Rate Lab Worksheet

Reaction rates, collision theory, and activation energy · Logical Home Schooling

Name: _____ **Date:** _____ **Period:** _____

Purpose: The purpose of this lab is for students to observe and test the following factors that influence the speed of a chemical reaction: surface area of starting reactants, concentration of reactants, and temperature.

Link: www.logicalhomeschooling.com/rate-lab.html

Objectives

By the end of this lab you will be able to:

- Use collision theory to explain what particles need in order to react.
- Test how surface area, concentration, and temperature affect reaction rate, and calculate rate as 1 ÷ time.
- Explain activation energy and how temperature and catalysts change the number of successful collisions.
- Find a rate law from initial-rate data and solve half-life problems.

Materials: a computer or tablet with Rate Lab open, a calculator, a pencil, this worksheet. Optional hands-on version: antacid tablets, cups of water at different temperatures, a stopwatch. Time: about 60 minutes.

Collision theory. Particles react only when they (1) collide, (2) with at least the activation energy, (3) in the right orientation. **Rate = 1 ÷ time**: a shorter time means a faster rate. In each experiment, change only **one** variable.

Part 1: Pre-lab

1. Hypothesis: for each factor, predict whether increasing it will speed up or slow down the reaction, and why.

Factor	Prediction and reason
Surface area	
Concentration	
Temperature	

2. Name one everyday example where people speed up or slow down a reaction on purpose.

_____

Part 2: Stage 1, Collisions

A–B collisions	Made product	Bounced apart	Percent that worked

3. Why didn't every collision make product? Give the two requirements besides colliding.

Part 3: Stage 2, Testing three factors

Experiment 1: Surface area. Antacid tablet in 200 mL of water at 20 °C.

Form of tablet	Time (s)	Rate = 1 ÷ time (s^{-1})
Whole tablet		
Broken into 4 pieces		
Crushed to powder		

Independent variable: _____ Dependent variable: _____
Two controlled variables: _____

4. Explain your results using the particle view.

Experiment 2: Concentration. 2 cm of magnesium ribbon in 50 mL of HCl at 20 °C.

HCl concentration	Time (s)	Rate = 1 ÷ time (s^{-1})
0.5 M		
1.0 M		
2.0 M		

5. What happens to the rate when the concentration doubles? Explain using collisions.

Experiment 3: Temperature. Whole antacid tablet in 200 mL of water.

Water temperature	Time (s)	Rate = 1 ÷ time (s^{-1})
10 °C		
30 °C		
50 °C		
70 °C		

Graph: plot rate (y-axis) vs. temperature (x-axis). Label both axes with units.



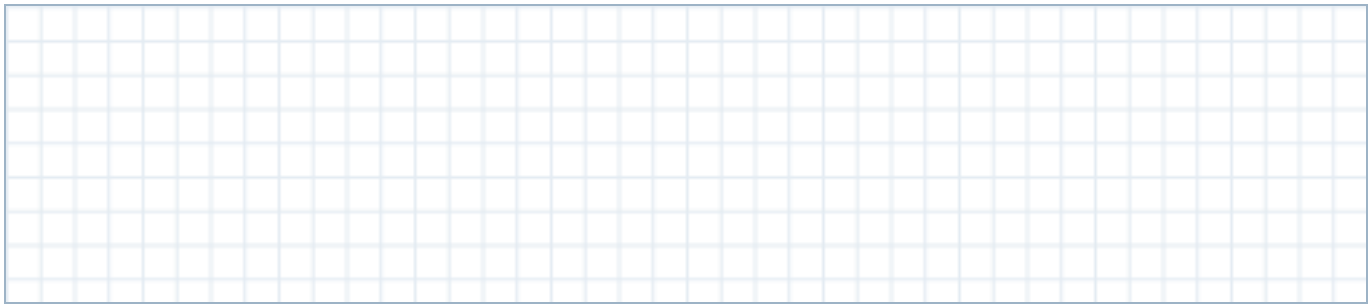
6. Describe the shape of your graph. Is the relationship a straight line?

7. Give TWO reasons that warmer particles react faster.

8. Were your hypotheses from Part 1 supported? Explain.

Part 4: Stage 3, Energy hill

Sketch the energy profile. Label the reactants, products, activation energy (Ea), ΔH, and the catalyst path.



1. Is the reaction exothermic or endothermic? How can you tell?

2. What does a catalyst change, and what does it NOT change?

Temperature (K)	% of molecules with E ≥ Ea (no catalyst)	% with E ≥ Ea (catalyst)
200		
300		
600		

3. Use the table to explain why raising the temperature and adding a catalyst both speed up a reaction, but in different ways.

Part 5: Stage 4, Rate laws and half-life (challenge)

Question	Answer and work
Order in A	
Order in B	
Rate law	
Value of k (with units)	
Mass of X left after 30 min (start 80 g, $t_{1/2}$ = 10 min)	
Time until 5 g remain	

Part 6: Practice problems

Answer these **without** Rate Lab.

1. Why do we keep food in the refrigerator? Explain with collision theory.

2. Flour dust in the air can explode, but a bag of flour just sits there. Explain.

3. A reaction takes 80 s. What is its rate (1 ÷ time)? If the rate doubles every 10 °C, how long would it take 20 °C warmer?

4. For rate = $k[A]^2$, what happens to the rate if [A] is tripled?

5. A 120 g sample has a half-life of 6 hours. How much is left after 24 hours?

6. Enzymes in your body are catalysts. Why are they so important for reactions that must happen quickly at body temperature (37 °C)?

Conclusion

Write 4 to 6 sentences answering the purpose of this lab: how did surface area, concentration, and temperature each affect the speed of the reaction, and why? Use your data and the words **collision**, **activation energy**, **rate**, and **catalyst**.