Formula Sheet

The first law of thermodynamics

$$\mathrm{d}U = đQ - p\,\mathrm{d}V$$
$$\Delta U = Q_{\text{in}} + W_{\text{on}}$$

Ideal gas equation of state

$$pV = n\mathrm{R}T$$

Ideal gas adiabatic process

$$pV^{\gamma} = \text{constant}\ ,\ \text{where}\ \gamma = C_p/C_V\ .$$

Heat Transfer

Rate of heat flow by conduction $\dot{Q} = -\kappa A \dfrac{\partial T}{\partial x}$

Stefan-Boltzmann $\dot{Q} = \sigma e A T^4$

Linear coefficient of thermal expansion, α

$$\ell(T) = \ell(T_0)[1 + \alpha(T - T_0)]\ .$$

Gamma function and Stirling's approximation

$$\Gamma(N+1) = N! = \int_0^{\infty} \mathrm{d}x\, x^N\, \mathrm{e}^{-x} \qquad \text{and} \quad N! \approx \left(\frac{N}{\mathrm{e}}\right)^N \Leftrightarrow\ \ln N! \approx N(\ln N - 1)\,.$$

Gaussian integral

$$\int_{-\infty}^{\infty} \mathrm{e}^{-\alpha x^2} \mathrm{d}x = \sqrt{\frac{\pi}{\alpha}}\ .$$

Normalised one-dimensional Maxwell-Boltzmann distribution

$$p_{\text{1d}}(v) = \sqrt{\frac{m}{2\pi \mathrm{k_B} T}}\exp\left(-\frac{mv^2}{2k_{\text{B}}T}\right)\ .$$