16.1 – Rate Expression

16.1.1 - Distinguish between the terms rate constant, overall order of reaction and order of reaction with respect to a particular reactant

Rate is proportional to the concentration of reactants present. Using this relationship, the following equation was deduced, called the rate expression:

$$Reaction\ Rate = k[reactants]$$

Where k is the rate constant. Since the concentration in this equation is raised to the power of one, it is called a first-order reaction. However, the order of reaction can change. The concentration of the reactants may be raised to a power. Also, a reaction may involve more than one reactant, leading to the equation:

$$Rate = [A]^m[B]^n$$

Therefore, if the order of reaction and the concentration for each reactant is known, we can calculate the rate of reaction. However, it is important to remember that the order of reaction may be different for each of the reactants.

Rate Constant

Symbol is **k**. A constant for a particular reaction at a specified temperature

Overall Order of Reaction

The sum of the individual orders for all reactants, *m + n,* from the equation:

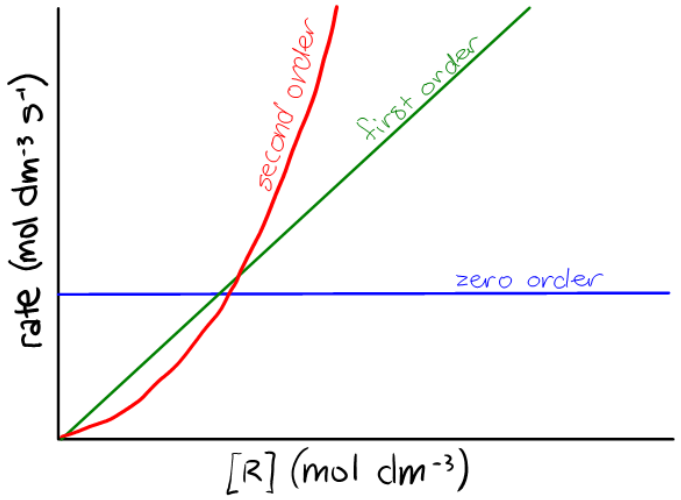
$$Rate = [A]^m[B]^n$$

NOTE
The order of reaction can only be found using experimental data

Order of Reaction

In the equation $Rate \propto [R]^n$, n is the order of reaction. It indicates the relationship between the concentration of the reactant and the rate of reaction. This tends to be 0, 1 or 2, being called zero-, first- or second-order reactions.

Rate Equation	n Value	Order of reactions	Why
$Rate \propto [R]^0$	0	Zero	$[R]^0 = 1$ so Rate = constant. The rate of reaction is not affected if [R] is changed.
$Rate \propto [R]^1$	1	First	This means that they are directly proportional, changing by the same factor.
$Rate \propto [R]^2$	2	Second	Also directly proportional, changing it by the square factor.



Units of k

The overall order of reaction will affect the units of k in the equation.

Order of Reaction	Rate Expression	Units of k
0	Rate = k	= units of rate = **mol dm^{-3} s^{-1}**
1	Rate = k[A]	$= \frac{\text{units of rate}}{\text{units of concentration}}$ = **s^{-1}**
2	Rate = k[A]^2	= **mol^{-1} dm^3 s^{-1}**
3	Rate = k[A]^3	= **mol^{-2} dm^6 s^{-1}**