$$\Delta E \, \Delta t \quad \simeq \quad \hbar$$

$$\Delta E \Delta t \simeq \hbar$$

$$\frac{\Delta \lambda}{\lambda_0} \quad = \quad \sqrt{\frac{1-(v/c)}{1+(v/c)}}$$

$$\frac{\Delta \lambda}{\lambda_0} \quad \simeq \quad \frac{v}{c}$$

$$\text{mean free path} \;\; \ell \quad = \quad \frac{1}{n\sigma}$$

$$v_{\text{thermal}} \quad = \quad \sqrt{\frac{2kT}{m}}$$

$$\Delta t \quad = \quad \frac{\ell}{v_{\text{thermal}}} \quad = \quad \frac{1}{n\sigma} \sqrt{\frac{m}{2kT}}$$