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**INSTRUCTIONS:**

- **Answers must be rounded off to TWO decimal places or written in scientific notation where two decimal places are not possible**
  - **When referring to the rate of the reaction – only write the words- reaction rate**
  - **Use comma's when numbers have decimals**
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**Question 1**

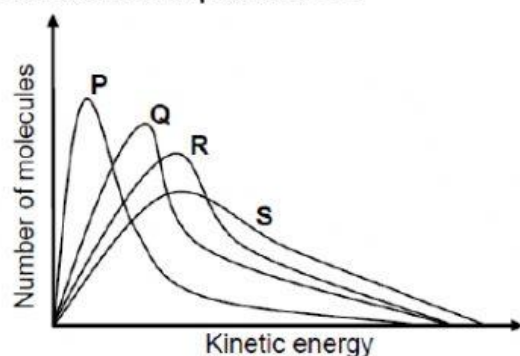
Give one word/term for the following:

- 1.1 A theory used to explain how factors, such as concentration, change the rate of a reaction. **(2 words)** (1)
- 1.2 The minimum energy needed for a chemical reaction to occur. **(2 words)** (1)
- 1.3 A substance in the same phase as the reactants which increases the rate of the reaction without getting used up in the reaction. **(2 words)** (1)
- 1.4 A factor that increases the rate of a reaction by increasing the kinetic energy of the particles. (1)
- 1.5 A reaction that releases energy in the form of heat and/or light. **(one word)** (1)
- 1.6 The change in concentration of reactants or products per unit time. (1)

[6]

### Question 2

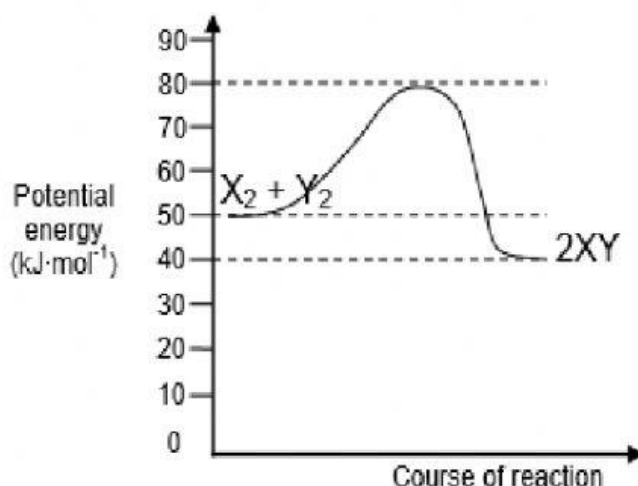
2.1 The graphs below represent the molecular distribution for a reaction at different temperatures.



Which ONE of the graphs above represents the reaction at the highest temperature?

- A P
- B Q
- C R
- D S

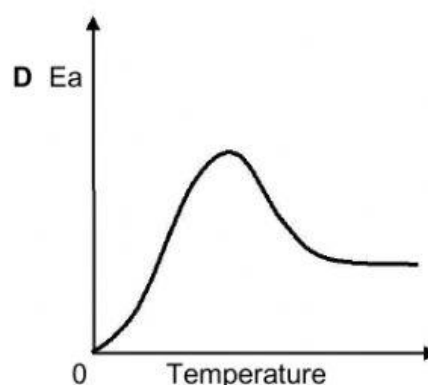
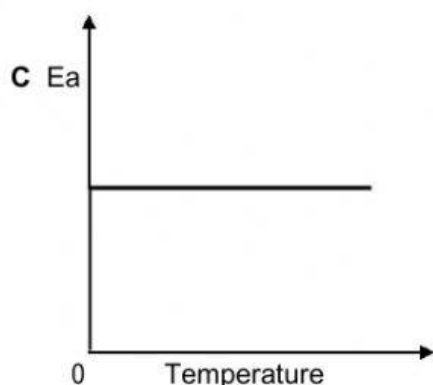
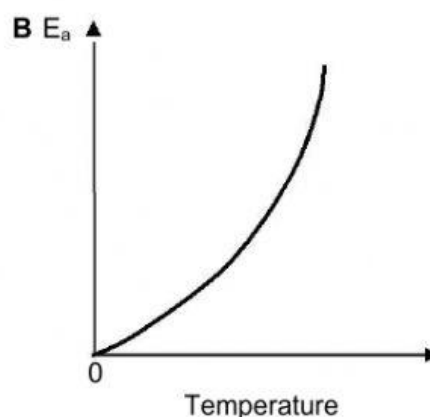
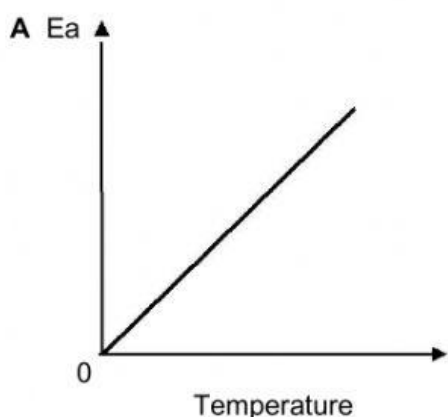
2.2 The potential energy diagram below refers to the following hypothetical reaction taking place in a closed container:  $X_2 + Y_2 \rightleftharpoons 2XY$



What is the heat of reaction, in  $\text{kJ}\cdot\text{mol}^{-1}$ , for the reverse reaction that is  $2XY \rightarrow X_2 + Y_2$ ?

- A + 30
- B + 10
- C - 10
- D - 40

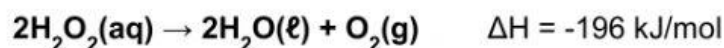
2.3 Which ONE of the following graphs shows the relationship between activation energy ( $E_a$ ) of a reaction and temperature?



[3]

### Question 3

A hydrogen peroxide solution dissociates slowly at room temperature according to the following equation:



During an investigation, learners compare the effectiveness of three different catalysts on the rate of decomposition of hydrogen peroxide. They place EQUAL AMOUNTS of sufficient hydrogen peroxide into three separate containers. They then add EQUAL AMOUNTS of the three catalysts, **P**, **Q** and **R**, to the hydrogen peroxide in the three containers respectively and measure the rate at which oxygen gas is produced.

- 3.1 Is this reaction endothermic or exothermic? (1)
- 3.2 For this investigation, write down the:
- 3.2.1 Independent variable (one word) (1)
- 3.2.2 Dependent variable (1)



3.5 Calculate the AVERAGE rate of decomposition (in  $\text{mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1}$ ) of  $\text{H}_2\text{O}_2(\text{aq})$  in the first 400 s. (5)

Average rate =  $\frac{\Delta}{\Delta}$  \_\_\_\_\_ (write the formula in words)

(show your workings below and leave no spaces between numbers and signs)

= \_\_\_\_\_

= \_\_\_\_\_  $\text{mol}\cdot\text{dm}^{-3}\cdot\text{s}^{-1}$

(write exponents as follows  $1\times 10^6$  and leave **no spaces** between numbers and signs)

3.6 Will the rate of decomposition at 600 s be:

GREATER THAN,

(1)

LESS THAN or

EQUAL TO the rate calculated in QUESTION 3.5?

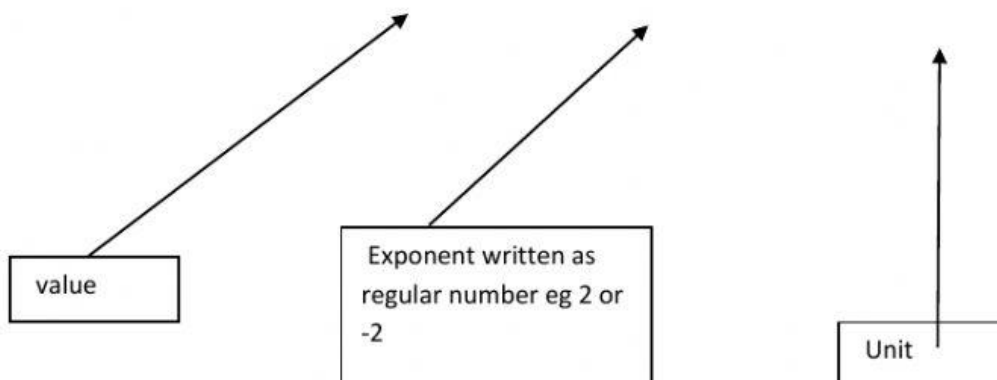
3.7 Calculate the mass of oxygen produced in the first 400 s if  $45\text{ cm}^3$  of hydrogen peroxide decomposes in this time interval.

**(This is a multi-step question. Complete each block required and write all answers in scientific notation)**

n (of  $\text{H}_2\text{O}_2$  used up) = \_\_\_\_\_ x  $10$  \_\_\_\_\_ (3 decimal places)

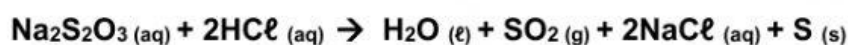
n (of  $\text{O}_2$  formed) = \_\_\_\_\_ x  $10$  \_\_\_\_\_ (3 decimal places)

m (of  $\text{O}_2$  formed) = \_\_\_\_\_ x  $10$  \_\_\_\_\_ (2 decimal places)



#### Question 4

Learners use the reaction of a sodium thiosulphate solution ( $\text{Na}_2\text{S}_2\text{O}_3$ ) with a hydrochloric acid solution ( $\text{HCl}$ ) to investigate the factors which influence reaction rate. The balanced equation for the reaction is:



The time lapse from the moment of mixing equal volumes of the two solutions until a certain degree of turbidity (sulphur precipitation formation) appeared, is taken as a measure of the rate of the reaction. The experiments were conducted as shown in the table:

	Temperature ( $^{\circ}\text{C}$ )	Concentration of $\text{Na}_2\text{S}_2\text{O}_3$ ( $\text{mol}\cdot\text{dm}^{-3}$ )	Concentration of $\text{HCl}$ ( $\text{mol}\cdot\text{dm}^{-3}$ )	Time (s)
<b>Experiment 4</b>	20	0,5	0,5	40
<b>Experiment 5</b>	30	0,5	0,5	20
<b>Experiment 6</b>	50	0,5	0,5	10

4.1 What is the dependent variable for this reaction? (1)

4.2 What is the independent variable for this reaction? (1)

4.3 In which experiment is the rate of the reaction the fastest? 4 5 6 (1)

4.4 Explain your observation in QUESTION 4.3 in terms of the collision theory key

words: **(The mark allocation should guide you in terms of how many options to choose)** (4)

Due to the variable change, the number of particles per unit volume increases.

Due to the variable change, the kinetic energy of the particles increases.

Due to the variable change, the activation energy of the reaction is lowered.

Surface area increased

Surface are decreased

This causes particles to move faster.

This causes more collisions to occur.

This results in more particles having sufficient energy to react.

Thus more effective collisions occur per unit time, resulting in an increase in reaction rate.

[7]

### Question 5

Learners use the reaction between IMPURE POWDERED calcium carbonate and **excess hydrochloric acid** to investigate reaction rate. The balanced equation for the reaction is:



They perform four experiments under different conditions of concentration, mass and temperature as shown in the table below. They use identical apparatus in the four experiments and measure the volume of gas released in each experiment.

	EXPERIMENT			
	1	2	3	4
Concentration of acid ( $\text{mol}\cdot\text{dm}^{-3}$ )	0,5	1	1	1
Mass of impure calcium carbonate (g)	15	15	15	25
Initial temperature of acid ( $^{\circ}\text{C}$ )	30	30	40	40

5.1 The results of experiments **2** and **3** are compared in the investigation.

Write down the:

5.1.1 Independent variable (1)

5.1.2 Dependent variable (1)

5.2 In which experiment (**2** or **3**) will the rate of the reaction be the fastest? **2 3** (1)

5.3 Experiments **1** and **2** are now compared. Choose the collision theory key words which explain why the change in independent variable causes a higher reaction rate in experiment **2** than that in experiment **1**. (3)

Due to the variable change, the number of particles per unit volume increases.

Due to the variable change, the kinetic energy of the particles increases.

Due to the variable change, the activation energy of the reaction is lowered.

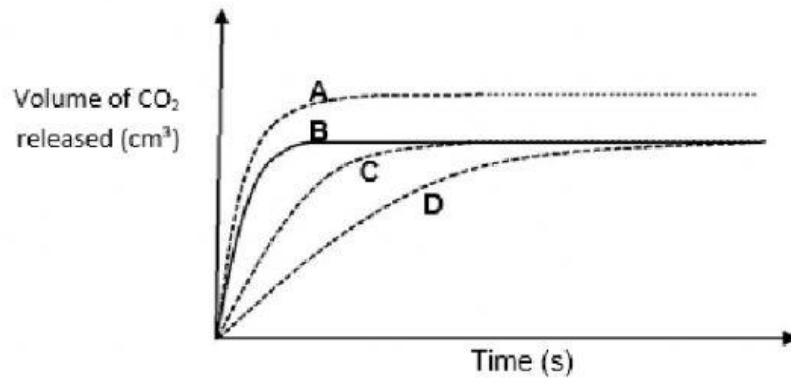
This causes particles to move more.

This causes more collisions to occur.

This results in more particles having sufficient energy to react.

Thus more effective collisions occur per unit time, resulting in an increase in reaction rate.

The learners obtain graphs **A**, **B**, **C** and **D** below from their results.



5.4 Which one of the graphs (A,B, C OR D) represents experiment 2?

**A B C D**

**Ensure to complete the second half of this test on the next worksheet**



