**TABLE 9.1 Physical Processes Obeying the "Gradient-Flux Law"[a]**

| Law | Equation | Definition of Variables | |
|---|---|---|---|
| First Fick's law for molecular diffusion | $F = -D \frac{\partial C}{\partial x}$ | $F$ (mol·m$^{-2}$·s$^{-1}$) | Mass flux |
| | | $C$ (mol·m$^{-3}$) | Concentration |
| | | $D$ (m$^{2}$·s$^{-1}$) | Molecular diffusion coefficient |
| Conduction of heat (Fourier) | $F_{th} = -\kappa \frac{\partial T}{\partial x}$ | $F_{th}$ (W·m$^{-2}$) | Heat flux |
| | | $T$(K) | Temperature |
| | | $\kappa$(W·m$^{-2}$·K$^{-1}$) | Thermal conductivity |
| Flow of fluid through porous medium (Darcy's Law) | $q = -K \frac{\partial h}{\partial x}$ | $q$ (m·s$^{-1}$) | Velocity of fluid |
| | | h(m) | Hydraulic head (or pressure change along flow path $x$) |
| | | $K$ (m·s$^{-1}$) | Hydraulic conductivity of medium |
| Electric conductivity[b] (Ohm's Law) | $j = +k \frac{\partial V}{\partial x}$ | $j$ (A·m$^{-2}$) | Electric current per area |
| | | $V$ (V) | Electric field |
| | | $k$ ($\Omega^{-1}$·m$^{-1}$) | Electric conductivity |

[a]The partial derivatives ($\partial/\partial x$) are used to point out that the property variables ($C$, $T$, etc.) generally depend on time and space and that the spatial derivatives are calculated by keeping the other (spatial and temporal) coordinates constant.

[b]The positive sign results from the special sign convention used for electric currents and fields.