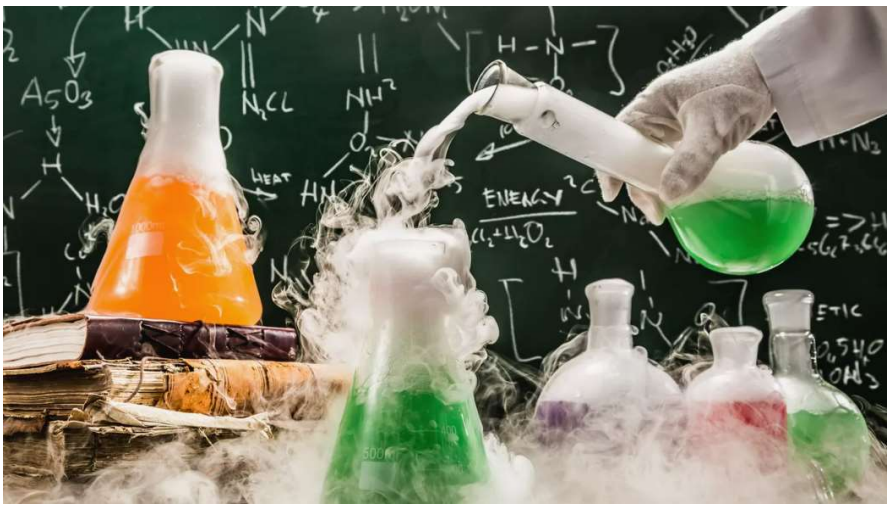
MASTER

Kirkcaldy High School



S3 Chemistry

Unit 1

Rates of Reaction

Name:_____

Class:_____

Teacher:_____

Assessment Page

End of topic questions

Topic title	Date	Mark/Total Mark
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		/
		/
		/
		/
		/

Homework

Homework title	Date	Mark/Total Mark
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		/
		/
		/

Check test

Test title	Date	Mark/Total Mark
		/

Teacher comments

Using Command Words

Command words in questions are crucial as they guide us on the specific type of response required. Let's delve into some examples within the context of simple chemistry concepts, focusing on the states of matter. These are arranged into the level of detail that must be given and therefore their difficulty, from least to most.

In chemistry, often a drawn diagram will give you a mark instead of a written answer as long as it is labelled.

Identify:

This command word requires you to establish and name a particular item or concept.

For instance*, "Identify the three states of matter."*

In response, you would say*, "The three states of matter are solid, liquid, and gas."*

State: This command word requires you to express the main points concisely.

For instance, "State the process of changing from a solid to a gas."

Your answer would be*, "The process of changing from a solid to a gas is called sublimation."*

Indicate: This command word requires you to point out or show something.

For instance, *"Indicate whether the volume of a gas is fixed or variable."*

Your answer would be, *"The volume of a gas is variable."*

Provide/Give: These command words mean you need to present a specific item or concept, often an example.

For instance, *"Provide an example of a liquid."*

You could answer, *"An example of a liquid is water."*

Describe: Here, you are expected to provide a detailed account of a particular topic.

For example, *"Describe the properties of a solid state of matter."*

You would respond by saying*, "Solids have a definite shape and volume. The particles in solids are closely packed together and vibrate in fixed positions."*

Outline: This command word asks you to give a brief summary or overview of a topic.

For example, *"Outline the process of evaporation."*

You might respond, *"Evaporation is the process by which liquid turns into gas upon heating. It occurs when the particles of a liquid gain enough energy to leave the liquid and become gas."*

Explain: This command word asks you to make something clear or easy to understand by describing it in more detail.

For example, "Explain why gases easily fill their containers."

An appropriate answer might be, *"Gases easily fill their containers because their particles are free to move in all directions and will spread out until they occupy the entire container."*

Discuss: This command word is asking you to present a detailed and balanced argument about a specific topic.

For example, "Discuss the importance of understanding the states of matter."

Your response would involve discussing various aspects like the role of states of matter in natural phenomena, their significance in various scientific and industrial processes, etc.

Create: This command word often represents one of the highest levels of difficulty in command words. It requires not just recall or understanding of existing knowledge, but the ability to generate new ideas or products based on that knowledge. It involves synthesis, imagination, and critical thinking, and it's often used in tasks such as designing an experiment, writing an original essay, or proposing a solution to a problem.

Date: _____

Chemical and physical changes

Learning Intentions

- To learn about the difference between chemical and physical changes.

Success Criteria

- ☐ I can identify and define physical and chemical changes.
- ☐ I can describe processes and outcomes of physical changes.
- ☐ I can explain processes and outcomes of chemical changes.
- ☐ I can outline and discuss key differences between physical and chemical changes by giving examples of each.

Introduction

Chemical and **physical** changes are two types of changes that can happen to **matter**. They are different, and knowing the difference helps us understand the world around us better.

Physical Changes

A physical change happens when a substance changes its **form** or looks different, but its chemical makeup **stays the same**. Physical changes can usually be **reversed**.

Examples of physical changes are:

- **Melting ice**
- **Boiling water**
- **Breaking a glass**

In all these examples, the substance itself doesn't change, only its **state** or **shape**.

Chemical Changes

A chemical change happens when the chemical makeup of a substance changes and **new substances are formed**. Chemical changes are usually not reversible.

Examples of chemical changes are:

- **Burning wood**
- **Rusting iron**
- **Digesting food**

In these cases, the original substance changes into something new and different.

Summary

The main difference between **physical** and **chemical changes** is in the substance's **composition**. In a **physical change**, the **chemical makeup** stays the same, but the **form** or **appearance** changes. In a **chemical change** a new **substance** is created. Understanding these differences helps us make sense of the changing world around us.

Key words:

Bonds: The forces that hold atoms together in a molecule or compound.

Composition: The makeup of a substance, including the types and amounts of its constituent elements, molecules, or compounds.

Matter: Anything that has mass and takes up space, including solids, liquids, and gases.

Reversible: The ability to return to the original state or condition, often applied to physical changes that can be undone.

State: The form in which matter exists, such as solid, liquid, or gas.

Questions

1. **Identify** the two types of changes that can happen to matter.

2. **Describe** what happens to a substance during a physical change.

3. **State** whether physical changes are generally reversible or irreversible.

4. **Provide** an example of a physical change.

5. **Explain** what happens to a substance during a chemical change.

6. **Indicate** whether chemical changes are generally reversible or irreversible.

7. **Give** an example of a chemical change.

8. **Outline** the key difference between physical and chemical changes.

9. **Discuss** how understanding the differences between physical and chemical changes helps us make sense of the world around us.

Date: _____

Signs of a chemical reaction

Learning Intentions

- To learn how to observe and name signs of a chemical reaction.

Success Criteria

- ☐ I can state the words used to describe the observed signs of chemical reactions.
- ☐ I can describe the chemical significance of each of the signs of chemical reactions.
- ☐ I can explain the importance of recognising the signs of chemical reactions.

Introduction

Chemical reactions involve the transformation of one or more substances into new substances with different properties. Observing these transformations is essential to understanding chemistry and recognizing when a chemical reaction has occurred. There are several key signs or indicators of a chemical reaction that can help us identify when a reaction is taking place.

Signs of a Chemical Reaction

Fill in the blanks to begin with.

Once you have completed an experiment that shows each of following signs, come back and draw an annotated diagram for each..

- **Effervescence**: The production of gas bubbles during a reaction, often observed as **fizzing** or **bubbling** in a liquid. This is a result of the formation of a **gas** as one of the **products** of the reaction.

- **Colour change:** A reaction may cause a substance to **change colour**, indicating that **new chemical co**mpounds have formed.

- **Precipitation**: The formation of a **solid** (**precipitate**) from a solution during a reaction. This occurs when two **soluble** reactants combine to form an **insoluble** product that **settles** out of the solution.

- **Temperature change**: Some reactions **release** energy (exothermic) or **absorb** energy (endothermic) in the form of **heat**. A noticeable change in temperature, either an increase or decrease, can be a sign that a chemical reaction is occurring.

    - **Exothermic**: A reaction that involves a **release** of heat, which results in the surroundings becoming warmer

    - **Endothermic**: A reaction that involves **absorption** of heat, which results in the surroundings becoming colder

Signs of a chemical reaction experiment

Aim: _____

_____

Method:

Results:

Reaction	Observation	Chemical Reaction? (yes/no)
A + B		
C + D		
E + F		
G + H		
I + J		
K + L		
M + N		
O + P		

Conclusion: _____

_____

_____

Importance of Recognizing Signs

Being able to recognize the signs of a chemical reaction is crucial for understanding and predicting the behaviour of substances in various contexts, such as in laboratory experiments, industrial processes, and even everyday situations (e.g. cooking food). Identifying these signs can also help us determine the conditions necessary for specific reactions to occur and guide us in controlling and optimizing these processes.

Create a mind map/flow chart to summarise signs of a chemical reaction

Questions

1. **Define** effervescence and how it indicates that a chemical reaction has occurred.

2. **Define** precipitation and how it signifies a chemical reaction.

3. **Describe** how a temperature change can indicate that a chemical reaction is taking place.

4. **Describe** how a colour change can help identify a chemical reaction.

5. **Explain** the importance of recognizing the signs of a chemical reaction.

6. **Provide** an example of an everyday situation where recognizing the signs of a chemical reaction might be useful.

7. **Discuss** the importance of recognizing the signs of a chemical reaction in laboratory experiments.

8. **Explain** how observing the signs of a chemical reaction can aid in controlling and optimizing industrial processes. *You may wish to research your answer.*

9. **Discuss** how the signs of a chemical reaction help us understand and predict the behaviour of substances in various contexts. *You may wish to research your answer.*

Date: _____

Reactions

Learning Intentions

- To learn about collision theory.

Success Criteria

- ☐ I can state what happens to particles when chemicals react
- ☐ I can describe reactions in terms of collision theory
- ☐ I can state the factors that effect the rate of reaction
- ☐ I can explain why the factors cause a change in rate in terms of collisions

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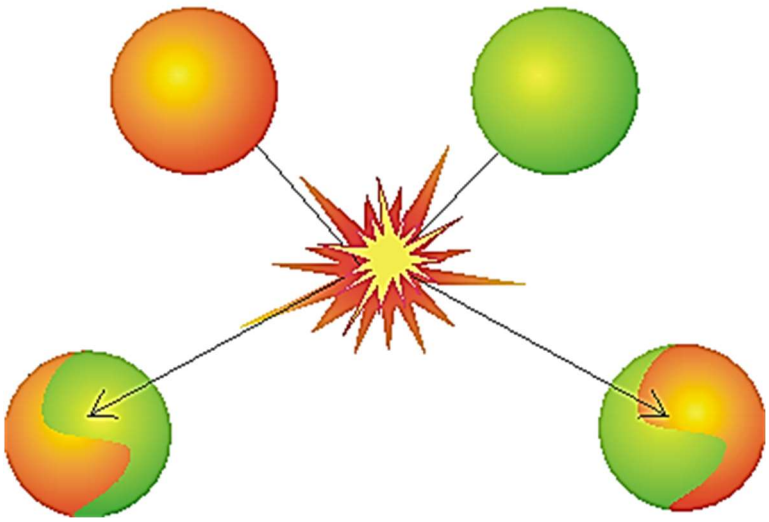
Introduction

Reactions involve changes in the **arrangement** of atoms or molecules, resulting in the formation of **new substances**. A key factor that influences these reactions is the **collision** of **particles**. Understanding the role of particle collisions in reactions provides valuable insight into the world of chemistry.

Particle Collisions

For a reaction to occur, particles of the reacting substances, such as atoms, molecules, or ions, must **collide** with each other. These collisions bring the **particles** into **close contact**, allowing them to **exchange** or **rearrange** their components and create **new substances**.

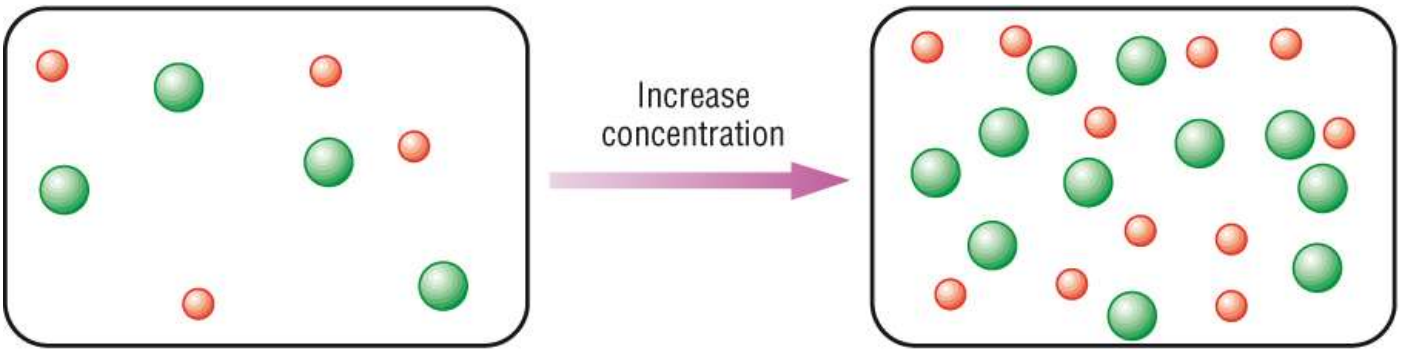
Remember:
A chemical change happens when the chemical makeup of a substance changes and new substances are formed. Chemical changes are usually not reversible.



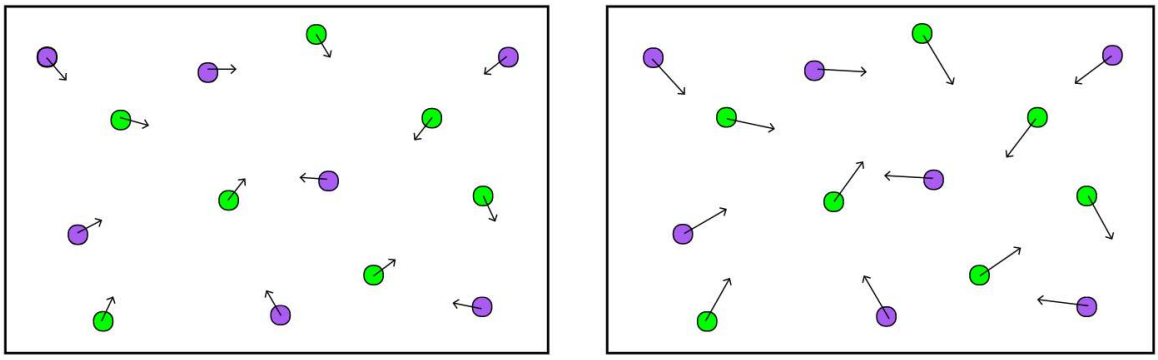
Factors Affecting Collisions

Several factors influence the likelihood and effectiveness of **particle collisions**, which in turn affect the rate of reactions:

Concentration: Higher concentrations of reactants increase the chances of particle collisions as there are **more particles**, leading to a faster reaction rate.

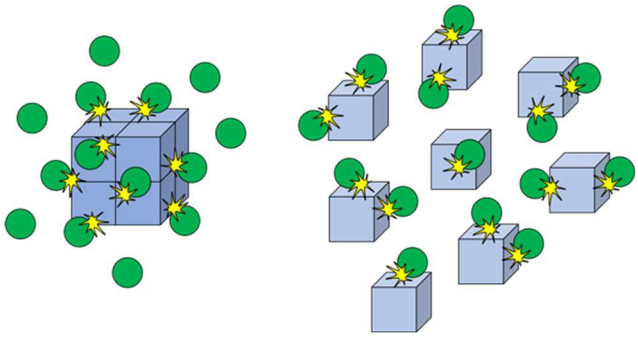


Temperature: Higher temperatures cause particles to **move faster**, resulting in **more frequent** collisions, which can increase the reaction rate.



Lower temperature Higher temperature

Surface area: Increasing the surface area of reactants **exposes** more particles to **potential** collisions, increasing the reaction rate.



Catalysts: **<u>Catalysts are substances that can speed up reactions without being used up.</u>**

Summary

Particle collisions play a crucial role in reactions, as they bring reacting particles into close contact, allowing for the exchange or rearrangement of atoms. Factors such as concentration, temperature, surface area, and the presence of catalysts can influence the frequency and effectiveness of these collisions. By understanding the importance of particle collisions in reactions, we can better comprehend the complex chemical processes occurring in the world around us.

Create a mind map/flow chart to summarise factors that change the rate of reactions.

Key words:

Atoms: The basic units of matter, consisting of a nucleus (containing protons and neutrons) and electrons surrounding the nucleus.

Catalysts: Substances that speed up chemical reactions by lowering the activation energy required for effective particle collisions, without being consumed or permanently altered in the reaction

Collision: The process of particles (atoms, molecules, or ions) coming into contact with each other, which is essential for chemical reactions to occur.

Concentration: A measure of the amount of a substance (solute) dissolved in a specific volume of solution, often expressed as moles per litre (M).

Molecules: Groups of two or more atoms bonded together, which represent the smallest fundamental units of a chemical compound.

Rate: The speed at which a reaction or process occurs, often measured as the change in the concentration of reactants or products over time.

Reactions: Chemical processes in which atoms or molecules rearrange to form new substances, often involving the breaking and forming of chemical bonds.

Surface area: The total area on the surface of a solid object, which can affect the rate of reactions by influencing the number of exposed particles available for collisions.

Temperature: A measure of the heat energy is a system, measured in ^{o}C.

Questions

1. **Define** what needs to happen between particles, such as atoms, molecules, or ions, for a reaction to occur.

2. **Explain** why particle collisions are important in chemical reactions.

3. **Describe** the concept of the reaction rate and its relationship to particle collisions.

4. **Discuss** how the concentration of reactants affects the likelihood of particle collisions and the reaction rate.

5. **Explain** the influence of temperature on the frequency of particle collisions and the reaction rate.

6. **Describe** the relationship between the surface area of reactants and the reaction rate.

7. **Explain** how increasing the concentration of reactants affects the reaction rate.

8. **Discuss** the role of temperature in particle movement and collision frequency.

9. **Evaluate** whether the rate of a reaction can be decreased and, if so, explain how.

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Check your answers.

Extension questions:
Chemcord purple books (N5): page 1 – 6

Hyperlinked past papers(N5):

Topic	2015	2016	2017	2018	2019
Rate of reaction		MC – 2 S2 – 3b(ii & iii)		MC - 1	

MC = multiple choice section, S2 = section 2, the written section.

Date: _____

Rate of Reaction Experiments

Learning Intentions

- To investigate rates of reactions experimentally

Success Criteria

☐ I can make accurate observations

☐ I can write detailed lab reports

☐ I can construct aims and draw conclusions given just the written method.

Investigating rates of reactions

As you progress through this section, you will embark on a series of experiments designed to enhance your understanding of reaction rates and their underlying principles. Each experiment has been carefully curated to showcase the influence of various parameters, such as reactant concentration, temperature, surface area, and the presence of catalysts, on the speed of chemical reactions. You will be using the **laboratory booklet** pages **7 – 11** to help you carry them out.

By carrying out these experiments and writing lab reports, you will not only develop a solid foundation in the study of reaction rates, but also sharpen your **observational** and **analytical** skills. As you proceed, we encourage you to think **critically** about the results you obtain, **compare** them with established theories, and foster a deeper understanding of the chemical processes at play.

These hands-on activities will ignite your curiosity and inspire you to further explore the intricacies of chemical reactions and their real-world applications. So, let's dive in and uncover the secrets behind the fascinating phenomena of reaction rates.

Reaction Title: _____

Aim: _____
_____

Method:

Results:

Conclusion: _____
_____
_____

Evaluation: _____
_____
_____

Reaction Title: _____

Aim: _____

_____

Method:

Results:

Conclusion: _____

_____

_____

Evaluation: _____

_____

_____

Reaction Title: _____

Aim: _____

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Method:

Results:

Conclusion: _____

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Evaluation: _____

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Reaction Title: _____

Aim: _____

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Method:

Results:

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Conclusion: _____

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Evaluation: _____

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Reaction Title: _____

Aim: _____

_____

Method:

Results:

Conclusion: _____

_____

_____

Evaluation: _____

_____

_____

Date: _____

Measuring the rate

Learning Intentions

- To learn how to measure the rate of reaction

Success Criteria

- ☐ I can state the two main methods used to measure the rate of reaction.
- ☐ I can describe how to measure the rate using these methods.
- ☐ I can draw a diagram of the methods used to measure rates of reaction.
- ☐ I can draw a line graph of the rate of reaction
- ☐ I can explain which method would be best suited for a particular experiment.

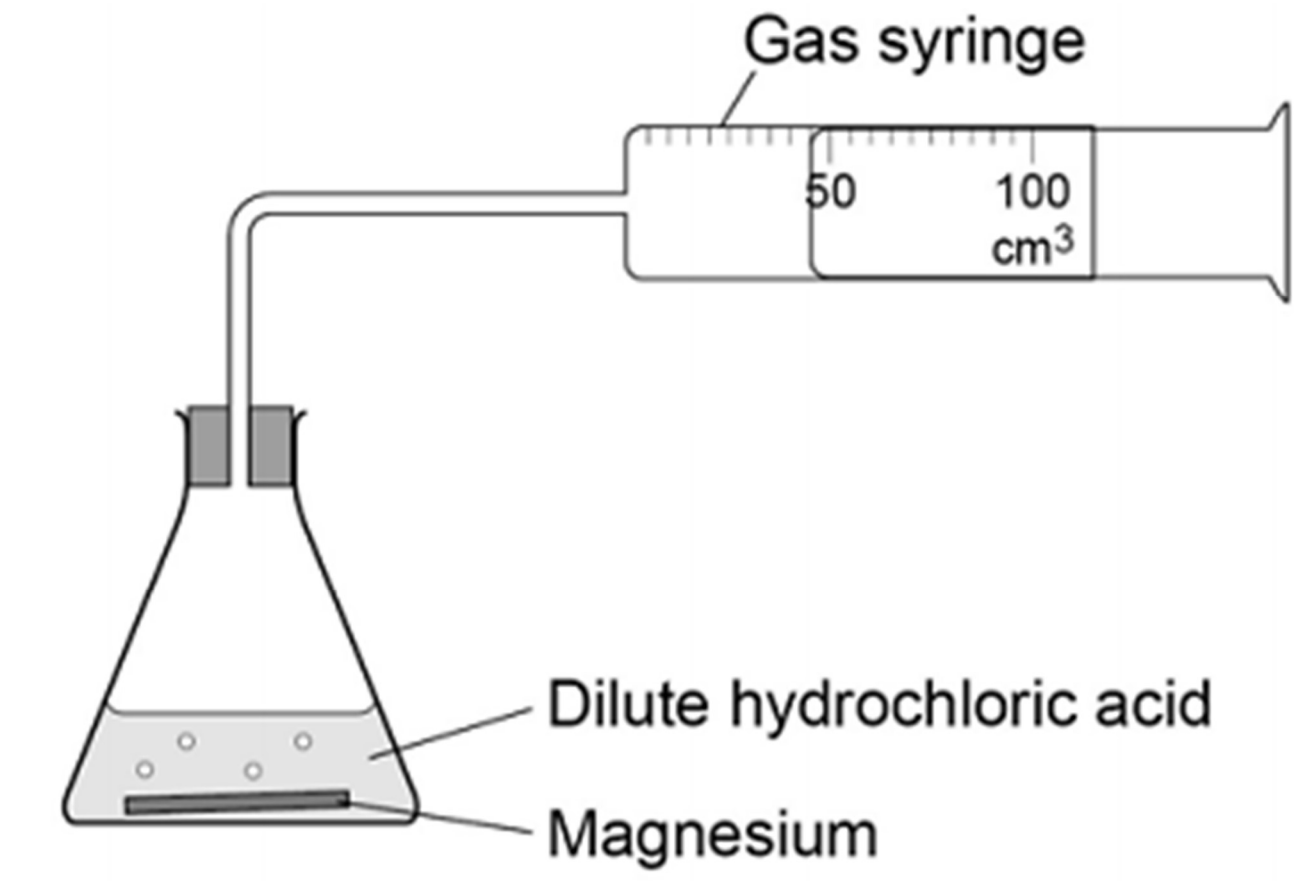
Introduction

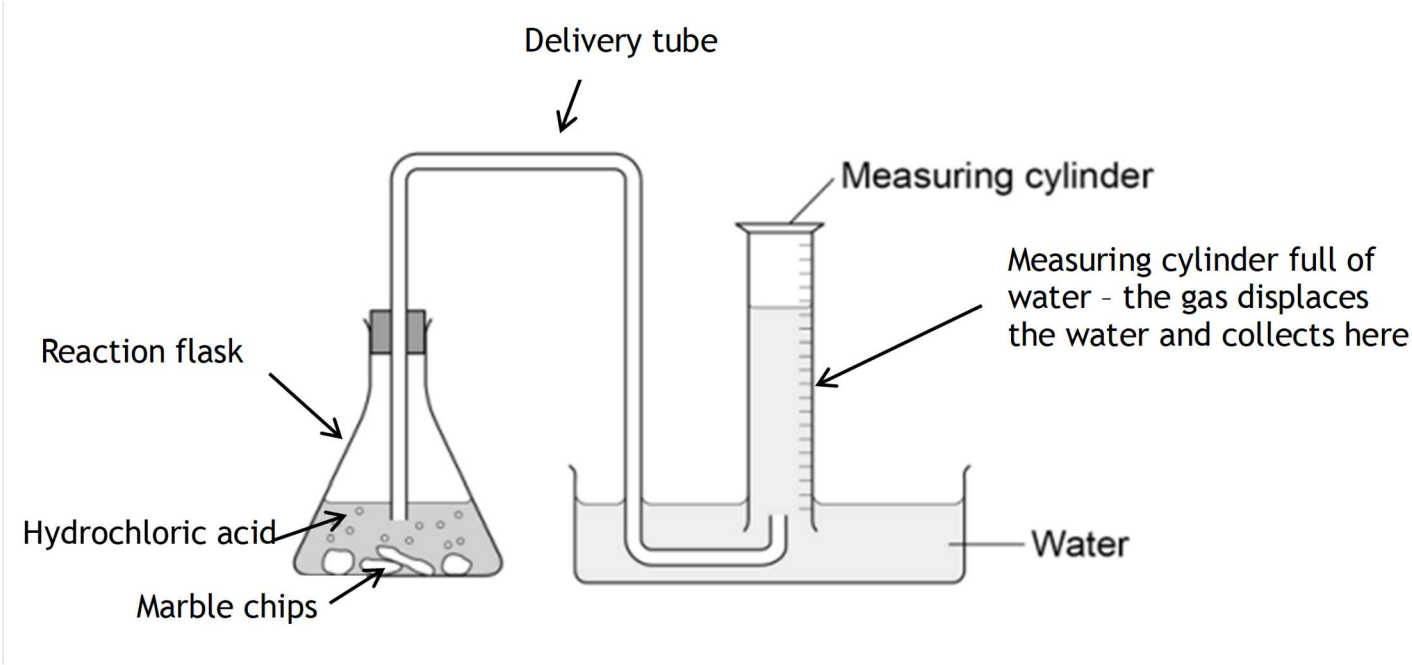
The rate of reaction is an important aspect of understanding chemical processes, as it provides information on how quickly reactants are transformed into products. There are several methods for measuring the rate of reaction, with two common approaches being the measurement of the volume of gas produced or the measurement of mass loss during the reaction. These methods allow scientists to track the progress of a reaction and quantify its rate.

Measuring the Volume of Gas Produced

In reactions that produce a gas as a product, one way to measure the rate of reaction is to collect and measure the volume of **gas produced** over time. This can be done using a **gas syringe** or a **graduated cylinder filled** with water and inverted in a water bath. As the gas is produced, it **displaces water** or **air** in the collection apparatus, allowing for an accurate measurement of the gas volume. By recording the volume at regular **time intervals**, the rate of gas production can be determined, which in turn provides information on the reaction rate.

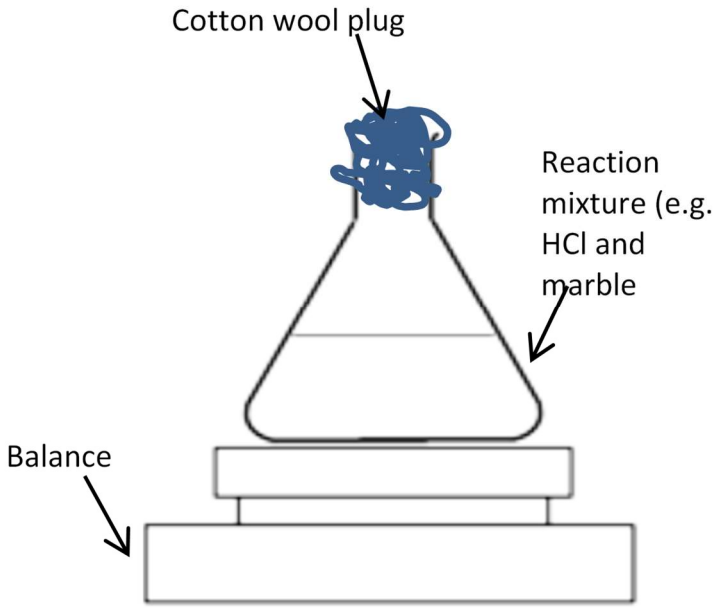
Diagrams


Gas syringe
50
100
cm3
Dilute hydrochloric acid
Magnesium


Delivery tube
Measuring cylinder
Measuring cylinder full of water – the gas displaces the water and collects here
Reaction flask
Hydrochloric acid
Marble chips
Water

Measuring Mass Loss

In some reactions, a reactant is transformed into a **gas** that **escapes** the **reaction vessel**, leading to a **decrease in mass**. In these cases, the reaction rate can be determined by **measuring** the mass **loss over time**. To do this, the reaction vessel can be placed on an electronic **balance**, and the **mass** can be **continuously** recorded as the reaction progresses. As the mass decreases, the rate of mass loss can be calculated, which provides information on the reaction rate.



Factors to Consider

When selecting a method to measure the rate of reaction, it is important to consider the **specific reaction** and the **apparatus** available. Both the measurement of gas volume and mass loss can provide accurate results, but each method may be more **suitable** for specific reactions or experimental setups. If the gas produced is **soluble** in water, the inverted graduated **measuring cylinder** is **not** suitable.

Reaction Title: _____

Aim: _____
_____

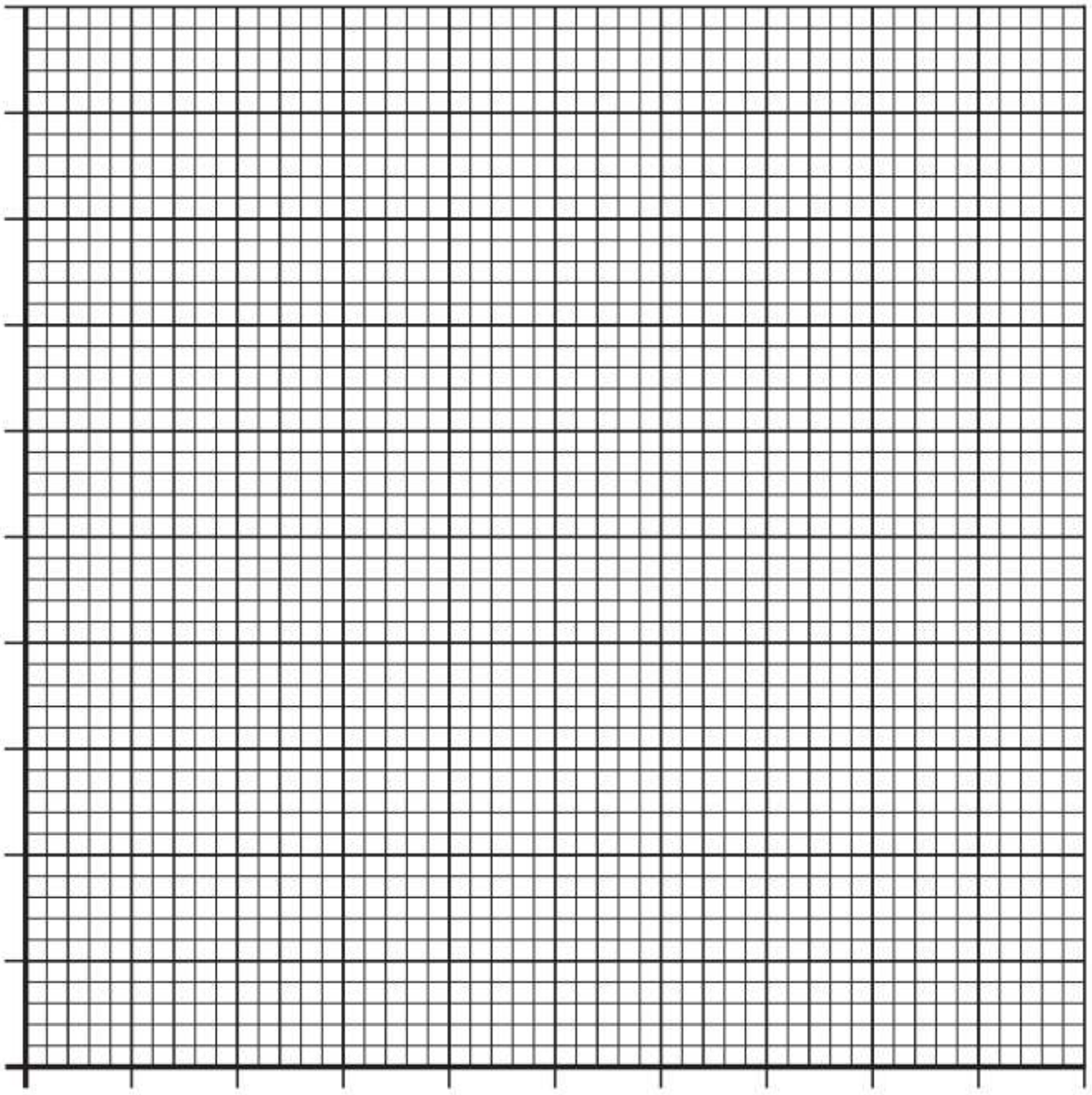
Method:

Results:

Conclusion: _____
_____
_____

Evaluation: _____
_____
_____

Draw a graph of your results:



Reaction Title: _____

Aim: _____
_____

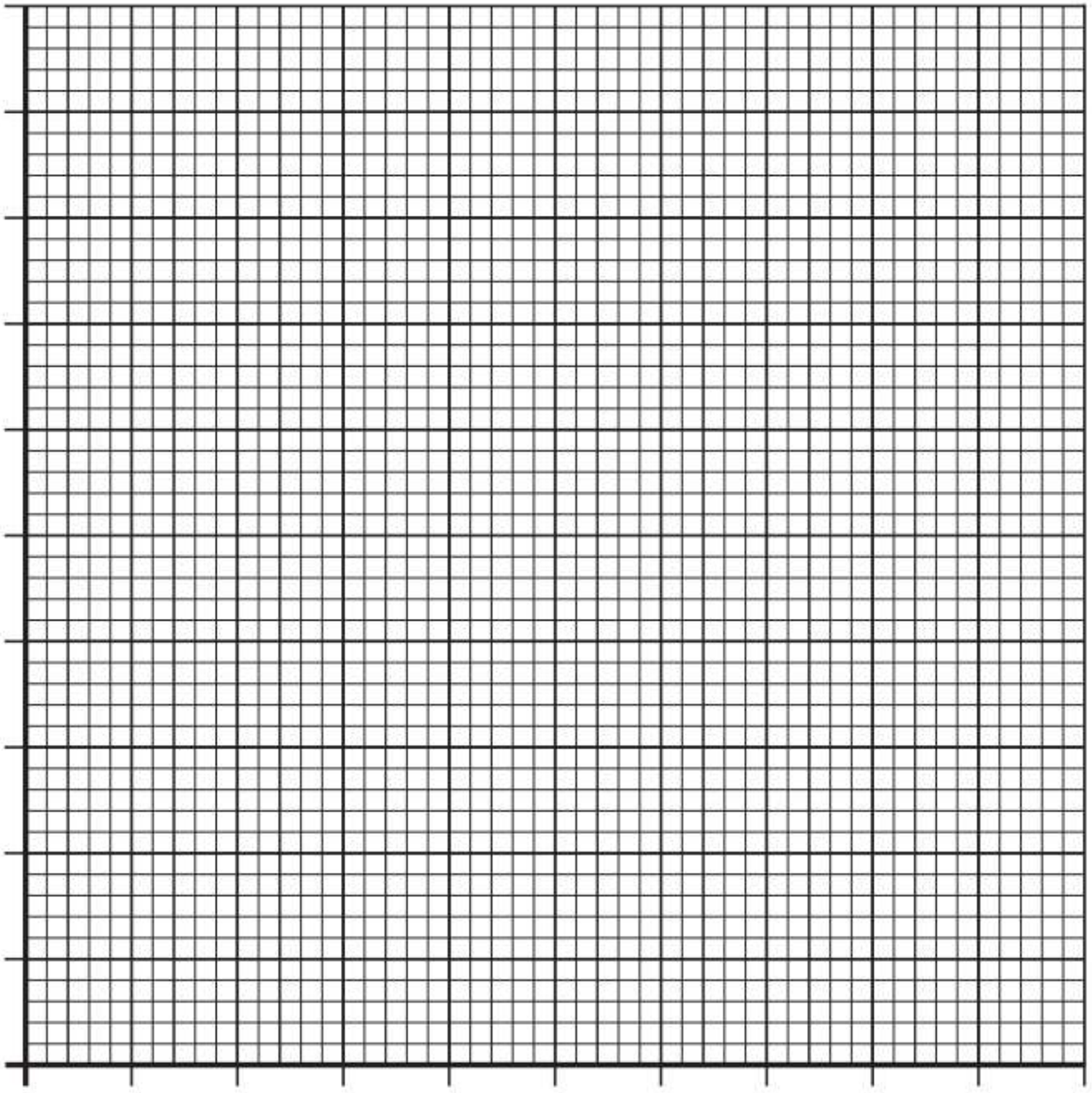
Method:

Results:

Conclusion: _____
_____
_____

Evaluation: _____
_____
_____

Draw a graph of your results:



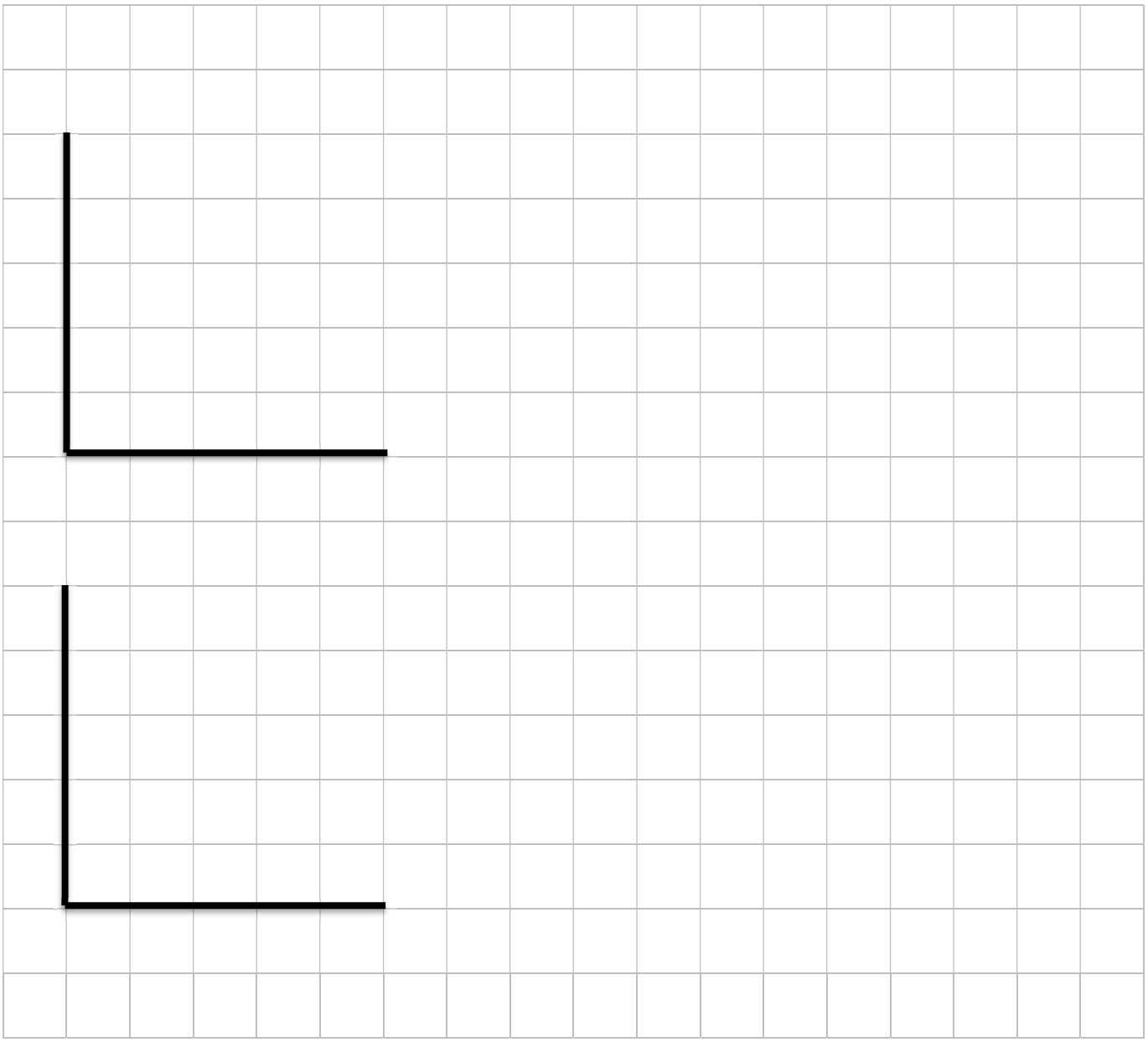
Summary page

i. Draw a sketch of each of the types of graphs.

ii. Include a sketch of the apparatus associated with the graph on the right hand side.

iii. With a different coloured pen, sketch the on top of the previous graph another curve with a faster/slower rate of reaction. Mark

iv. Mark on each graph where the end of the reaction and the total volume of gas produced can be read on the *x* and *y* axis.



Questions

1. **Explain** why measuring the rate of reaction is important for understanding chemical processes.

2. **Identify** the two common approaches for measuring the rate of reaction described in the passage.

3. **List** some apparatuses that can be used to collect and measure the volume of gas produced during a reaction.

4. **Describe** how the rate of gas production can be determined from the collected data.

5. **Discuss** the types of reactions where measuring mass loss is an appropriate method for determining the rate of reaction.

6. **Consider** what factors should be taken into account when selecting a method to measure the rate of reaction.

7. **Evaluate** how temperature, concentration, and catalysts can affect the rate of reaction.

8. **Evaluate** the importance of choosing an appropriate method for measuring the rate of reaction for specific reactions or experimental setups.

Date: _____

Average rate

Learning Intentions

- To learn how to calculate the average rate of reaction

Success Criteria

☐ I can state which equation is used to measure the average rate of reaction.

☐ I can calculate the average rate of reaction.

☐ I can use appropriate units for the rate of reaction.

☐ I can compare and explain different average rates of reaction.

Introduction

The **average rate** of a reaction is a measure of the **overall speed** at which reactants are **converted** into products. It is usually determined by **dividing** the change in **quantity** of **reactants** or **products** by the **time taken** for the change to occur.

Depending on the nature of the reaction, the average rate can be expressed in various units, including **volume per time** (e.g., cm^3 per minute or second) for **gaseous** products, or mass per time (e.g., grams per minute or second) for reactions involving solid, liquid, or gaseous reactants or products.

The equation (found in the data booklet):

$$\text{Average rate} = \frac{\Delta\text{Quantity}}{\Delta\text{Time}}$$

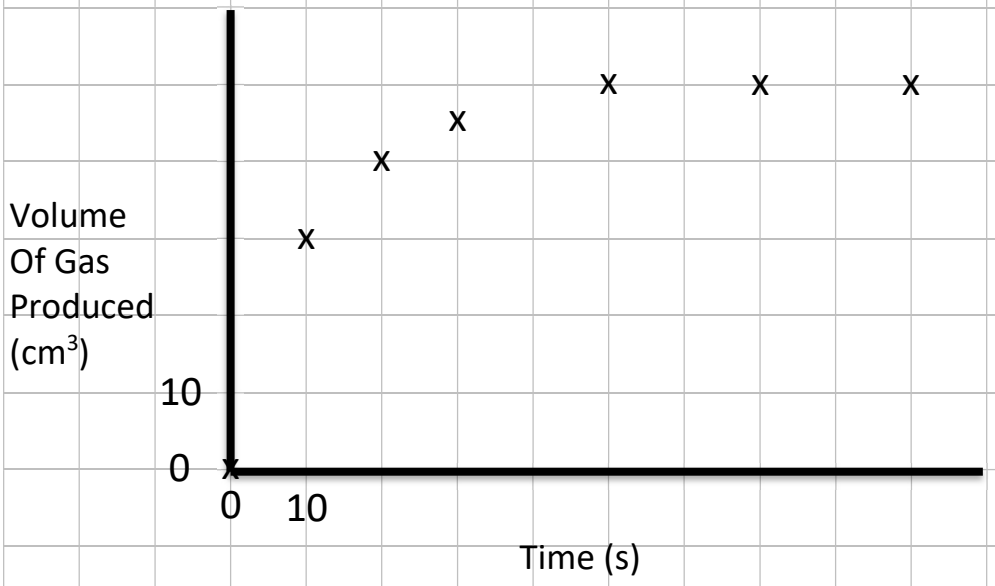
This is the same of a gradient that you learn in maths

If the quantity is a volume, the rate might be expressed in cubic centimetres per minute (**$cm^3\ min^{-1}$**) or cubic centimetres per second (**$cm^3\ s^{-1}$**). If the quantity is a mass, the rate could be expressed in grams per minute (**$g\ min^{-1}$**) or grams per second **($g\ s^{-1}$**).

Key words:

Quantity: In the context of a chemical reaction, quantity refers to the **amount** of a particular substance involved in the reaction. This could be measured in terms of mass (grams), volume (cubic centimetres, litres), or the number of moles.

Finish the graph …



1. Calculate the average rate of reaction between 0 and 10 seconds.

$$\text{Average Rate} = \frac{\Delta\text{Quantity}}{\Delta\text{Time}}$$

$$= \frac{\quad}{\quad}$$

$$=$$

2. Calculate the average rate of reaction between 10 and 30 seconds.

$$\text{Average Rate} = \frac{\Delta\text{Quantity}}{\Delta\text{Time}}$$

$$= \frac{\quad}{\quad}$$

$$=$$

Questions (SHOW ALL WORKING)

1. In an experiment, a reaction produced 100 cm^3 of gas in 5 minutes. What is the average rate of the reaction in $cm^3\ min^{-1}$ and $cm^3\ s^{-1}$?

2. A chemical reaction resulted in a loss of 50 grams of a reactant over a 10 minute period. Calculate the average rate of reaction in $g\ min^{-1}$ and $g\ s^{-1}$.

3. If a reaction produced 1200 cm^3 of gas in 2 hours, what is the average rate of the reaction in $cm^3\ min^{-1}$ and $cm^3\ s^{-1}$?

4. A scientist observed that a reaction consumed 30 grams of a reactant in 180 seconds. What is the average rate of this reaction in g min^{-1} and g s^{-1}?

5. In an experiment, a solid reactant disappeared at a rate of 0.2 grams every minute for 30 minutes. What is the average rate of the reaction in g min^{-1} and g s^{-1}?

Check your answers.

Extension questions:

Chemcord purple books (N5): page 7 – 9

Hyperlinked past papers(N5): *scan the QR code or get a laptop*.

Topic	2015	2016	2017	2018	2019
Rate of reaction	S2 – 1	S2 – 3 (b)	MC – 1	S2 – 1	MC – 1 & 2

MC = multiple choice section, S2 = section 2, the written section.

Literature Question

In August 2020, a catastrophic explosion occurred in Beirut, Lebanon. The event led to the unfortunate loss of many lives and caused substantial damage to the city. Investigations revealed that about 2750 tons of a chemical substance known as ammonium nitrate was the primary cause behind this incident.

Ammonium nitrate is a widely used substance in the agriculture sector, primarily as a fertilizer because of its high nitrogen content. It's a salt made from ammonium and nitric acid, and it's highly soluble in water. Under normal conditions, it's relatively safe to handle. However, under certain conditions, particularly when exposed to high temperatures or fire, it can transform from a stable compound to a highly explosive one. When it decomposes, it releases gases including nitrogen, oxygen, and water vapour.

The explosion in Beirut occurred in a warehouse where the ammonium nitrate had been stored for six years without the necessary safety measures. On the day of the explosion, a fire broke out in the warehouse, heating the ammonium nitrate and triggering the explosion. The explosion was so powerful it was felt over 200 kilometres away.

Assume that during the explosion, all the ammonium nitrate reacted in a span of 3 seconds. The reaction produced a total volume of 1,500,000 cubic meters of gas.

Questions

1. From the passage provided, **state** what ammonium nitrate is typically used for.

2. **State** the two conditions mentioned in the passage that can transform ammonium nitrate from a stable compound to a highly explosive one.

3. **Explain** in your own words, what is meant by the term 'rate of reaction'.

4. From the passage, **identify** the conditions that led to the ammonium nitrate in the Beirut warehouse becoming explosive.

5. The passage mentions that the explosion produced a total volume of 1.5 million cubic meters of gas in 3 seconds. **Calculate** the average rate of gas production during the explosion in terms of cubic meters per second. Show your workings clearly.

6. There are several factors that can affect the rate of a chemical reaction. **List** these factors and provide a brief explanation for each.

7. Considering the factors you listed in the previous question, **discuss** how they might have influenced the rate of reaction in the real-world event of the Beirut explosion.

8. **Examine** the consequences of improper storage and management of chemical substances, drawing on the Beirut explosion as an example.

9. Homework

Research and **summarize** other incidents in history where chemical reactions have led to similar large-scale disasters.