

Seb Academy  
 Topic: Rate of Reaction  
 Time allowed: 40 min

Name: \_\_\_\_\_

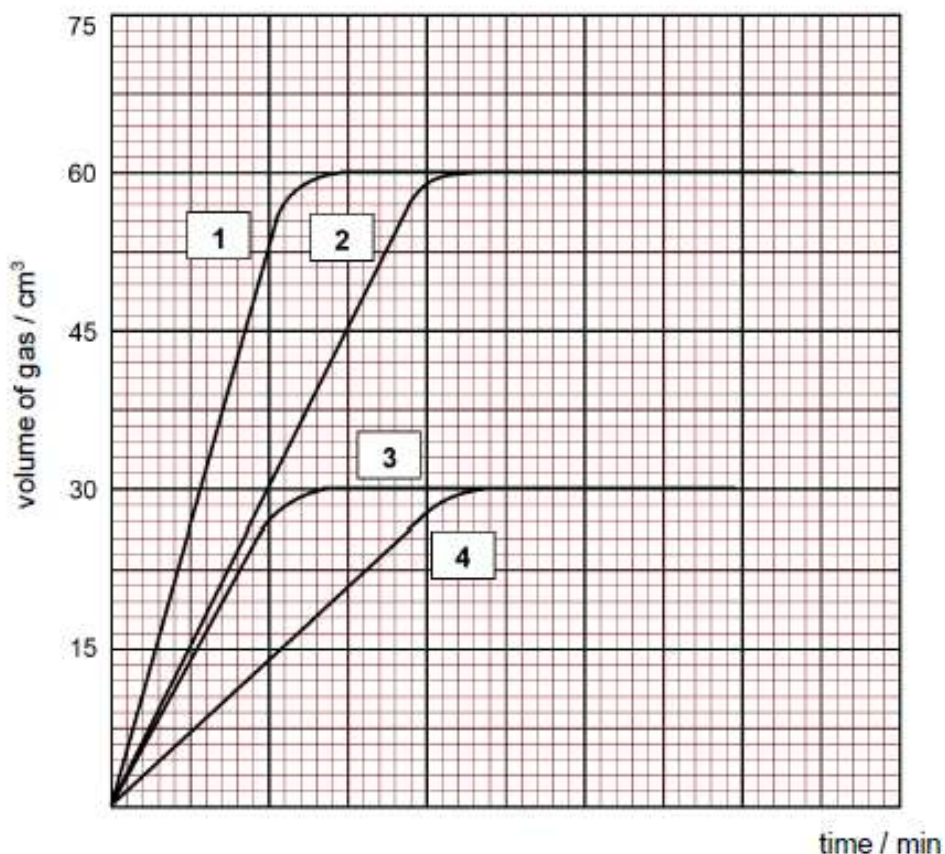
**Homework 2**

(2019/VS/S4/EP) Skill 4 Rate Graphs Identifying Graphs

- A series of experiments was carried out to compare the rate of reaction of different acids and zinc under different conditions. In each experiment, 5.00 g of zinc and 25.0 cm<sup>3</sup> of acid were used.

experiment	size of zinc	type of acid used
•	Granular	0.200 mol dm <sup>-3</sup> of HCl
•	Powder	0.200 mol dm <sup>-3</sup> of HCl
•	Powder	0.100 mol dm <sup>-3</sup> of HCl
•	granular	0.0500 mol dm <sup>-3</sup> of H <sub>2</sub> SO <sub>4</sub>

The gas given off was collected and its volume was measured every 15 seconds for 10 minutes. The results obtained were plotted as shown in the graph below.



- State which of the curves 1 to 4 corresponds to the results obtained in experiments A to D.

Experiment	A	B	C	D
Curve				

[2]

- Experiment **E** was conducted with the same conditions as experiment **D** but at a lower temperature.
    - On the grid, sketch the curve for experiment **E** and label it.
    - Using ideas about collision of particles, explain how a lower temperature affected the rate of reaction in experiment **E**.
- (2008/O/GCSE/N/2)  
The rate of reaction can be increased by changing the reaction condition. Explain, in terms of reaction rate, how the rate increases when

(i) The hydrogen peroxide is heated to a higher temperature.

(ii) The catalyst is more finely powdered.

(2020/VS/S4/FE/10) Data Handling: Strengths of acid, volume of gas

- Three test tubes contain the following acid solutions:

Test tube **A**: 3.00 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> dilute nitric acid

Test tube **B**: 3.00 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> dilute ethanoic acid

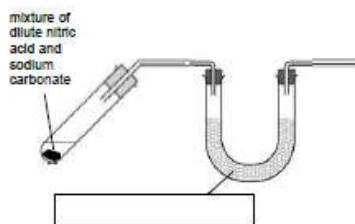
Test tube **C**: 3.00 cm<sup>3</sup> of 1.00 mol dm<sup>-3</sup> dilute sulfuric acid

Excess powdered sodium carbonate was added to each test tube and the volume of carbon dioxide gas produced was measured over time.

- (a) What observation shows that powdered sodium carbonate was added in excess?

[1]

- (b) (i) Complete the diagram below to show the chemical and apparatus required to collect and measure a dry sample of the gas produced in test tube **A**.



- (ii) Describe a test to confirm the identity of the gas produced.

[2]

[1]

- (c) The graph below shows the results obtained with test tube **A** and test tube **B**.

- (i) Explain why the volume of gas produced is the same for test tubes **A** and **B**.

[1]

[2]

- (ii) Using collision theory, explain the difference in results for test tubes **A** and **B**.

[2]

- (d) In the graph in (c), sketch the results obtained with test tube **C**. Label the graph **C**.

[1]

- (e) An experiment was conducted with  $3.00 \text{ cm}^3$  of  $1.00 \text{ mol dm}^{-3}$  warm dilute nitric acid and an excess of powdered sodium carbonate.

In the graph in (c), sketch the results obtained in this experiment. Label the graph **W**

[1]

[Total: 10]

- (2021/SA/C18/1) Excess zinc was added to  $100 \text{ cm}^3$  of  $1 \text{ mol/dm}^3$  hydrochloric acid. Graph X refers to this reaction. Sketch the graphs for:

- (a) excess zinc reacting with  $100 \text{ cm}^3$  of  $2 \text{ mol/dm}^3$  hydrochloric acid
- (b) excess zinc reacting with  $100 \text{ cm}^3$  of  $1 \text{ mol/dm}^3$  sulfuric acid

- (c) excess zinc reacting with 100 cm<sup>3</sup> of 1 mol/dm<sup>3</sup> ethanoic acid
- (d) excess magnesium reacting with 100 cm<sup>3</sup> of 1 mol/dm<sup>3</sup> hydrochloric acid

- Aqueous hydrogen peroxide decomposes to form water and oxygen as shown in the equation below:



The following two experiments were carried out to measure the rate of production of oxygen from aqueous hydrogen peroxide.

Experiment	Solutions used
I	500 cm <sup>3</sup> of 0.200 mol/dm <sup>3</sup> H <sub>2</sub> O <sub>2</sub>
II	100 cm <sup>3</sup> of 1.00 mol/dm <sup>3</sup> H <sub>2</sub> O <sub>2</sub>

Which graph best shows the results obtained?

A

B

C

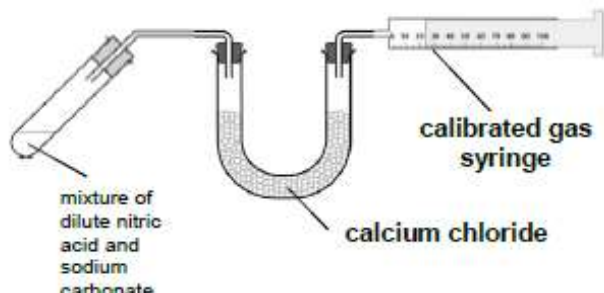
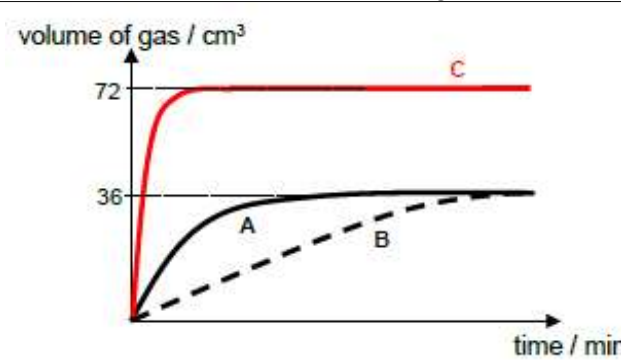
D

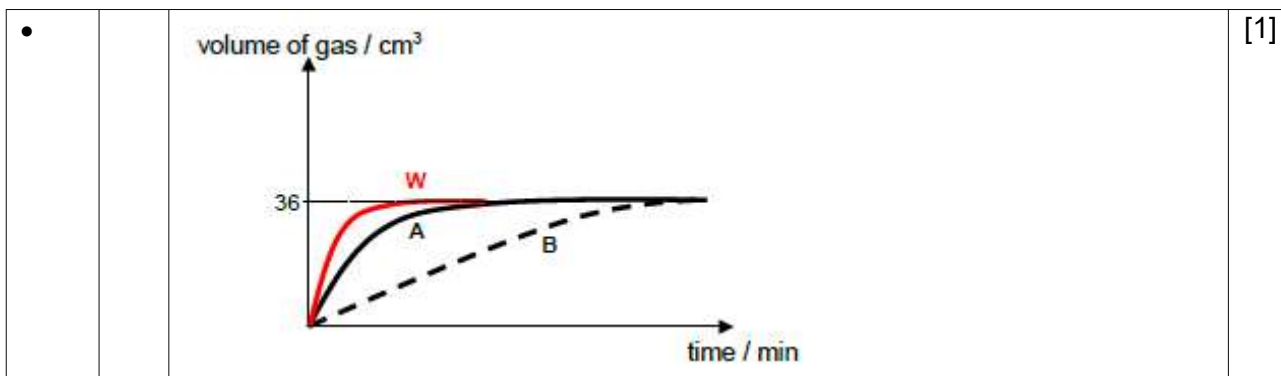
•			
	•	<ul style="list-style-type: none"> <li>• 2</li> <li>• 1</li> <li>• 3</li> <li>• 4</li> <li>• 2</li> <li>• 1</li> <li>• 3</li> <li>• 4</li> </ul> <p>[all 4 correct – 2 marks; any 2 correct – 1 marks]</p>	2
	•		
	•	Curve 5 less steep than curve 4	1
	•	When temperature is lowered, the hydrogen ions lose kinetic energy. Hence frequency of collisions between the zinc atoms and hydrogen ions decreases, frequency of effective collisions decreases, and rate of reaction decreases.	1 1

(2008/O/GCSE/N/2)

Answers

2	(i)	As hydrogen peroxide molecules are heated, the molecules gain kinetic energy and moves faster. [1] As the molecules move faster, it increases the probability of effective collisions between molecules, leading to the increase in rate of reaction. [1]
	(ii)	As the catalyst is powdered, it increases the surface area of the catalyst which increases the frequency of collisions between the catalyst and the hydrogen peroxide molecules, leading to an increase in effective collisions. [1]

• 3		There is powdered sodium carbonate which did not dissolve/react. [1]
•	•	 <p>[1m] – calcium chloride [1m] – calibrated gas syringe</p> [2]
	•	Bubble the gas into <u>limewater</u> / <u>aqueous calcium hydroxide</u> . <u>White precipitate</u> will be formed. [1]
•	•	The <u>limiting reactant</u> is the <u>acid</u> . Both acids <u>have the same number of moles of hydrogen ions</u> / <u>are monobasic</u> and <u>have the same concentration of hydrogen ions</u> so the volume of gas produced is the same in both test tubes <b>A</b> and <b>B</b> . [1] [1]
	•	Ethanoic acid is a <u>weak acid</u> but nitric acid is a strong acid. Hence, ethanoic acid will dissolve and <u>dissociate partially</u> to produce a <u>low concentration of hydrogen ions</u> / <u>lower number of hydrogen ions per unit volume</u> . This results in less collisions hence <u>lower frequency of effective collisions</u> between the <u>reacting particles</u> (sodium carbonate particles and hydrogen ions) so <u>slower rate of reaction</u> , so for graph <b>B</b> has a gentler gradient. [1] [1]
•		 [1]



4	Ans	
(a)	<b>[On Concentration]</b> Concentration of HCl is doubled ( $2 \text{ mol/dm}^3$ ), therefore the rate of reaction has been doubled. The amount of $\text{H}^+$ ions is doubled (0.2 mol, from 0.1 mol in Experiment X) and the total volume of hydrogen gas evolved is double of graph X.	
(b)	<b>[On Concentration]</b> Sulfuric acid is dibasic ( $\text{H}_2\text{SO}_4$ ). Hydrochloric acid is monobasic (HCl). The rate of reaction is faster in sulfuric acid.  <b>[On Moles]</b> Therefore, 1 mol of sulfuric acid dissociates to form 2 moles of $\text{H}^+$ ions compared to 1 mol hydrochloric acid forming 1 mole of $\text{H}^+$ ions. The amount of $\text{H}^+$ ions is doubled (0.2 mol, from 0.1 mol in Experiment X) and the total volume of hydrogen gas evolved is double of graph X.  Hence, total volume of $\text{H}_2$ gas evolved is double of graph X & rate of reaction is faster.	
(c)	<b>[On Concentration]</b> Ethanoic acid is a weak acid. Therefore, it only partially dissociates in water to form $\text{H}^+$ ions. Therefore, the concentration of $\text{H}^+$ ions is lower and the rate of reaction is slower. <b>[On Moles]</b> Both hydrochloric acid (HCl) and ethanoic acid ( $\text{HCH}_3\text{COOH}$ ) are monobasic. 0.1 mol of acid molecules were used in both reactions. They will produce the same moles of $\text{H}_2$ gas.	
(d)	Magnesium is more reactive than zinc. Therefore, magnesium reacts with hydrochloric acid faster than zinc and the rate of reaction is faster.	

Q1									
D									