Unit 12 Rates & Kp (Paper 1 & 3)

12.1 Rate equations

Rate equations

The rate of a chemical reaction is related to the concentration of reactants by a rate equation of the form: **Rate = $k[A]^m[B]^n$**

where m and n are the orders of reaction with respect to reactants A and B and k is the rate constant.

The orders m and n are restricted to the values 0, 1, and 2.

The rate constant k varies with temperature as shown by the equation: **$k = Ae^{-E_a/RT}$**

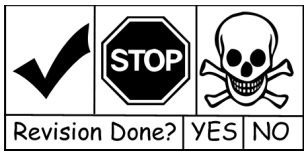
where A is a constant, known as the Arrhenius constant,

E a is the activation energy and T is the temperature in K.

You should be able to:

- define the terms order of reaction and rate constant
- perform calculations using the rate equation
- explain the qualitative effect of changes in temperature on the rate constant k
- perform calculations using the equation $k = Ae^{-E_a/RT}$
- understand that the equation $k = Ae^{-E_a/RT}$ can be rearranged into the form ln k = –Ea/RT + ln A and know how to use this rearranged equation with experimental data to plot a straight line graph with slope –Ea/R

These equations and the gas constant, R, will be given when required.



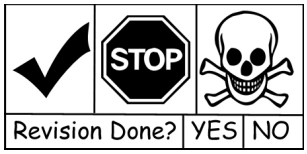
Determination of rate equation

The rate equation is an experimentally determined relationship.

The orders with respect to reactants can provide information about the mechanism of a reaction.

You should be able to:

- use concentration–time graphs to deduce the rate of a reaction
- use initial concentration–time data to deduce the initial rate of a reaction
- use rate–concentration data or graphs to deduce the order (0, 1 or 2) with respect to a reactant
- derive the rate equation for a reaction from the orders with respect to each of the reactants
- use the orders with respect to reactants to provide information about the rate determining/limiting step of a reaction.



12.2 Equilibrium constant K_p for homogeneous systems

The equilibrium constant K_p is deduced from the equation for a reversible reaction occurring in the gas phase.

K_p is the equilibrium constant calculated from partial pressures for a system at constant temperature.

You should be able to:

- derive partial pressure from mole fraction and total pressure
- construct an expression for K_p for a homogeneous system in equilibrium
- perform calculations involving K_p
- predict the qualitative effects of changes in temperature and pressure on the position of equilibrium
- predict the qualitative effects of changes in temperature on the value of K_p
- understand that, whilst a catalyst can affect the rate of attainment of an equilibrium, it does not affect the value of the equilibrium constant.