

Chemistry 12 Lab Investigation:
Factors which *Affect* Reaction Rate

Name: _____ Block: _____
Group Members: _____ Due Date: _____

✓ **Objective:** To conduct a series of experiments which test factors affecting the rate of a chemical reaction. Through this investigation you will analyse factors such as: surface area, temperature, concentration and presence of a catalyst. Research, data & results will be presented as a **formal lab report**.

Task Outline & What to Hand In:

- ✓ Pre-lab flow chart completed individually by each group member **before the lab!**
- ✓ Data & results to be completed on attached pages (as a group)
 - Reaction **Rate calculations on a separate page (individual)**
 - Each group member is to complete their own Analysis & discussion (~1 paragraph per experiment)
 - Evaluation ~1-2 paragraphs (individual)
 - Conclusion ~1 paragraph which answers the aim of the experiment
 - Presentation (cover page included, word processed, calculations may be hand written neatly with correct significant figures, includes appropriate section headings, completed in order)
 - Safety (this mark will be given by teacher during the lab)

Criteria	Excellent	Good	Satisfactory	Needs Improvement	Poor/Not shown	Student Self Evaluation	Teacher Assessment
	5	4	3	2	1		
✓ Aim, Background (and Hypothesis & Variables where applicable) Clearly states the aim of the experiment and briefly outlines the related theory						n/a	n/a
✓ Data, Results & Calculations: (hand written neatly) Provides results/observations (and diagrams where appropriate) that are presented in correctly annotated tables and/or graphs							
Analysis & Discussion: (word processed) Correctly identifies and explains the theory relating to the experiment and supports this with accurate observations							
Evaluation: (word processed) + sources of error Identifies and defines the appropriateness of the experimental method (and presents a model for future experimental investigations where appropriate)							
Conclusion: (word processed) Identifies and defines important concepts and principles relevant to the experiment by relating back to the aim and hypothesis.							
Presentation: Practical report is presented in the correct format, is written fluently and provides appropriate and accurate referencing							
Safety: Demonstrates an organized and safe approach to experimental work							
	Results Summary					/30	/30

Headings:
Calculations:

Part A:

$$\text{rxn rate} = \frac{\text{quantity}}{\text{time}} = \frac{\Delta \text{mass of CaCO}_3}{\text{time (s)}} = \frac{\text{g}}{\text{s}}$$

(marble chips)

$$\text{rxn rate} = \frac{\text{''}}{\text{''}} = \frac{\text{''}}{\text{''}}$$

(powdered)

Part B:

3 rxn rate calc. ① cool
② warm
③ hot

$$\frac{\Delta Q}{\Delta t} = \frac{\Delta \text{temp}}{\text{time(s)}} = \frac{^{\circ}\text{C}}{\text{s}}$$

Part C:

4 rxn rate $\left\{ \begin{array}{l} \text{H}_2\text{O} \\ 0.5\text{M} \\ 1.5\text{M} \\ 3.0\text{M} \end{array} \right.$

$$\frac{\Delta Q}{\Delta t} = \frac{\Delta \text{temp}}{\text{time(s)}} = \frac{^{\circ}\text{C}}{\text{s}}$$

~~Analysis & Discussion:~~

- small paragraph 2-3 sentences per experiment (A, B, C)
- Re-state hypothesis and analyze if your results support it or not? why?

Evaluation: ~1 paragraph

Critique method
suggest improvements +

better ways to
measure more accurately

Conclusion: 2-3 sentences.

Look @ objective & state
whether your experiments
achieved this.

→ do altering these
factors (S.A, temp, [conc.])
affect the rxn. rate?

Part A: Effect of Surface Area on Reaction Rate

Aim: To determine the effect of the size of pieces (marble chips, or powder) on the rate of a chemical reaction.

Materials:

- 3g Calcium carbonate (marbles x2, powdered)
- 50mL Dilute hydrochloric acid (1.5M)
- 250mL beaker (x2)
- Stopwatch
- Balance/ weigh scale
- Measuring cylinder
- Paper plate
- Funnel
- Safety glasses

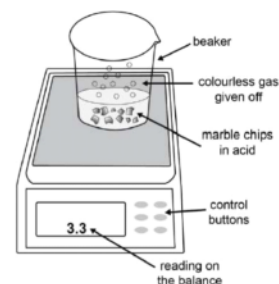


Fig 1. Experimental set-up

1. Identify the **independent and dependent variables** in this experiment

- a. Independent variable..... *surface area*
- b. Dependent variable..... *rxn rate (mass of CaCO₃ / min)*

2. Write a **hypothesis** for the reaction between calcium carbonate and hydrochloric acid

If.....

Method:

- Identify the independent variables, and construct a hypothesis for the experiment **before you begin!**
- A paper plate, then a 250 mL beaker were placed on the electronic balance and the balance was zeroed (tare the scale).
- Using a measuring cylinder, 50mL of HCl was added to the beaker and the mass was recorded in your results table, and the beaker placed aside.
- In a separate beaker, Calcium carbonate (marble chips) were added to the beaker until the balance measured *close to 3 g*. Record this mass in your results table
- 50 mL of the hydrochloric acid was carefully poured into the beaker containing CaCO₃ while it was still on the balance.
- Timing commenced as soon as the acid was added.
- The reading on the balance was recorded every 30 seconds **for 5 mins** and recorded in a table.
- ***This experiment was repeated for powdered calcium carbonate***

3. Write a balanced chemical equation to represent the reaction:

.....

Safety: Acid hazard. Wear safety glasses. Wash hands with soap and water.

Observations & Notes:.....

Part B: Effect of Temperature on Reaction Rate

Aim: To determine the effect of temperature on reaction rate

Materials:

- 1.0M HCl
- Mg ribbon (~1cm strip x3)
- Test tubes (x3)
- Test tube rack
- Stopwatch
- 250mL beaker (x3)
- 10mL measuring cylinders
- Safety glasses
- Kettle (for hot water)
- Thermometer
- Dropping pipette

Method:

- Identify the variables, and construct a hypothesis for the experiment (question #4-5)
- Prepare solutions: **10mL of hydrochloric acid in 3 separate test tubes**, and **3 approx 1cm strips of magnesium**. Test tube rack should contain 3 labelled test tubes.
- Prepare water baths: cool, warm and hot as indicated below (3 separate 250mL beakers)

Water Bath Ratio	COOL	WARM	HOT
Tap water	200mL	100mL	50mL
Kettle water	0mL	100mL	150ml

- As shown in the diagram to the right → Place 1 test tube containing HCl into each water bath
- Allow the test tubes to remain in the water baths for 2min, prior to starting the experiment and record the initial temperature in results table 2.
- **Start timer!** Carefully drop Mg strip into HCl solution and leave the test tube containing the reaction mixture in the water bath while the reaction time is measured.
- **The reaction is finished when the magnesium strip disappears and no more hydrogen gas is produced.**

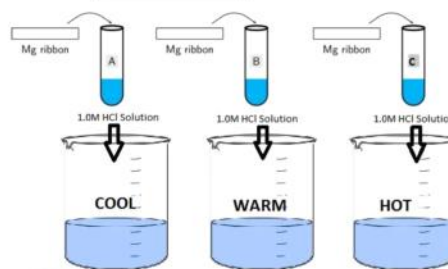


Fig 2. Experimental Set-Up B

Safety: Acid hazard. Avoid contact. Wear safety glasses. Wash hands with soap and water.

4. Identify **the independent and dependant variables** in this experiment
- a. Independent variable temp. of the reactant
 - b. Dependent variable rxn rate (temp °C / time(s))

5. Write a **hypothesis** for the reaction between magnesium and hydrochloric acid in this experiment.
 If _____

6. Write a balanced chemical equation to represent the reaction:

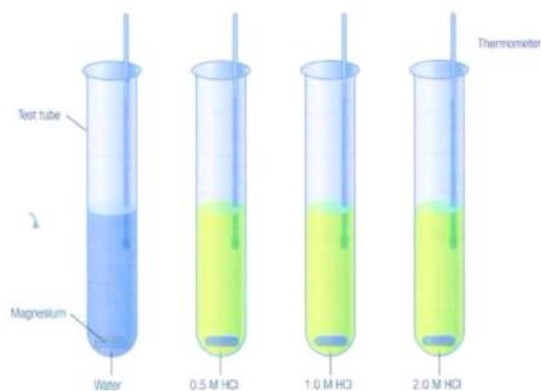
Observations & Notes: _____

Part C: Effect of Concentration on Reaction Rate

Aim: To investigate the effect of concentration on reaction rate

Materials:

- 15mL x 0.5M HCl (hydrochloric acid)
- 15mL x 1.0M HCl
- 15mL x 3.0M HCl
- Distilled water
- Strips of magnesium (~2cm long)
- 4 test tubes
- Test tube rack
- 4 thermometers
- 10mL measuring cylinder
- Stopwatch
- Safety glasses



Method:

1. Set up test tubes *in a test tube rack*, numbered and containing **15mL** of various solutions as described in the table below.

Test Tube	1	2	3	4
15mL	Distilled water	0.5M HCl	1.0M HCl	3.0M HCl

The following steps are to be conducted for each test tube **INDIVIDUALLY** as you only have 1 thermometer. This means complete steps #2-5 for test tube 1, THEN test tube 2, THEN test tube 3....etc.

2. Record the initial temperature of the solution (table 3)
3. **Start time!** Add the magnesium strips to the test tube
4. Continue to record temperature and time throughout the experiment **to a max of 5min.**
5. Include qualitative and quantitative results & observation in table 3.

Safety: Acid hazard. Wear safety glasses. Wash hands with soap and water.

7. Identify **the independent and dependent variables** in this experiment

- c. Independent variable.....
- a. Dependent variable.....

8. In this experiment, hydrochloric acid reacts with magnesium metal. Write a **hypothesis** which reflects the aim of the experiment.

If.....

Observations & Notes:.....

Part D: Effect of a Catalyst on Reaction Rate

Aim: To investigate the effect of a catalyst on reaction rate

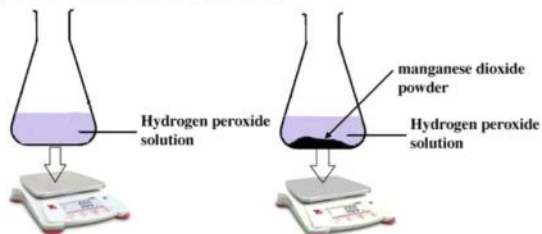
Materials:

- 30-40mL x 6% H₂O₂ (hydrogen peroxide)
- Manganese dioxide, MnO₂ (solid, powdered)
- Distilled water
- 2 Erlenmeyer (conical) Flasks
- 2 x 50mL measuring cylinder
- Stopwatch
- Scale x 2
- Safety glasses

Method:

6. Place a measuring cylinder on a scale and tare the balance. Measure out **40mL** of hydrogen peroxide, and **record the initial mass of H₂O₂**. **Keep in the measuring cylinder** until start of reaction.

Flask	1	2
MnO ₂	-	~1 scoop
40mL	H ₂ O ₂	H ₂ O ₂



The following reaction will be conducted simultaneously, pay careful attention to mass numbers & time.

7. Place Flasks on 2 separate scales, and tare the balance.
8. Add approximately scoop of manganese dioxide to #2 and **record the mass of Mn(s) in table 3**
9. **Start time!** Add the H₂O₂ to the flasks at the same time, and observe the results.
10. Include qualitative and quantitative results & observation in table 4.

Safety: *Weak acid hazard. Wear safety glasses. Wash hands with soap and water. Manganese dioxide- material causing other toxic effects: hazardous in case of skin contact (irritant), of eye contact (irritant), of ingestion, of inhalation.*

9. Identify **the independent and dependent variables** in this experiment
 - d. Independent variable.....
 - b. Dependent variable.....

10. In this experiment, hydrogen peroxide reacts in the presence of a catalyst, manganese dioxide. Write a **hypothesis** which reflects the aim of the experiment.

If.....

.....

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Observations & Notes:.....

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.....

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DATA RECORD

Name: _____

Date: ____/____/____

Part A: Effect of Surface Area on Reaction Rate

Initial Mass: CaCO₃ (Marble Chips).....g CaCO₃ (powdered).....g
 50mL HCLg 50mL HCLg

Results Table 1:.....

Time (seconds)	Mass of CaCO ₃ Marble Chips + 50mL HCl (g)	Change in Mass (grams)	Mass of powdered CaCO ₃ + 50mL HCl (g)	Change in Mass (grams)
0				
30				
60				
90				
120				
150				
180				
210				
240				
270				
300				

Part B: Effect of Temperature on Reaction Rate

Record Results in Table 2:.....

Water Bath	Initial Temp (°C)	Final Temp (°C)	Reaction Time (sec.)	Observations
Cold				
Warm				
Hot				

Part C: Effect of Concentration on Reaction Rate

Record **results** in Table 3:.....

Time (mins)	Distilled Water	Temperature (°C)			Observations
		0.5M HCl	1.0M HCl	3.0M HCl	
0					
1					
2					
3					
4					
5					

Part D: Effect of a Catalyst on Reaction Rate

Record **Results** in Table 4:.....

	Flask #1	Flask #2	Observations
Initial Mass H ₂ O ₂ (g)			
Mass MnO ₂ (g)			
Final Mass (g)			
Δ Mass (g)			
Reaction Time (sec.)			