What is temperature?

1. How hot something feels. 
   - Simple, not quantitative, subject to perception.

2. What a thermometer reads: quantitative
   - What kind? Mercury bulb thermometer, Alcohol bulb, IR, Galileo floating balls (density of water), optical pyrometer.
   - Overlay thermometer scales
     - Linear? 100°C

3. Thermocouple: temp. diff → voltage
   - Thermistor: temp. diff → changes resistance
   - Arbitrariness

3. Measure of average kinetic energy: \( T \cdot U \)

   Ideal gas: \( U = \frac{3}{2} PV = \frac{3}{2} nRT \)
   - \( R \) is absolute temp.

   Specific Heat at constant volume
   \[ C_v = \left( \frac{\partial U}{\partial T} \right)_V = \left( \frac{dU}{dT} \right)_V = \frac{3}{2} nR = \text{constant} \]
4) Ideal gas Thermometer

$$T = 273.16 \, K \quad \frac{\text{limit (PV) system}}{\text{limit (PV) triple point of ice + water + vapor}}$$

0.01°C

$$[\Delta T = 1^\circ C = 1^K] = 1 \, \text{ Kelvin}$$

5) Thermodynamic Temp. Scale

Build a reversible heat engine

= Carnot Engine

Carnot efficiency

$$\eta = 1 - \frac{T_c}{T_H}$$

6) The thing that does not change when two systems in thermal equilibrium are placed in thermal contact, connected by diathermal walls, walls allow heat to flow though

7) \( k_B T \) is the Lagrange multiplier that enforces the constraint that the average energy is fixed in a system with many energy levels.