

RATES OF REACTION

TEMPERATURE AND CONCENTRATION



Answer all the questions below then check your answers.

The affect of temperature on reaction rate.

1. What happens to the kinetic energy of particles when the temperature increases?
2. Explain why increasing the temperature generally increases the rate of a chemical reaction.
3. Describe an experiment you could carry out to investigate the effect of temperature on the rate of a reaction between hydrochloric acid and magnesium ribbon. Include the variables you would control.
4. The rate of a reaction doubles for every 10°C increase in temperature. If the rate of reaction is $0.5 \text{ mol dm}^{-3}\text{s}^{-1}$ at 20°C , what will the rate be at 40°C ? Explain your answer.

The affect of concentration on reaction rate

1. Define concentration in the context of a chemical reaction.
2. State the relationship between concentration and the rate of reaction.
3. True or False: A dilute acid reacts faster with a metal than a concentrated acid.
4. Explain why increasing the concentration of reactants generally speeds up a reaction.

5. A student investigates the reaction between magnesium ribbon and hydrochloric acid. They use different concentrations of acid.
- Describe how the student could measure the rate of reaction.
 - Predict what would happen to the rate of reaction as the acid concentration increases.
 - Explain your prediction in terms of particle collisions.
6. In a factory, a chemical reaction is used to produce a valuable product. The manager wants to increase the rate of production.
- Suggest two ways the manager could increase the reaction rate.
 - Evaluate which method would be more cost-effective, explaining your reasoning.

Answers

1. What happens to the kinetic energy of particles when the temperature increases?

The kinetic energy of particles increases.

2. Explain why increasing the temperature generally increases the rate of a chemical reaction.

Increasing temperature gives particles more kinetic energy, causing them to move faster. This leads to more frequent collisions between particles, and a higher proportion of these collisions have enough energy to overcome the activation energy barrier, resulting in a faster reaction rate.

3. Describe an experiment you could carry out to investigate the effect of temperature on the rate of a reaction between hydrochloric acid and magnesium ribbon. Include the variables you would control.

Equipment: Magnesium ribbon, hydrochloric acid of a specific concentration, measuring cylinder, stopwatch, water bath, thermometer.

Method:

Cut equal lengths of magnesium ribbon.

Measure a fixed volume of 1M hydrochloric acid using the measuring cylinder.

Set up different water baths at various temperatures (e.g., 10°C, 20°C, 30°C, 40°C).

Place the hydrochloric acid in a test tube and submerge it in the first water bath until the temperature is constant.

Add a piece of magnesium ribbon to the test tube, start the stopwatch, and observe the reaction.

Record the time taken for the magnesium ribbon to completely react.

Repeat the experiment at each temperature, using a fresh piece of magnesium ribbon and the same volume and concentration of hydrochloric acid each time.

Controlled variables: Concentration of hydrochloric acid, surface area of magnesium ribbon (by using the same length each time).

4. The rate of a reaction doubles for every 10°C increase in temperature. If the rate of reaction is $0.5 \text{ mol dm}^{-3}\text{s}^{-1}$ at 20°C , what will the rate be at 40°C ? Explain your answer.

The temperature increases by 20°C , which is two increments of 10°C . Since the rate doubles for each 10°C increase, the rate will double twice:

$$0.5 \text{ mol dm}^{-3}\text{s}^{-1} * 2 \text{ (at } 30^{\circ}\text{C)}$$

$$1 \text{ mol dm}^{-3}\text{s}^{-1} = 2 \text{ mol/dm}^3/\text{s} \text{ (at } 40^{\circ}\text{C)}$$

The affect of concentration on reaction rate

1. Define concentration in the context of a chemical reaction.

Concentration is the amount of a substance (reactant) in a certain volume of solution.

2. State the relationship between concentration and the rate of reaction.

Increasing the concentration of reactants usually increases the rate of reaction.

3. True or False: A dilute acid reacts faster with a metal than a concentrated acid.

False.

4. Explain why increasing the concentration of reactants generally speeds up a reaction.

Higher concentration means more reactant particles in the same space. This leads to more frequent collisions between particles, increasing the chance of successful (reaction-causing) collisions.

5. A student investigates the reaction between magnesium ribbon and hydrochloric acid. They use different concentrations of acid.
- Describe how the student could measure the rate of reaction.
 - Predict what would happen to the rate of reaction as the acid concentration increases.
 - Explain your prediction in terms of particle collisions.

The student could measure the volume of hydrogen gas produced over time.

The rate of reaction would increase as the acid concentration increases.

Higher concentration means more acid particles, leading to more collisions with magnesium, and a faster reaction.

6. In a factory, a chemical reaction is used to produce a valuable product. The manager wants to increase the rate of production.
- Suggest two ways the manager could increase the reaction rate.
 - Evaluate which method would be more cost-effective, explaining your reasoning.

Increase the concentration of reactants or increase the temperature.

Increasing concentration is often more cost-effective as it only involves adding more reactants, whereas increasing temperature requires energy input for heating. However, the best method would depend on the specific reaction and costs involved.

