ROYAL SOCIETY OF CHEMISTRY

UNIVERSITY OF BIRMINGHAM

Topic 6 – Rate & Extent of Chemical Change

Dr Mark S. D. Read
School of Chemistry

Nuclear Education and Research Centre
www.chem.bham.ac.uk

Topic 6 – The Rate and Extent of Chemical Change

Sub Topics

- Rates of Reaction
- Factor Affecting Rates of Reaction
- Measuring Rates of Reaction
- Rate Experiments
- Finding Reaction Rates from Graphs
- Reversible Reactions
- Le Chatelier's Principle

Topic 6 – The Rate and Extent of Chemical Change

Rates of Reaction

The rate of a chemical reaction = how fast reactants are changed into products

SLOW → **MODERATE** → **FAST**

Rusting of iron

Chemical weathering

Mg + acid

Burning

Explosions

Topic 6 – The Rate and Extent of Chemical Change

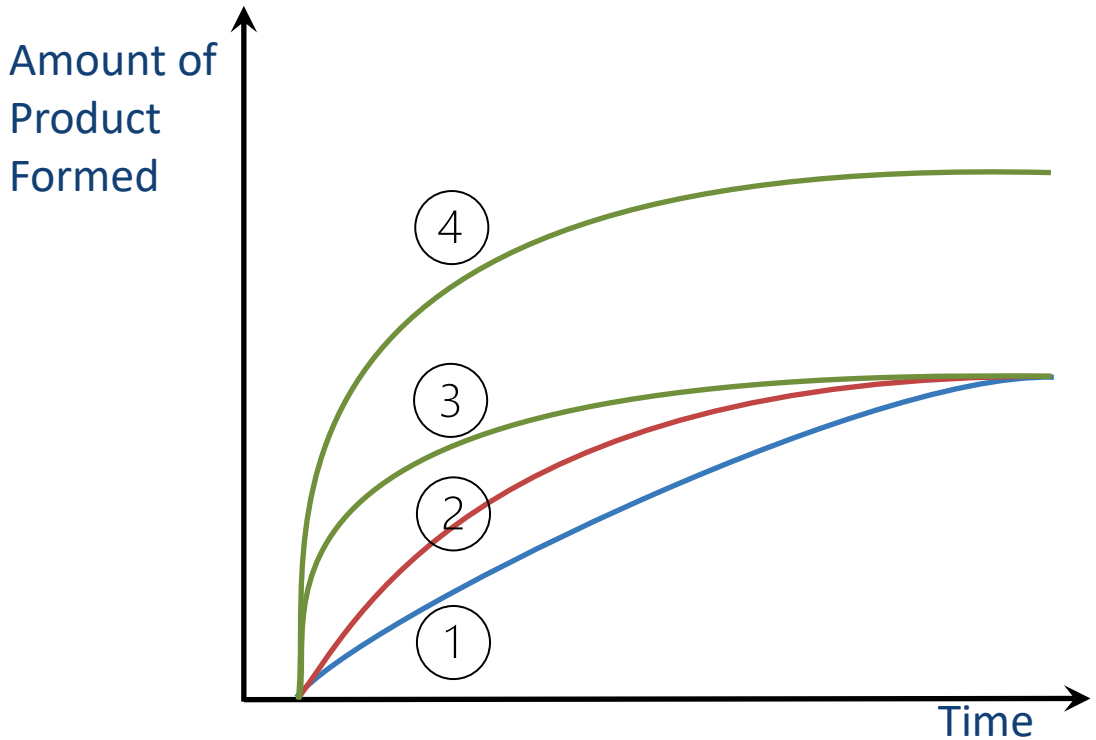
Rates of Reaction

Speed of reaction = amount of product formed or amount of reactant used up over time

Steeper the line on the graph, the faster the rate of reaction.

Over time, line becomes less steep as reactants are used up.

Quickest reactions have steepest lines – become flat quicker



4 – More product and Faster Rxn
More reactants at start

2 & 3 – Quicker Rxn same initial amounts
Slopes steeper than 1

1 – Original Rxn

Factors Affecting Rates of Reaction

Particles Must Collide with Enough Energy in Order to React

Reaction Rates explained by Collision Theory: Rate of Chemical Reaction depends on:

- Collision Frequency of reacting particles (more collisions – faster reaction)
- Energy Transferred during Collision: Particles have to collide with enough energy for collision to be successful

Minimum amount of energy needed for particles to react = Activation Energy

(Particles need this much energy to break reactant bonds and start reaction)

Factors that increase number of collisions (so a greater proportion of reacting particles collide) or the amount of energy particles collide with – will increase Rate of Reaction

Factors Affecting Rates of Reaction

Rate of Reaction Depends on Four Things

1. Temperature
2. Concentration of a solution or pressure of a gas
3. Surface Area – changes rate depending on the size of the lumps of a solid
4. The presence of a catalyst

More Collisions Increases the Rate of Reaction

All four methods of increasing the rate of reaction can be explained in terms of Increasing the number of successful collisions between reacting particles.

Factors Affecting Rates of Reaction

Increasing the Temperature Increases the Rate

1. When Temperature increased:

   Particles all move faster

2. Faster moving particles:

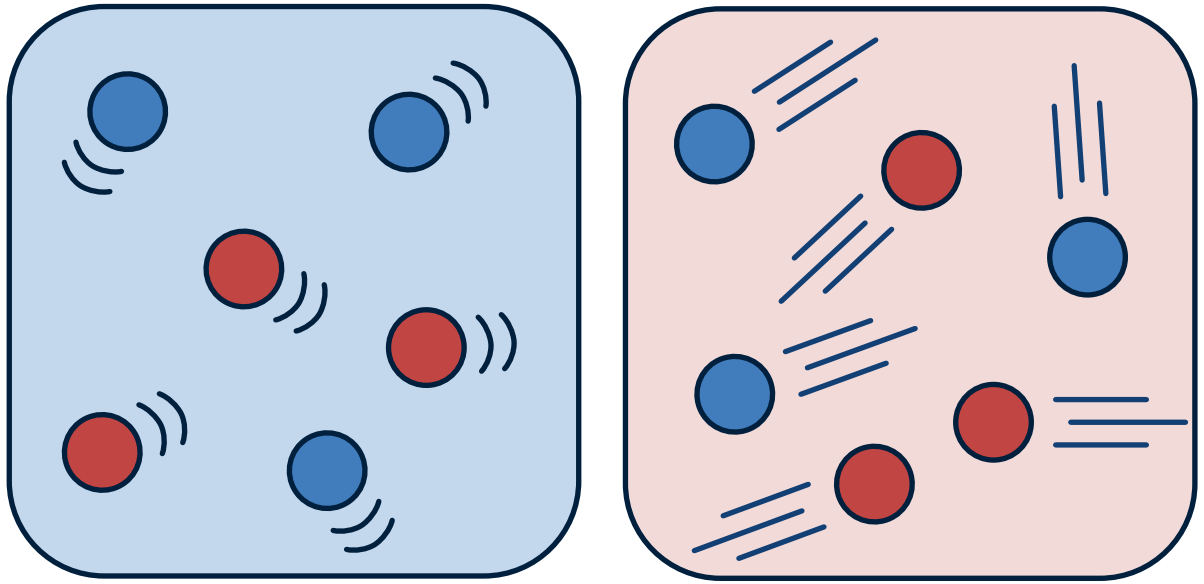
   Collide more frequently

3. The Faster particles move:

   The more energy they have:

   So more of the collisions will have

   enough energy to make the reaction happen

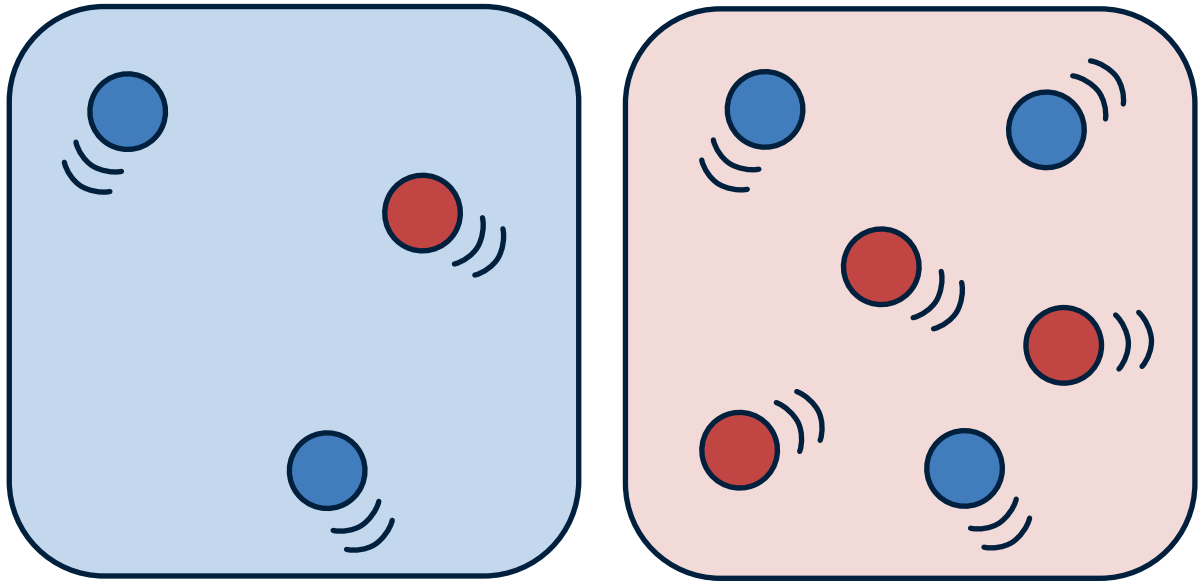


Cold Hot

Factors Affecting Rates of Reaction

Increasing the Concentration or Pressure Increases the Rate

1. If a solution is made more concentrated: there are more particles in the same volume of solvent.
2. When the pressure of a gas is increased: Same number of particle occupy a smaller space/volume.
3. Both make collisions between the reactant particles more frequent.



Low Concentration or Pressure

High Concentration or Pressure

Factors Affecting Rates of Reaction

Increasing the Surface Area Increases the Rate

1. If one of the reactants is a solid:

   Breaking up into smaller pieces:

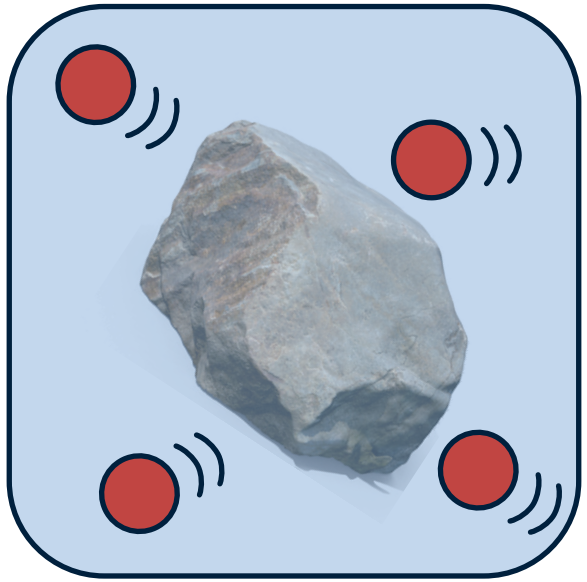
   Increases its surface area to volume ratio

2. For the same volume of solid:

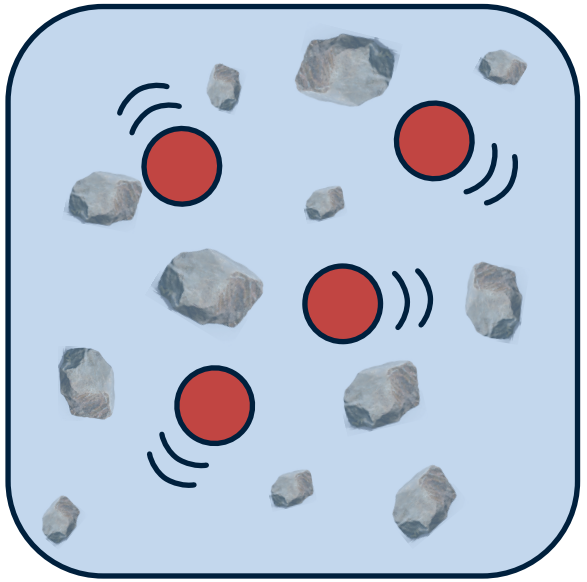
   surrounding particles have more area

   to interact with:

3. Leading to more frequent collisions



Small Surface Area



Large Surface Area

Factors Affecting Rates of Reaction

Using a Catalyst Increases the Rate

1. Catalyst: A substance that speeds up a reaction, without being used up itself (not part of reaction equation)
2. Different catalysts needed for different reactions.
3. All work by decreasing the activation energy needed for reaction to occur.
   Done by providing an alternative reaction pathway with lower activation energy
4. Enzymes are biological catalysts catalysing reactions in living organisms