PHYS 4C Exam 1 Reference Sheet (with LaTeX)
Write Units Anything not in here can be found in the textbook or your notes.

Laws of Thermodynamics

0. Transistive Thermodynamic Equilibrium
1. $\Delta E = Q_{in} + W_{in}$
2. $\Delta S \geq 0$
3. 0K can't be reached in finitely many steps

$$T_F = \frac{9}{5}T_C + 32$$

Thermal Expansion

$$\Delta L = \alpha L_i \Delta T$$
$$\Delta V = 3\alpha V_i \Delta T$$

Heat

Flows from hot to cold

$$Q = cm\Delta T(\text{Temperature change})$$
$$Q = L_m m(\text{Phase change})$$

Thermal processes

$$W = -p\Delta V = -\int p\, dV$$
$$PV = NkT = nRT; \Delta E = nC_V \Delta T$$
$$C_V = \left(\frac{f}{2}\right) R; C_p = C_V + 1; \gamma = \frac{C_p}{C_V}$$

Constant	Name	Formulae
p	Isobaric	$Q = nC_p\Delta T; W = -p\Delta V$
T	Isothermal	$Q = -W = nRT\ln(V_f/V_i)$
$pV^\gamma, TV^{\gamma-1}$	Adiabatic	$Q = 0; W = \Delta E$
V	Isochoric	$Q = nC_V\Delta T; W = 0$

Conductance equations

k is the conductance of a material. Conductance over multiple objects works like capacitance equivalence

$$\frac{\mathrm{d}Q}{\mathrm{d}t} = K\Delta T; K = \frac{kA}{L}$$
$$\frac{1}{A}\frac{\mathrm{d}Q}{\mathrm{d}t} = -k\frac{\mathrm{d}T}{\mathrm{d}x}; \vec{J} = -k\nabla T$$

Entropy (S) change

$$\Delta S = \int_i^f \frac{1}{T}\, dQ$$

Engines and Refrigerator

Carnot engines/fridges are perfect and ideal versions. Engine efficiency denoted ε

$$\varepsilon = \frac{|W_{out}|}{|Q_H|}; \varepsilon_C = 1 - \frac{|Q_L|}{|Q_H|} = 1 - \frac{T_L}{T_H}$$

Refrigerator efficiency denoted K

$$K = \frac{|Q_L|}{|W_{in}|}; K_C = \frac{|Q_L|}{|Q_H| - |Q_L|} = \frac{T_L}{T_H - T_L}$$