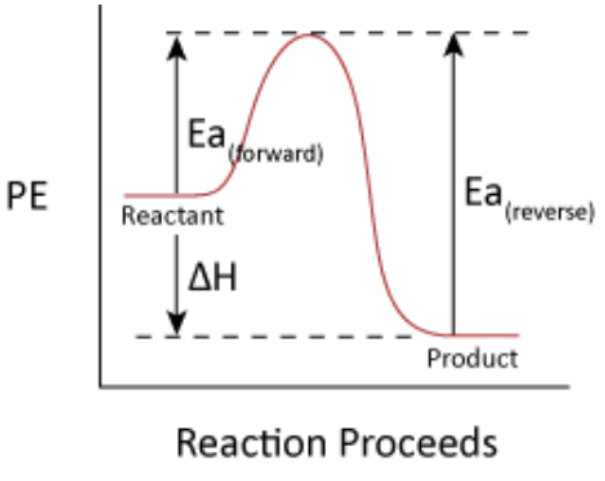
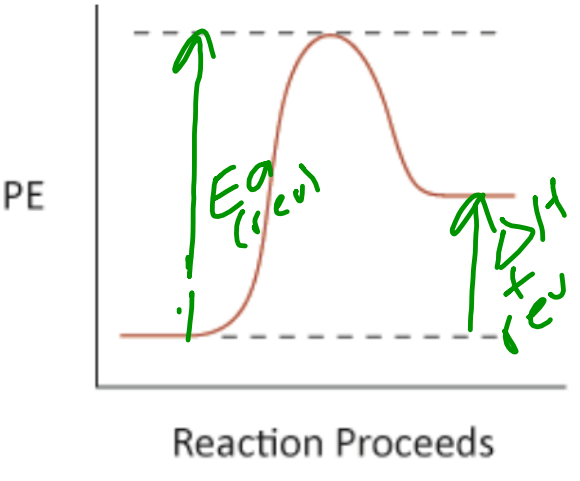
Reversible Reactions

- in most spontaneous reactions, the **formation of products is greatly favoured** over the reactants and the **reaction proceeds to completion** (one direction)
- in some reactions, the **product is only slightly favoured** over the reactants and can proceed in **both directions**

> **REVERSIBLE REACTION** = reactions that proceed in the forward (R → P) and reverse (P → R) direction **simultaneously**

- reversible reactions involve 2 competing reactions that occur at the same time
  - > FORWARD REACTION = conversion of reactants to products
  - > REVERSE REACTION = conversion of products to reactants

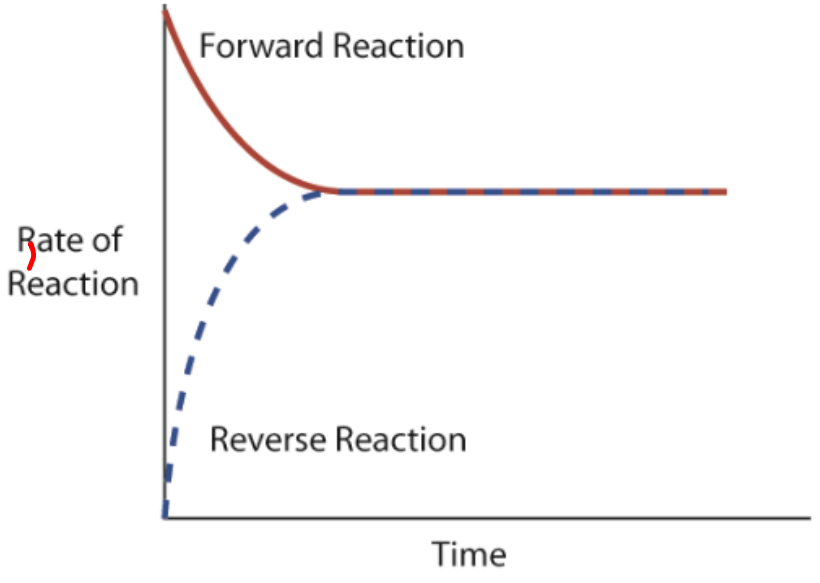




Consider the following reversible reaction:

$$2SO_2(g) + O_2(g) \rightleftarrows SO_3(g)$$

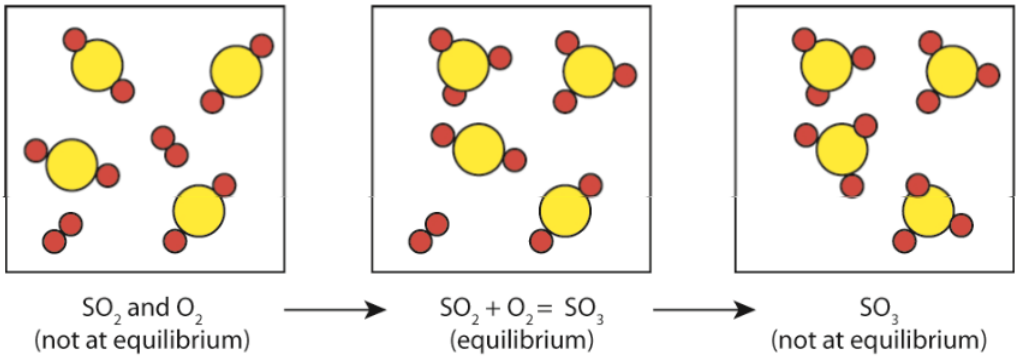
- the **double arrow** ($\rightleftarrows$) indicates that reaction is reversible
- when a reversible reaction begins, **only the forward reaction occurs** (if starting from reactants)
- as the reaction proceeds, the **forward reaction slows** and the **reverse reaction speeds up**
- eventually, the system reaches **equilibrium**



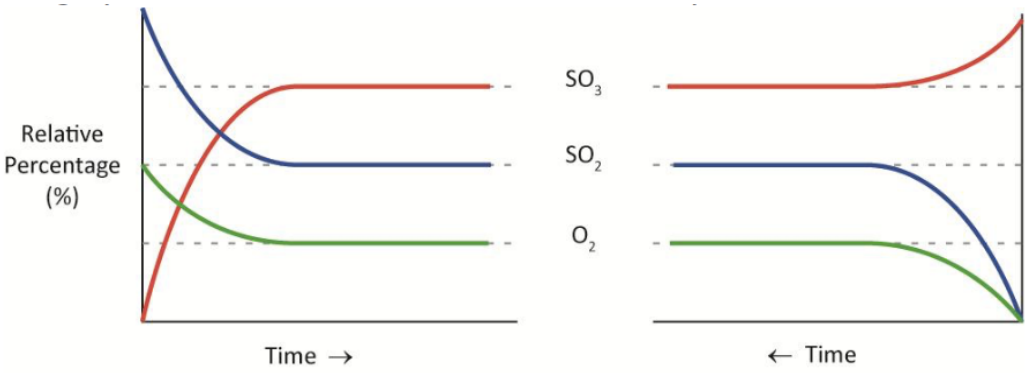
A reversible reaction is said to be at EQUILIBRIUM when the rate of the forward reaction EQUALS the rate of the reverse reaction.

$$Rate_{(forward)} = Rate_{(reverse)}$$

- a reversible reaction will achieve equilibrium **regardless of the direction from which it is approached**



- these graphs show the variation of reactant and product concentration with time

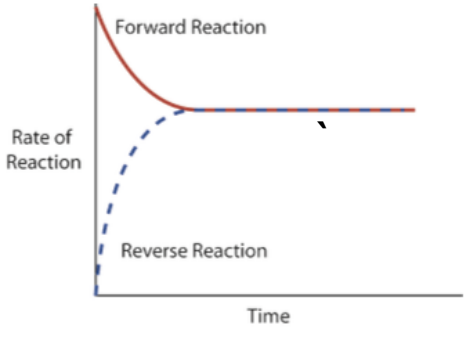


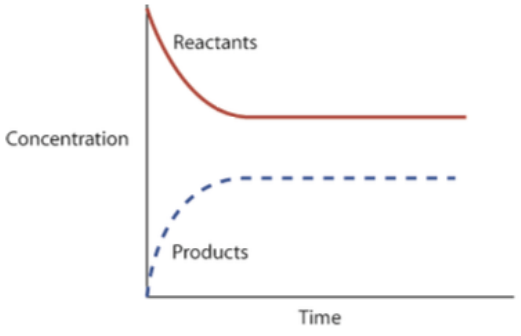
- at equilibrium, the concentration of **reactant and product do not change** and the **relative amounts** of reactants and products are the **same** regardless of whether the reaction began from the reactants or the products

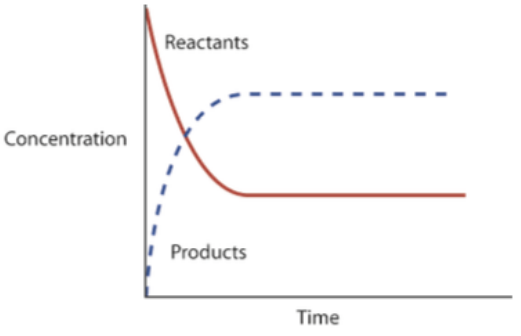
Chemical equilibrium are said to be:

DYNAMIC = forward and reverse reactions continue to occur although there is no net change in the MACROSCOPIC properties.

- when a reaction reaches equilibrium, all MACROSCOPIC properties (measurable) are constant
  - > colour intensity, concentration, pressure
  - > Note: when system reaches equilibrium, the rates of the forward and reverse reactions are equal but the concentrations of the reactants and products are not.







Systems at equilibrium are characterized by the following:

1. closed system - nothing enters or leaves
2. opposite reactions occur at the same rate
3. equilibrium reached starting with either reactants or products
4. Temperature is constant
5. no change in macroscopic properties