Box 2 - Diffusion kinetics.

Heat, matter (molecules), charges (ions, electrons) or other properties can migrate in a fluid or a solid. The transport rate in the y direction is defined by the flux J_y, proportional to the driving force (temperature or concentration gradient ....).

Fick's first law of diffusion :

heat flux	$J_y = -\chi \frac{\partial T}{\partial y}$	χ = coefficient of thermal conductivity ($J\,K^{-1}\,m^{-1}\,s^{-1}$)
Matter flux	$J_y = -D \frac{\partial C}{\partial y}$	D = diffusion coefficient ($m^2\,s^{-1}$)
Momentum flux	$J_y = -\eta \frac{\partial v_z}{\partial y}$	η = coefficient of viscosity ($kg\,m^{-1}\,s^{-1}$)

Fick's second law of diffusion :

The continuity equation, or mass conservation for a flux of matter, $\frac{\partial C}{\partial t} = -\frac{\partial J}{\partial y}$, leads to the diffusion equation, or Fick's second law (D is supposed constant) :

$$\frac{\partial C(y,t)}{\partial t} = D\nabla^2 C(y,t)$$

The evolution of concentration with time is proportional to the second derivative of concentration with respect to distance. Solutions of this partial differential equation are obtained when specific boundary conditions are applied.

Momentum and energy conservation leads to the Navier-Stokes and energy transport equation (see Rosenberger for details).