

What is temperature?

① How hot something feels.

- Simple

- Not quantitative, subject to perception.

② What a thermometer reads.

- Quantitative

- What kind? e.g. Hg, optical... pyrometry

- ~Linear? Galileo thermometer

③ Ideal Gas Thermometer

↑ Idealization

of neon, e.g.

$$T \equiv 273.16 K$$

III
 $0.01^{\circ}C$

lim (PV) system
 $P \rightarrow 0$

lim (PV) triple point of water
 $P \rightarrow 0$

neon (liquid + ice + vapor)

(4) Measure of Average Kinetic Energy

- monatomic ideal gas

$$\underline{U} = \frac{3}{2} PV = \frac{3}{2} \underset{\substack{\uparrow \\ \text{\# moles}}}{\nu} \hat{R} \overset{\text{"universal"}}{\text{gas constant}} T$$

$U \propto T$

- non-ideal (interacting) gas

$U \not\propto T$

- non-gaseous system

e.g. paramagnet $U \not\propto T$

(5) Thermodynamic Temp. Scale

Build a "reversible" heat engine

= Carnot Engine

$$\text{efficiency } \eta = 1 - \frac{T_c}{T_H} = \frac{\text{Work out}}{\text{Heat In}}$$

⑥ The thing that does not change when two systems in thermal equilibrium are placed in contact.

- walls of system are diathermal
(permits energy to flow).

- opposite of diathermal is adiabatic.
((= insulating

⑦ $(k_B T)^{-1}$ is Lagrange multiplier that enforces the constraint that the average energy is fixed. $U_{avg} = \text{const.}$

⑧ $T = \left(\frac{\partial U}{\partial S} \right)_{V, N}$

how fast the total energy changes with respect to entropy, holding volume and number of particles fixed.

→ leads to negative absolute temps.

