The content on this sheet is assessed on paper 2 only.

# Topic 7a—Rates of reaction

* Indicates that these are some examples only: you could be asked about any substance / reaction.

## 7.1a—CP6—Measuring production of a gas (hydrochloric acid + marble)

Method:

1) Measure out a known volume of acid using a measuring cylinder.
2) Add the acid to a conical flask connected to a bung & delivery tube.
3) Measure out a known mass of marble using a digital balance.
4) Add the marble to the acid, insert the bung & start timing.
5) Collect the gas over water, or using a gas syringe.
6) Measure the amount of time taken to produce a fixed volume of gas.
7) Repeat, changing a reaction condition (for example: _____ area of the marble, temperature or the concentration of the acid.

Suggest a safety precaution that should be taken when carrying out this practical:

Wear safety glasses to protect the eyes.
Wash any spills off skin with plenty of water.

## 7.1b—CP6—Observing a colour change (sodium thiosulfate & hydrochloric acid)

Method:

1) Measure out a known volume of acid using a measuring cylinder.
2) Add the acid to a conical flask, placed over a black cross.
3) Measure out a known volume of thiosulfate using a measuring cylinder.
4) Add the thiosulfate to the acid & start timing.
5) Wait until the cross disappears, and stop timing.
6) Repeat, changing a reaction condition (for example: temperature or the concentration of the thiosulfate.

Suggest a safety precaution that should be taken when carrying out this practical:

Wear safety glasses to protect the eyes.
Wash any spills off skin with plenty of water.

## 7.2—Suggest practical methods for determining rate

There are a number of ways of determining how fast a reaction occurs:

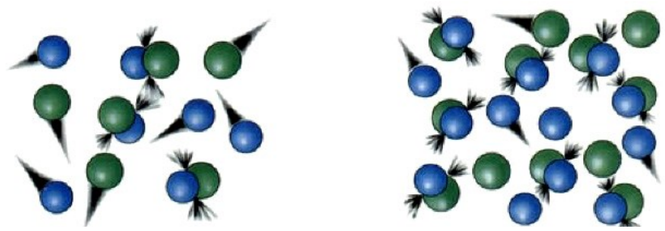
a) collecting a gas.
b) measuring a change in colour.
c) measuring a loss of mass (caused by a gas being released).
d) measuring a change in temperature.

The method chosen depends on the reactants and products.

Methods a and c can be used when one of the products is a gas.

Method b can be used when one of the products is either a solid, or a different colour from the reactants.

## 7.3—Collision theory



Reactions occur when particles collide with one another. These collisions must have sufficient energy in order for the particles to react. This quantity is known as the activation energy.

There are two main ways of increasing the rate of a reaction: either by increasing the frequency of collisions (how often they happen) or by increasing the amount of energy in the collisions between the particles.

## 7.4—Explain the effects of condition changes on rate

Temperature

Increasing the temperature will increase the rate of a chemical reaction. This is because more of the particles have energy which is greater than or equal to the activation energy. This means they will move faster and collide more frequently, with more energy, and so more of the collisions will result in a reaction.

Concentration (of solutions)

Increasing the concentration of a solution in a reaction will increase the rate of a chemical reaction. This is because there are more particles per unit of volume, and so the particles will be able to collide more frequently.

Surface area to volume ratio (of solids)

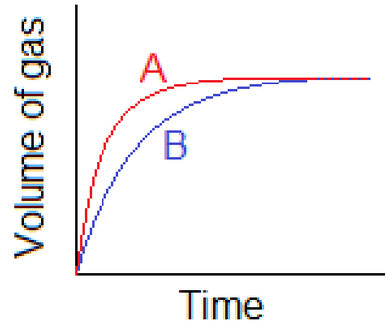
Increasing the surface area: volume ratio of a solid will increase the rate of a chemical reaction. This is because there are more reactant particles exposed at the surface of the solid. This will result in more frequent collisions.

Pressure (of gases)

Increasing the pressure of a gas in a reaction will increase the rate of a chemical reaction. This is because there are more particles per unit of volume, and so the particles will be able to collide more frequently.

NB. It is important to note that only increasing the temperature increases the energy of the particles. However, increasing all of the above conditions increases the frequency of collisions.

## 7.5—Interpret rate of reaction graphs




In the graph on the right, line A represents the reaction that is occurring faster. This is clear as the gradient of the curve is a lot larger (the curve is steeper) at the start. For both lines, the reaction starts off quickly (the gradient is bigger/steeper), then slows down before eventually stopping. It is worth noting that the total volume of gas produced is equal in both reactions: increasing the rate of a reaction does not affect the quantity of the product which is made.

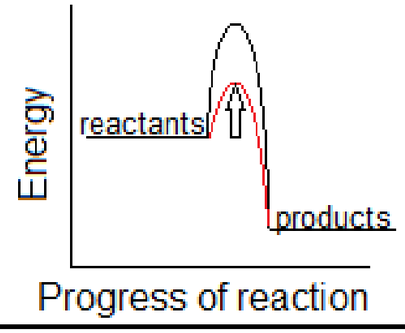
## 7.6—Catalysts

Catalysts are substances which increase the rate of a chemical reaction. However, using a catalyst does not alter the amount of the product that Is formed. The catalyst is also chemically unchanged at the end of the reaction.

## 7.7—Catalysts & activation energy

Adding a catalyst increases the rate of reaction by reducing the activation energy of the reaction. This means that more of the particles have an amount of energy which is greater than or equal to the activation energy.

For this reason, there will be more frequent collisions that result in reactions.




## 7.8—Enzymes

Enzymes are biological catalysts: that is, they are found inside living things, and help to increase the rate of reactions inside cells. Enzymes are also used in the production of alcoholic drinks: the enzyme helps to break down glucose into ethanol, with a by-product of carbon dioxide.