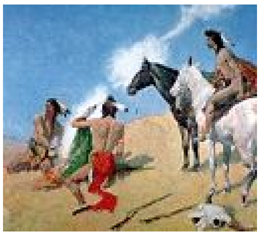
3.1.2 Essentials to Chapter 3.1: Diffusion Primer

- There is no technology without diffusion and no "*high*" technology without *controlled* diffusion.

– Diffusion =



- Fick's first law is the foundation of phenomenological diffusion.
  - Fick's second law is simply the continuity equation for diffusing entities (without changing the total particle number).

$$\textbf{1.}\quad j_i = -D\cdot\nabla c_i$$

$$\textbf{2.}\quad \frac{\partial c}{\partial t} = \mathrm{div}\,(D\cdot\nabla c) = D\cdot\Delta c$$

  - Diffusion is synonymous with "random walk". The basic equation for random walk relates the diffusion length ***L*** to the number of jumps ***N*** and the (average) distance ***a*** covered in one jump.

$$L^2 = a^2\cdot 3N$$

- The relation between the atomic point of view and the phenomenological point of view goes back to Einstein; ν is the jump frequency N/t.
  - The important parameter for atomic diffusion is now the migrations enthalpy H_M of the atom (or better defect) under consideration, and, somewhat less important, the pre-exponential factor D_0 that contains the migration entropy S_M and the lattice parameters.

$$D = g\cdot a^2\cdot\nu$$

$$= D_0\cdot\exp -\frac{H_M}{kT}$$

- If we combine the equations for ***D*** with the one for random walk, we obtain the Einstein-Smolukowski relation
  - Read backwards it tells us that the diffusion lengtt ***L*** is given by the square root of diffusion coefficient ***D*** times diffusion time ***t***.

$$D = \frac{L^2}{6t}$$