Diffusion

Fick's laws form the basis of diffusion theory applying to a two-component, single-phase solution at constant temperature and pressure

Fick's First Law can be expressed in the form

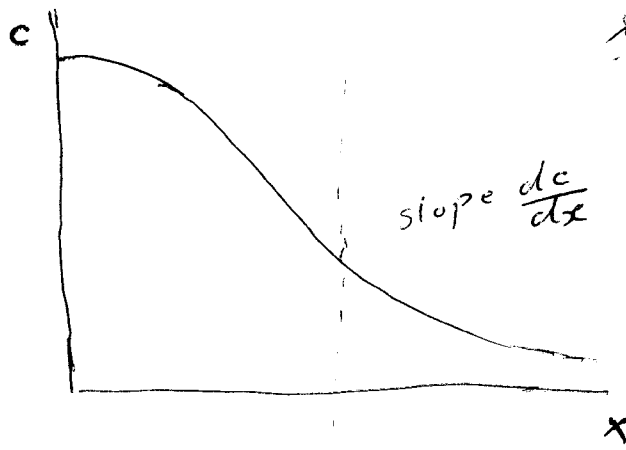
$$J = -D \frac{dc}{dx}$$

where J is the mass of diffusing substance passing in unit time through unit area of a plane at right angles to the direction of diffusion.

J is known as the "flux" and is proportional to the concentration gradient $\frac{dc}{dx}$ across the plane, where C is the concentration of the substance, X is the distance in the direction of diffusion.

* The constant of proportionality is D, the "diffusion coefficient" or

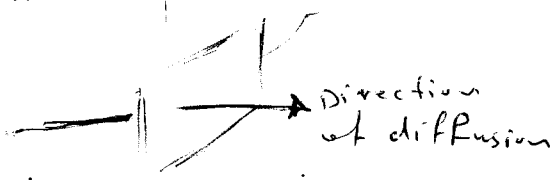
This law is similar to that relating to heat transfer by conductance and also the flow of an electric current along conductor.



* Fick's Second Law of Diffusion can be expressed in the form

$$\frac{\partial c}{\partial t} = \frac{\partial}{\partial x}\left(D \frac{\partial c}{\partial x}\right)$$

where $\frac{\partial c}{\partial t}$ is the rate of increase in concentration of the diffusing substance in a given volume and is equal to the difference between the flux entering the volume and that leaving the volume, $-\frac{\partial J}{\partial x}$



If D is considered to be constant at constant temp. can be written

$$\frac{\partial c}{\partial t} = D \frac{\partial^2 c}{\partial x^2}$$

but it usually found that D is not constant and varies with the concentration.

* The diffusion coefficient D is related to temperature by an expression similar to Arrhenius equation

$$D = D_0 \exp\left(-\frac{E_D}{RT}\right)$$

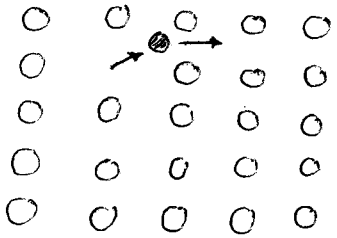
where E_D is the activation energy for diffusion.

Diffusion in the Solid State

* Two Mechanisms for solid state diffusion

1- The Frenkel defect (interstitial mechansim)

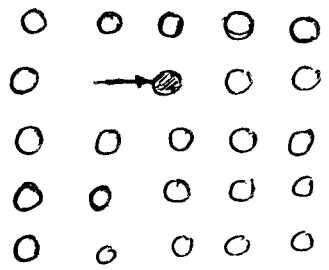
The diffusing atoms move Through the interstitial Spaces between the atoms in the normal lattice sites.



Frenkel defect diffusion

2- Schottky defect (Vacancy mechanism).

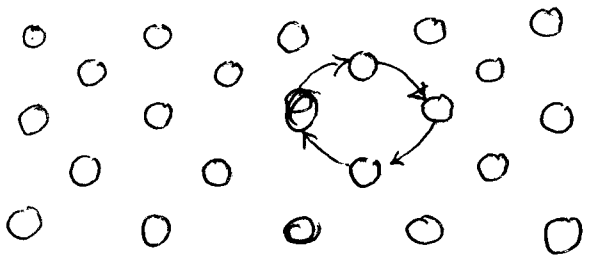
The atoms to move around by receiving atoms from neighbouring sites into vacancies, and then following up by similar movement by other neighbours in ~~the~~ to the vacant site.



⇐ Schottky defect diffusion.

3- Rotation of atoms (Dorn ~~diffusion~~ diffusion)

A third mechanism requires exchange or rotation within a Co planar group of atoms forming a closed ring



Rotation of atoms.