Thermal Physics
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1 Basics

1.1 Basic Laws

Definition 1.1. Variables which scale with the system size, like V and U, are called **extensive variables**. Those which are independent of system size, like p and T, are called **intensive variables**.

Thermodynamic limit $\implies$ Number of particles $\to \infty$

Theorem 1.1. Boyle's law

$$p \propto 1/V$$

Theorem 1.2. Charles's law

$$V \propto T$$

Theorem 1.3. Gay Lussac's Law

$$p \propto T$$

Theorem 1.4. Ideal Gas Equation

$$pV = Nk_bT$$

Stirling's Formula (For simplyfying factorials) **:** $\ln n! \approx n \ln n - n$

1.2 Heat

Definition 1.2. Heat is the thermal energy in transit.

Heat Capacity(C):

$$C = \frac{dQ}{dT} \tag{1}$$

Specific heat(s):

$$s = C/m \tag{2}$$

Remark. C_p (sp. heat at constant pressure) $> C_v$ (sp. heat at constant volume)
Because C_p needs to do work against external atmospheric pressure also.

1.3 Temperature

Definition 1.3. Thermal equilibrium is when the heat content or temperture of any two bodies does not change with time. The process that leads to it is called **thermalization**.

Theorem 1.5. Zeroth Law of thermodynamics
Two systems, each separately in thermal equilibrium with a third, are in equilibrium with each other.

- This is the reason thermometers work i.e. we calibrate it with a standard thermometer.
- Thermometers need to have low heat capacity(so they dont affect the measuring object).
- Electrical resistance can also be measured to measure temperature(eg.platinum) by measuring resistance vs temperature