Name : _____ ( ) Class: _____ Date : _____

Measuring Speed of Reaction

(a) When measuring speed of reaction, we measure how quickly a **reactant** is used up or how quickly a **product** is formed.

(b) To measure reaction speed, we can measure:

- ► The **time** taken for a reaction to be **completed .**
- ► The amount of **product** produced in a period of time, or the amount of **reactant** remaining in a period of time.

1. Time for a Reaction to be Completed

The shorter the time taken for a reaction to be completed, the **greater/faster** the speed of reaction i.e. dissolving magnesium ribbon in different solutions of hydrochloric acid.

2. Measuring Changes that Occur in a Period of Time During a Reaction

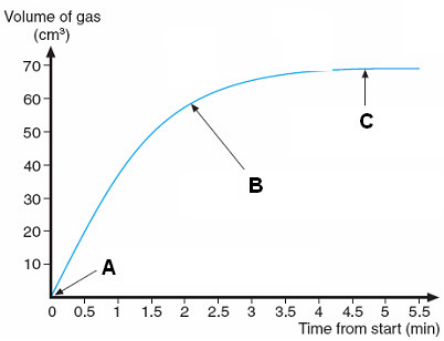
The gas produced in the reaction between calcium carbonate and dilute hydrochloric acid is **carbon dioxide .**

For reactions involving a gas being produced as one of the products, several changes can be measured.

- The change in the **volume** of the gas. The gas produced is collected in a **gas syringe** and measured at regular time intervals.
- The change in **mass** of the reaction mixture as the reaction proceeds. The mass **decreases** with time as the gas produced escapes from the flask.
- The change in **pressure** of the gas formed.

Graphs on Speed of Reaction

The graph below shows how the amount of product changes during a reaction.



At point A: The speed of reaction is **greatest** where the gradient is **largest** .
At point B: The speed of reaction has **decreases** as the gradient **decreases** with time.
At point C: The speed of reaction is **zero** as the gradient is **zero** .

Factors Affecting the Speed of Reaction

Several factors can affect the speed of reaction, namely,

- the **particle size** of a reactant;
- the **concentration** of a solution
- the **pressure** (for reactions involving gases)
- **temperature**
- the use of **catalyst**

Using Particle Theory to explain factors affecting the speed of reaction

1. **Particle Size and Speed of Reaction**
   a) Rate of reaction of solids with liquids or gases **increases** when the solids are broken down into **smaller** pieces.
   b) Small pieces of solids have a larger **total surface area** as compared to a large piece of the same **mass** .
   c) Molecules of liquids and gases react with solid molecules when they collide on the surface of the solid. The smaller the **size** of the solid particles, the **greater** their total surface area and thus the more **frequent** the **collision** between the solid and the molecules of liquids and gases. Hence the rate of reaction is **increased.**
2. **Concentration and Speed of Reaction**
   a) Most (but not all) chemical reactions are faster when the **concentration** of the reactants is higher.
   b) At **higher** concentrations, there are more **particles** per unit volume and they **collide** more **frequently**.
3. **Pressure and Speed of Reaction**
   a) Reactions involving gases go faster at **higher** pressure as the molecules are **closer** together. Hence there are more **particles** per unit volume and they **collide** more frequently, resulting in higher rate of reaction.
4. **Temperature and Speed of Reaction**
   a) The speed of a chemical reaction **increases** when the temperature increases.
   b) The speed of reaction usually **doubles** for every **10** ºC rise in temperature.
   c) For particles to collide and react, they must have the necessary **activation energy.**
   d) To react, they must collide at great **speed** with a lot of **energy.**
   e) At higher temperature, the particles move **faster** and there is an **increase** in the **rate** of **collision**.
5. **Catalyst and Speed of Reaction**
   a) A catalyst is a substance which speeds up a chemical reaction without itself being used up and it remains **chemically unchanged** at the end of the reaction.
   b) A catalyst provides an **alternative** and **easier** pathway for the reaction that requires **lesser activation energy**.