everyday items (images not drawn to scale). (1 mark)

1 cm³ **1 dm³** **1 m³**

			
	drinks bottle	sugar cube	washing machine
Approx. volume			

2. Complete the following sentences; (1 mark)

To convert a volume in **cm³** into a volume in **dm³**, divide by.............................

To convert a volume in **cm³** into a volume in **m³**, divide by...............................

3. a. A balloon of helium has a volume of 1600 cm³. What is its volume in units of dm³?

b. The technician has prepared 550 cm³ of HCl(aq). What is its volume in units of m³?

c. An experimental method requires 1.35 dm³ of NaOH(aq). What volume is this in cm³?

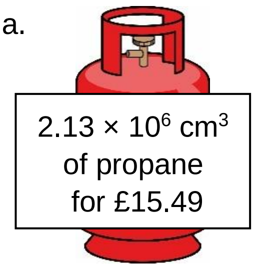
d. A swimming pool has a volume of 375 m³. What volume is this in cm³?

e. A 12 g cylinder of CO_2 contains 6.54 dm³ of gas. What volume of gas is this in units of m³?

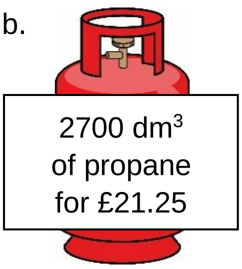
(5 marks)

4. Which cylinder of propane gas is the best value for money? (3 marks)

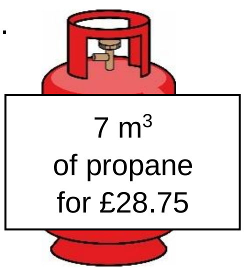
a.



b.



c.



2.Transition skills

0.2.8 Moles and mass

One mole of a substance is equal to **6.02×10^{23} atoms**, **ions** or **particles** of that substance. This number is called the **Avogadro constant**.

The value of the Avogadro constant was chosen so that the relative formula mass of a substance weighed out in grams is known to contain exactly 6.02×10^{23} particles. We call this mass its **molar mass**.

We can use the equation below when calculating an amount in moles:

$$\text{amount of substance (mol)} = \frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1}\text{)}}$$

How is a mole similar to a dozen?

Stating the amount of substance in moles is just the same as describing a quantity of eggs in dozens. You could say you had 24 or 2 dozen eggs.

Use the equation above to help you answer the following questions.

1. Calculate the amount of substance, in moles, in: (3 marks)

a. 32 g of methane, CH_4 (molar mass, 16.0 g mol^{-1})

b. 175 g of calcium carbonate, $CaCO_3$

c. 200 mg of aspirin, $C_9H_8O_4$

2. Calculate the mass in grams of: (3 marks)

a. 20 moles of glucose molecules (molar mass, 180 g mol^{-1})

b. 5.00×10^{-3} moles of copper ions, Cu^{2+}

c. 42.0 moles of hydrated copper sulfate, $CuSO_4 \bullet 5H_2O$

3. a. 3.09 g of a transition metal carbonate was known to contain 0.0250 mol.

i. Determine the molar mass of the transition metal carbonate. (1 mark)

ii. Choose the most likely identity for the transition metal carbonate from the list below:

$CoCO_3$ **$CuCO_3$** **$ZnCO_3$** (1 mark)

b. 4.26 g of a sample of chromium carbonate was known to contain 0.015 mol.

Which of the following is the correct formula for the chromium carbonate? (2 marks)

$CrCO_3$ **$Cr_2(CO_3)_3$** **$Cr(CO_3)_3$**

BONUS QUESTION

If you had 1 mole of pennies which you could share with every person on earth how much could you give each person? Approximate world population = 7 500 000 000.

2. Transition skills

0.2.9 Moles and concentration

To calculate the concentration of a solution we use the equation:

$$\text{concentration (mol dm}^{-3}\text{)} = \frac{\text{amount of substance (mol)}}{\text{volume (dm}^3\text{)}}$$

Use the equation to help you complete each of the statements in the questions below.

1. a. 1.5 mol of NaCl dissolved in 0.25 dm^3 of water produces a solution with a concentration of.................................mol dm^{-3}. (1 mark)

b. 250 cm^3 of a solution of HCl(aq) with a concentration of 0.0150 mol dm^{-3} contains ....moles. (1 mark)

c. A solution with a concentration of 0.85 mol dm^{-3} that contains 0.125 mol has a volume of ....dm^3. (1 mark)

2. In this question you will need to convert between an amount in moles and a mass as well as using the equation above.

Space for working is given beneath each question.

a. 5.0 g of $NaHCO_3$ dissolved in 100 cm^3 of water produces a solution with a concentration of .... mol dm^{-3}. (2 marks)

b.25.0 cm^3 of a solution of NaOH(aq) with a concentration of 3.8 mol dm^{-3} contains .... g of NaOH. (2 marks)

c. The volume of a solution of cobalt(II) chloride, $CoCl_2$, with a concentration of 1.3 mol dm^{-3} that contains 2.5 g of $CoCl_2$ is ....cm^3. (3 marks)

3.Transition skills

0.3.1 Laboratory equipment

Practical work is a key aspect in the work of a chemist.

To help you plan effective practical work it is important that you are familiar with the common laboratory equipment available to you.

1. For each of the pieces of glassware shown in the images below, state their name and give a possible volume(s).

a. 

Name: ....

Possible volume(s): ....

b. 

Name: ....

Possible volume(s): ....

c. 

Name: ....

Possible volume(s): ....

d. 

Name: ....

Possible volume(s): ....

e. 

Name: ....

Possible volume(s): ....

f. 

Name: ....

Possible volume(s): ....

(6 marks)

2. Name the common laboratory equipment in the images below. (4 marks)

a. 

....

b. 

....

c. 

....

d. 

3. Transition skills

0.3.2 Recording results

1. A student is looking at endothermic processes. He adds 2.0 g of ammonium nitrate to 50 cm^3 of water and measures the temperature change. He repeats the experiment three times.

His results are shown in the table below.

	Temperature at start	**Temperature at end**	**Temperature change**
Run 1	21.0	–1.1	22.1
Run 2	20	–2	22
Run 3	20.2	2	18.2
Mean			**22.05**

Annotate the table to suggest **five ways** in which the table layout and the recording and analysis of his results could be improved. (5 marks)

2. For each of the experiments described below, design a table to record the results.

Experiment 1: Simon is investigating mass changes during chemical reactions. He investigates the change in mass when magnesium ribbon is oxidised to form magnesium oxide:

magnesium + oxygen → magnesium oxide

He records the mass of an empty crucible. He places a 10 cm strip of magnesium ribbon in the crucible and records the new mass of the crucible. He heats the crucible strongly until all the magnesium ribbon has reacted to form magnesium oxide. He allows the crucible to cool before recording the mass of the crucible and magnesium oxide.

Experiment 2: Nadiya is investigating how the rate of a reaction is affected by concentration. She investigates the reaction between magnesium ribbon and hydrochloric acid.

magnesium + hydrochloric acid → magnesium chloride + hydrogen

She places 25 cm^3 of hydrochloric acid with a concentration of 0.5 mol dm^{-3} into a conical flask and fits a gas syringe. She adds a 3.0 cm strip of magnesium ribbon and measures the volume of hydrogen gas produced every 20 s for 3 minutes.

She repeats the experiment with hydrochloric acid with concentrations of 1.0 mol dm^{-3} and then 1.5 mol dm^{-3}. (5 marks)