Collision Theory

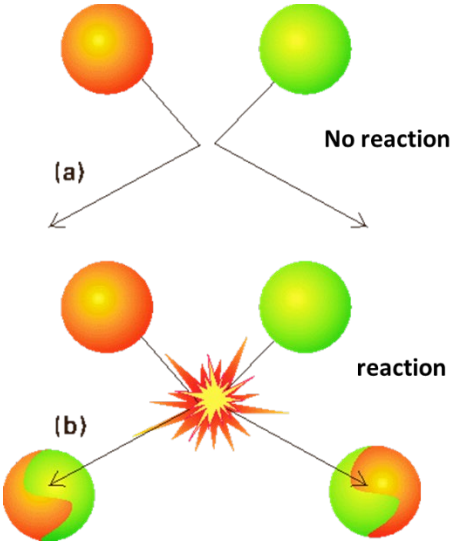
The reaction rate is the speed at which a chemical reaction occurs.

This is measured by how quickly the reactants change into products or how quickly one of the reactants disappears. Reactions can vary in their reaction rate

Iron oxidising

oxygen and hydrogen combusting

Chemical reactions occur when particle collide successfully

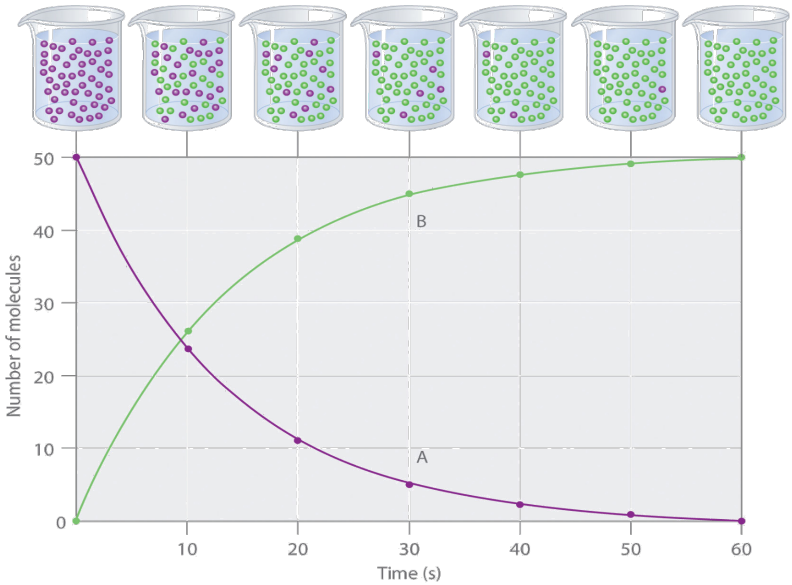


Chemical reactions between particles of substances only occur when the particles collide successfully.

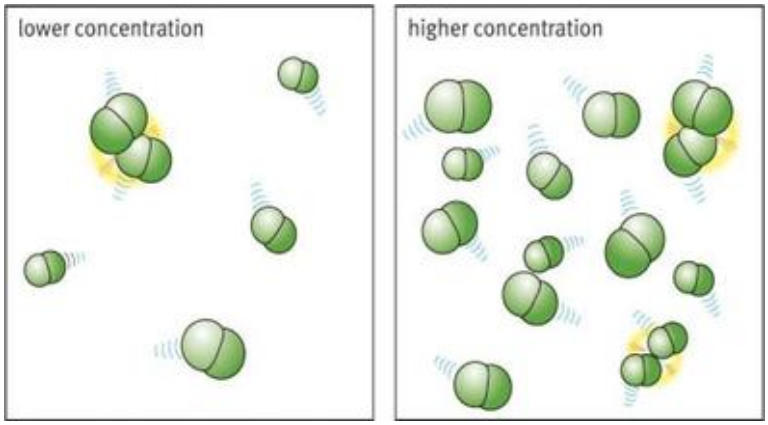
Changing factors such as temperature, concentration of reactants, surface area and adding a catalyst can change how many successful collisions occur or how quickly they occur. This then affects the reaction rate. Increasing these factors will increase the reaction rate.

Reactants over time

Reactions take place over time. As the amount of reactants decrease, the amount of products increase. The reaction rate is shown as a curve, because the amount of reactants at the start is greater, and the reaction rate slows as they decrease.



Reaction rate can be increased by increasing the concentration



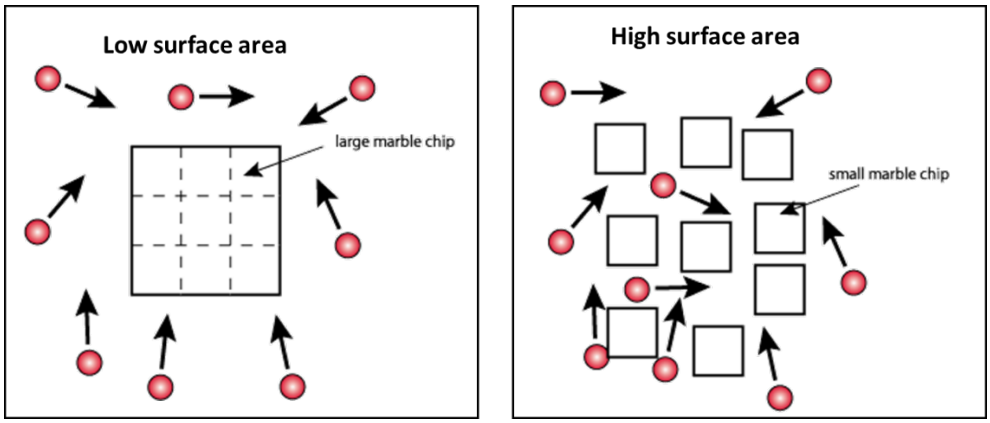
Increasing the concentration of one or more of the reactants will increase the reaction rate.

Decreasing the concentration of one or more of the reactants will decrease the reaction rate.

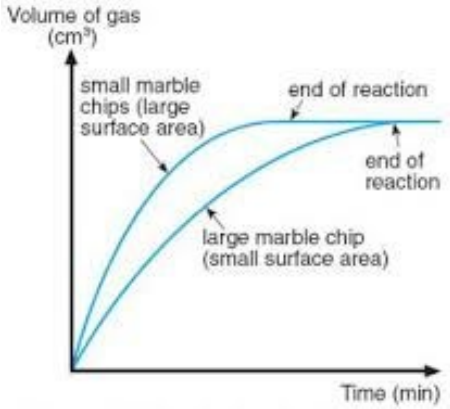
If there is a **higher concentration of a reactant**, there is a greater chance that particles will collide because there is less space between particles. There are **more particles per unit volume**. The **higher frequency of collisions** means there are more collisions per unit of time, and this will **increase the rate of the reaction**.

If there is a lower concentration, there will be fewer collisions and the reaction rate will decrease.

Reaction rate can be increased by increasing the Surface Area



Surface area can be increased by grinding and crushing large lumps into a finer powder. The smaller the pieces the greater the surface area. By increasing surface area, a greater number of reactant particles are exposed and therefore able to collide. The frequency of collisions (number of collisions per unit of time) will increase and therefore, the reaction rate will also increase.



An example is comparing the reaction between marble (calcium carbonate) and hydrochloric acid to produce carbon dioxide gas.

Note: although the reaction rate is higher for the smaller marble chips the total amount of gas (CO_2) produced is the same for both reactions as they both started off with the same amount of reactants.

Reaction rate can be increased by increasing the Temperature

Low Temperature | High Temperature

Increasing the temperature (kinetic energy) of the reacting particles will increase the reaction rate.

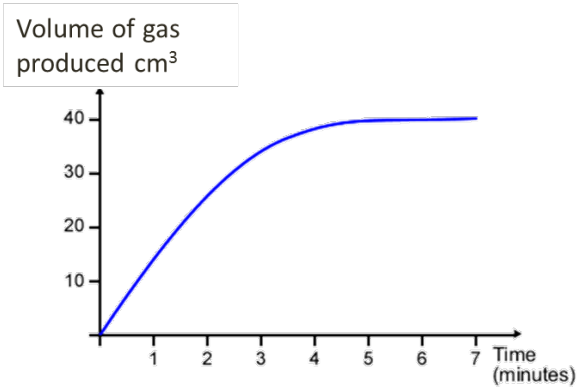
Decreasing the temperature (kinetic energy) of the reacting particles will decrease the reaction rate.

Increasing temperature affects the reaction rate in two ways.

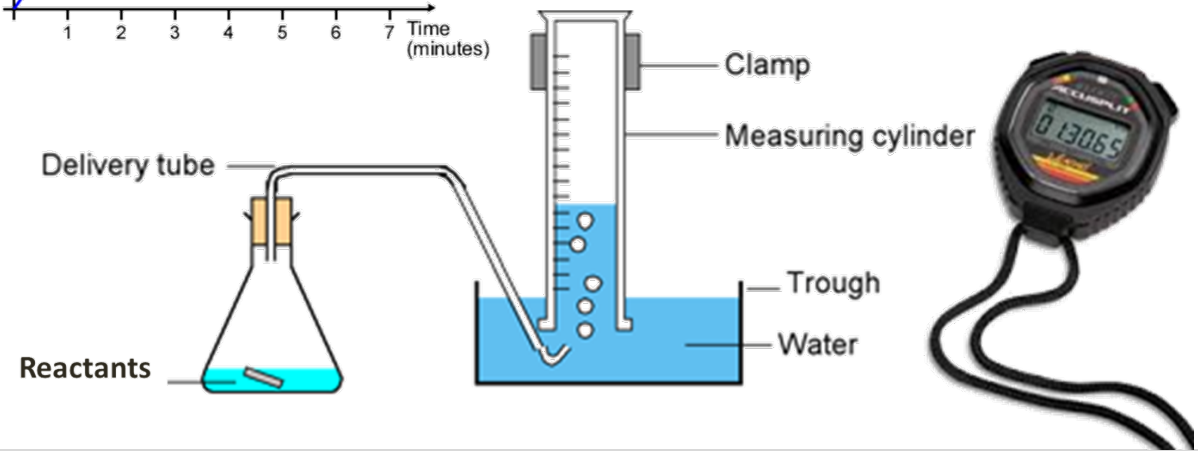
Firstly, when you raise the temperature of a system, the particles move around a lot more (because they have more kinetic energy). When they move around more, they are **more likely to collide, and the frequency of collisions increases**, therefore the reaction rate increases. When you lower the temperature, the molecules are slower and collide less frequently therefore the reaction rate decreases.

Secondly at a higher temperature a **larger proportion of particles have sufficient (kinetic) energy to have the energy required during a collision for it to be successful** and therefore a reaction to occur. This increases the proportion of successful collisions and therefore the reaction rate.

Measuring the rate of reaction



When gas is one of the products it can be collected in an upside-down cylinder. The water displacement is a measure of the volume of gas produced. The amount produced needs to be recorded at set time intervals and then graphed.



Experiment: Aim: to find how quickly salt is dissolved in water

Method.
- Add water to a beaker
- Measure a flat /level teaspoon of salt
- Use three different values of temperature of water from the tap
- Stir with a stirring rod the same way each trial
- See how long it takes for all the salt to be dissolved
- Record results in the table below

Water	Water temperature (°C)	Time to dissolve
Cold		
Warm		
Hot		

Students quickly wrote up an investigation to see if temperature affected reaction rate.

Many groups in class used the same method but their results were different each time.

It appeared the investigation method was not written well, and you now need to rewrite it.

1a. An aim needs to have both an independent variable (what is changed) and a dependent variable (what is measured) included.

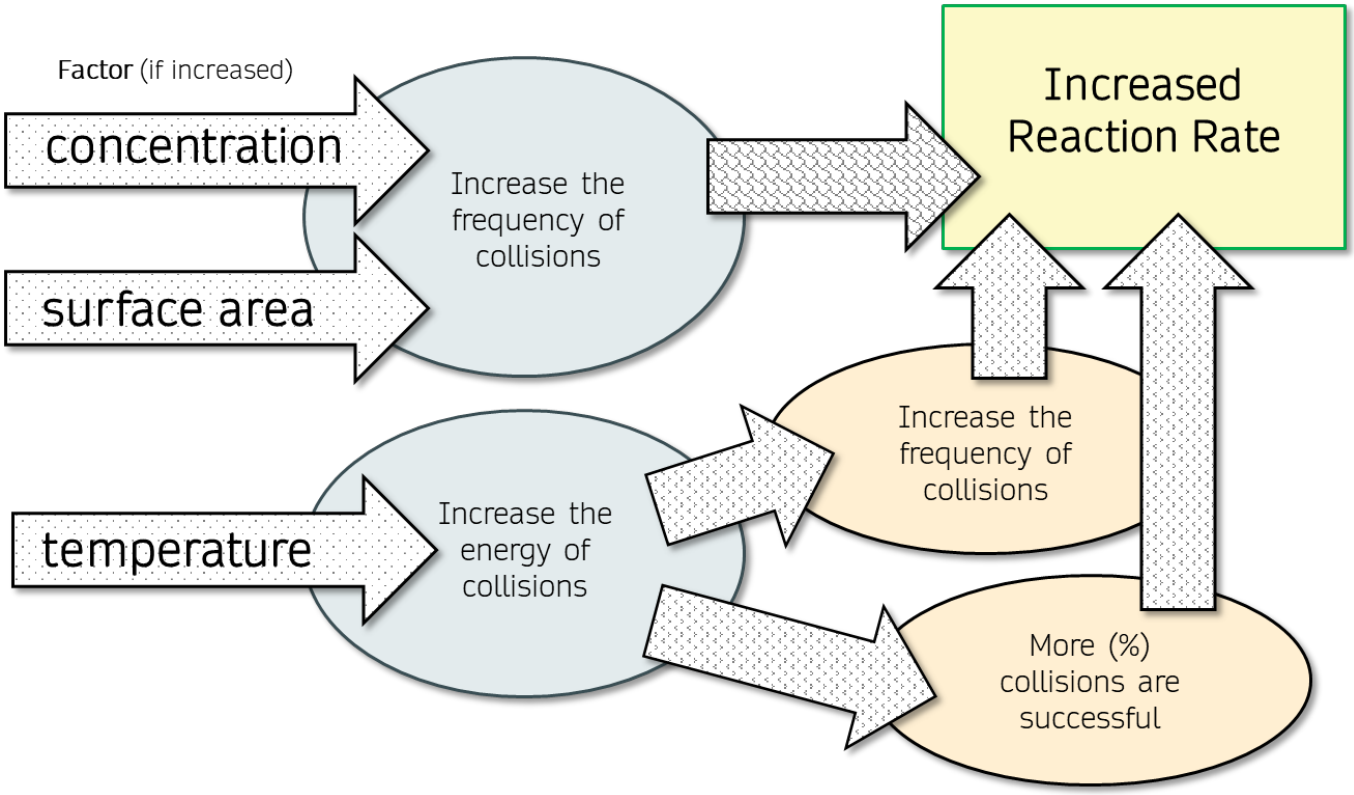
Write these below, then write a better aim than provided.

Independent variable
Dependent variable
Aim

1b. For each of the following steps in the method, rewrite and improve, making sure that variables are controlled, and other students can repeat the steps exactly.

❑ Add water to a beaker
❑ Measure a flat /level teaspoon of salt
❑ Use three different values of temperature of water from the tap
❑ Stir with a stirring rod the same way each trial
❑ See how long it takes for all the salt to be dissolved

2. Use the following flow chart to assist with explaining the following observations about reaction rates



The lid was left off the milo tin. Ruby noticed her milo with larger lumps took longer to dissolve in her cold milk. **Factor:** **Explanation:**
Warmed up vinegar causes a quicker reaction with baking soda, than cold vinegar **Factor:** **Explanation:**
The 4molL^{-1} hydrochloric acid made the piece of magnesium metal 'disappear' much quicker than 1molL^{-1}hydrochloric acid **Factor:** **Explanation:**