Collision Theory

16.1

Q1 Fill in the blanks below using each word once.

energy collide catalyst concentration collision theory

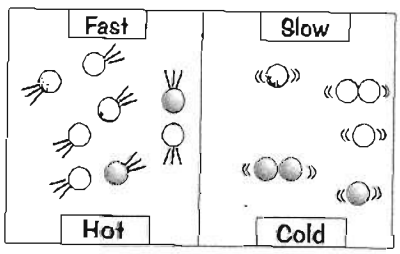
Particles can only react if they _____ with enough _____ for the reaction to take place. This is called the _____ _____. There are four factors that can change the rate of a reaction; temperature, _____, surface area and the use of a suitable _____.

Q2 Fill in the blanks in the text and complete the diagrams below using each word once.

moderate collision faster energy surface area faster catalyst fast slow particles faster faster more often collision successful slow fast faster low concentration catalyst present high concentration large surface area

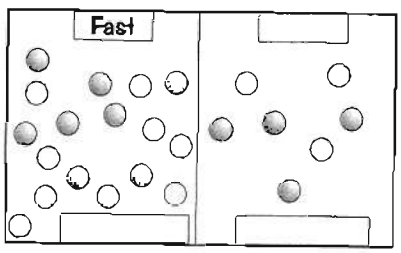
TEMPERATURE

Increasing the temperature will cause the particles to move _____ with more energy. They will therefore collide _____ _____ and with greater _____. These two things mean there are more successful collisions per second and therefore a _____ rate of reaction.



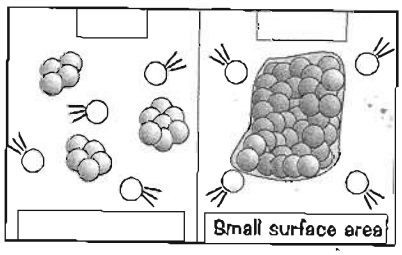
CONCENTRATION

Increasing the concentration of a reactant simply means there are more _____ which may collide and so react. More collisions means a _____ reaction.



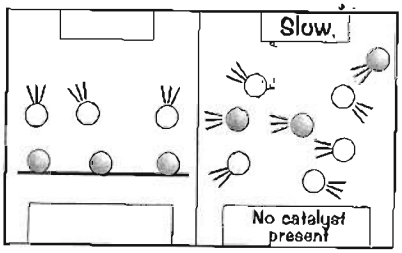
SURFACE AREA

Using a powder instead of a lump means the _____ _____ is greater, which means a greater area of reactant is exposed and so available for a collision. More collisions means a _____ reaction.



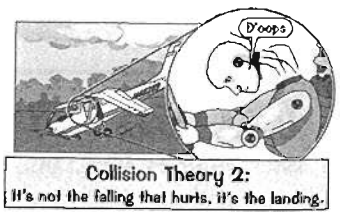
CATALYSTS

Use of a suitable catalyst means that the particles may react even if they collide with only _____ energy. This means more _____ collisions are likely. Some catalysts work because one of the particles is fixed to a surface. This makes the chance of a _____ more likely. More collisions means a _____ reaction.



Q3 Choose the sentence that **best describes** the collision theory:

- Particles collide at random and always react.
- Collisions between particles often result in a reaction.
- Reacting particles must collide with enough energy in order to react.
- Collisions between molecules are sometimes needed before a reaction occurs.



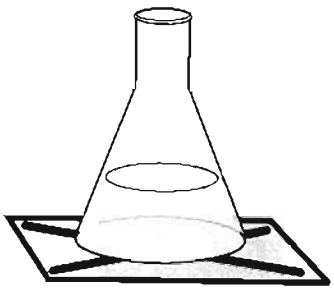
16.1 Experiments on Rates of Reaction

Q1 The reaction between sodium thiosulphate and hydrochloric acid produces a yellow precipitate of solid sulphur. This makes the solution cloudy and stops us seeing clearly through it. The cross below the flask in the diagram will slowly disappear as more precipitate is produced.

In an experiment to investigate rates of reaction, the time taken for the cross to disappear was measured.

$50cm^3$ of sodium thiosulphate solution was used and $10cm^3$ of hydrochloric acid was added.

The experiment was repeated at different temperatures.



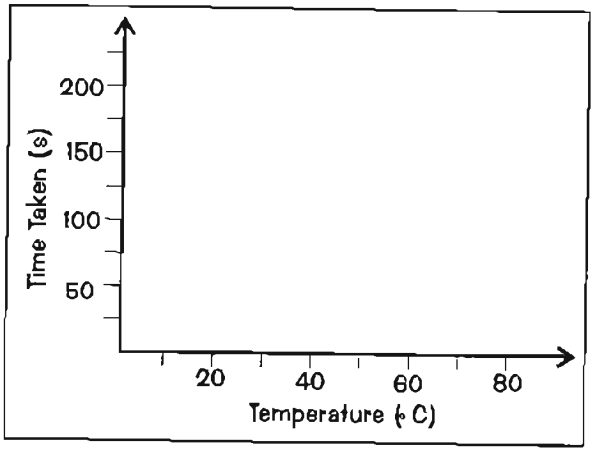
Temperature (°C)	20	30	40	50	60	70
Time taken (s)	163	87	43	23	11	5

a) **Copy the graph** on the right and use the results above to plot a line showing the relationship between temperature and time taken.

b) **Use the graph** to draw a simple conclusion about the effect of temperature on the time taken for the reaction to finish.

c) The rate of a reaction may be found by dividing 1 by the time taken (1/t). **Copy the table** above and add a row with the reaction rate at each temperature.

d) **Plot a graph** of rate against temperature. (If the actual numbers for the rate value are too small to plot, use 'Rate x1000' on the vertical axis).



e) **From the graph** work out how temperature affects the rate of a chemical reaction.

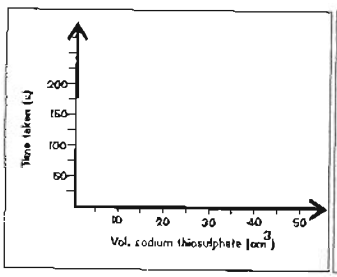
f) Use your knowledge of the collision theory to **explain** your conclusion.

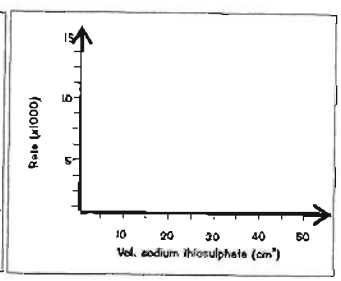
Q2 The same reaction can be used to investigate the effect of **concentration** on the rate of a reaction. When changing the concentration, it is important to keep the total volume used exactly the same.

Volume of sodium thiosulphate (cm^3)	50	40	30	20	10
Volume of water (cm^3)	0				
Time taken (s)	80	101	137	162	191
Rate (1/t)					

a) **Complete** the table above, adding the volume of water and calculating the rate of the reaction (to four decimal places).

b) Copy the axes on the right. Then, using data from the table, show how the volume of sodium thiosulphate used affects the time taken and rate of the reaction.





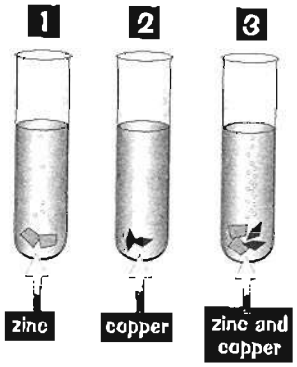
c) Use these graphs to draw a **simple conclusion** about the effect of concentration on reaction rate.

d) **Explain** your conclusion in terms of particles and the collision theory.

Catalysts

16.1

Q1 The diagrams to the right show how 0.5g of zinc and 0.5g of copper react with dilute sulphuric acid.



a) Does the **copper metal** react with dilute sulphuric acid?

b) Does **zinc** react with dilute sulphuric acid?

c) How do **zinc and copper** together react with dilute sulphuric acid?

d) **Describe** what copper does to the reaction in tube 3.

Tube 3 was left for several hours until the reaction was finished. The copper was removed, dried and weighed. Its mass was 0.5g.

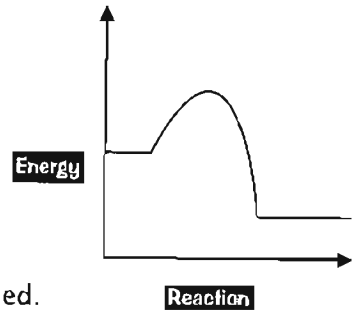
e) What does this tell you about the **action** of copper in speeding up the reaction between zinc and dilute sulphuric acid?

Q2 The graph shows an energy profile for a typical **exothermic** reaction.

a) Make a copy of the graph and mark on:

the reactants **the products** **the activation energy**

the energy change of the reaction

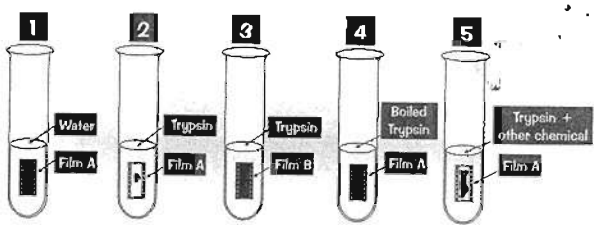


b) Use a different colour to mark the profile of the reaction when **catalysed**.

Q3 What are the **advantages** of using catalysts in the industrial manufacture of chemicals?

Q4 The experiment below can be used to investigate enzyme activity.

Trypsin is an enzyme which acts as a catalyst to the breakdown of protein. Photographic film has a protein layer that holds the silver compounds in place (these appear black). Different films use different proteins. If the protein is destroyed this black layer falls off leaving a clear plastic film.



a) Look at the test tubes carefully, then work out what you can say about the following test tube pairs:
i) 2 & 3 ii) 2 & 4 iii) 2 & 5

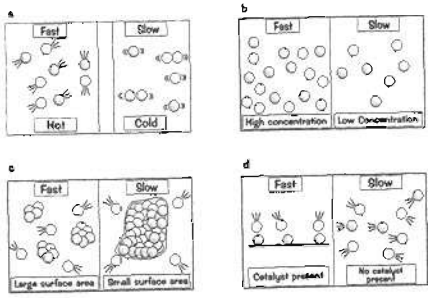
b) Why was test tube 1 included in the experiment?

Module Seven — Patterns of Chemical Change

Page 34 — Collision Theory

Q1 Collide; energy; collision theory; concentration; catalyst;

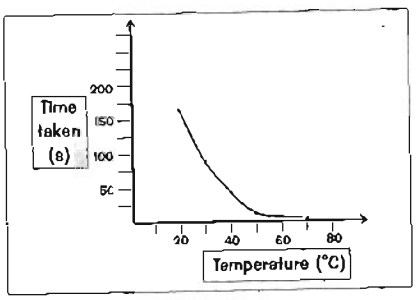
Q2 a) Faster; more often; energy; faster.
b) Particles; faster;
c) Surface area; faster.
d) Moderate; successful; collision; faster.



Q3 Reacting particles must collide with enough energy in order to react. (There is an activation energy barrier.)

Page 35 — Experiments on Rates of Reaction

Q1 a)

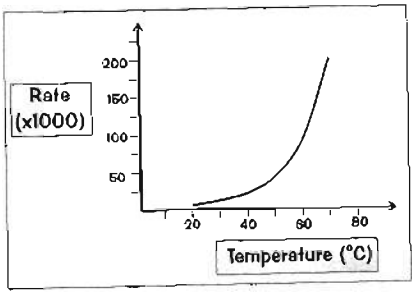


b) The higher the temperature, the less time is taken.

c)

Temperature (°C)	20	30	40	50	60	70
Time taken (s)	183	87	43	23	11	5
Rate (1/t)	0.0055	0.0115	0.0233	0.0435	0.0910	0.2000

d)



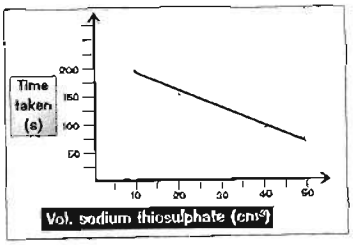
e) The higher the temperature, the faster the rate of reaction.

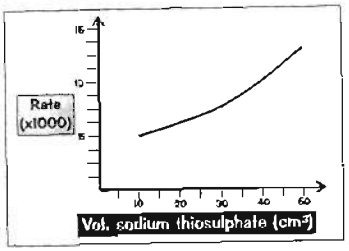
f) Higher temperatures give particles more energy, which makes them move faster. As the particles are moving faster, there are more collisions, and as they have more energy, more of these collisions are successful. Both mean a faster reaction rate.

Q2 a)

Volume of sodium thiosulphate (cm³)	50	40	30	20	10
Volume of water (cm³)	0	10	20	30	40
Time taken (s)	80	101	137	162	191
Rate (1/t)	0.0125	0.0099	0.0073	0.0061	0.0052

b)





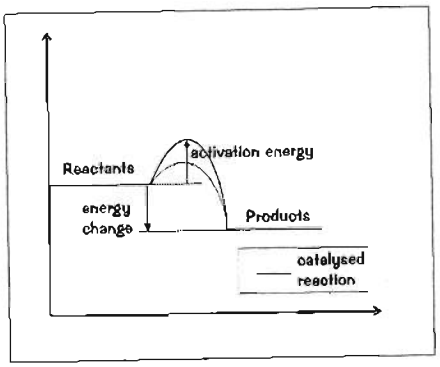
c) The greater the concentration the faster the reaction or the higher the rate.

d) With more particles in the solution there is a greater chance of a collision. More collisions means a faster reaction.

Page 36 — Catalysts

Q1 a) Copper doesn't react.
b) Zinc reacts slowly.
c) Zinc and copper react much better together.
d) Copper acts as a catalyst.
e) Copper is not used up, confirming its action as a catalyst.

Q2



Q3 Catalysts speed up the reaction therefore it takes less time to make more product. Catalysts also lower the operating temperature and this saves money.

Q4 a) i) Tubes 2 & 3... Trypsin does not work on the protein on film B - enzymes are substrate specific.
ii) Tubes 2 & 4 - boiling stops the enzyme working.
iii) Tubes 2 & 5 - some substances can block or inhibit the action of enzymes.

b) Tube 1 is included as a control to show that film does not disintegrate of its own accord.