Polleverywhere Q: HW deadline preference:

A M	C W	E F	G Sa
B T	D R	F Sa	

Thermodynamics

Temperature is empirically rooted but can also be described on a fundamental microscopic level

T scales

Fahrenheit	Celsius	Kelvin	
212	100	373.15	H_2O Boils
32	0	273.15	H_2O freezes
-459.67	-273.15	0	absolute zero

$T_F = 9/5\ T_C + 32°$

$T_C = 5/9 (T_F - 32°)$

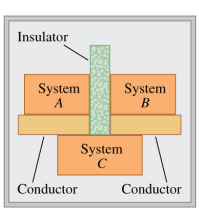
$T_K = T_C + 273.15$

Thermometers work by bringing some device sensitive to T into thermal contact with a body

Zeroth Law

If Body C is in thermal equilibrium with Body A and Body B, then A & B are in thermal equilibrium.

(a) If systems *A* and *B* are each in thermal equilibrium with system *C* …



(b) … then systems *A* and *B* are in thermal equilibrium with each other.

Concept Q sol.html thimble → small thimble and relatively large

thermometer ⇒ temp will actually be < 212°F.

Ways to measure T:

- volume expansion of a liquid in a tube (Hg, alcohol)
- infrared cameras
- change in pressure of a gas
- differential change in length of a bi-metallic strip
- change in resistivity of a wire

Absolute T on the kelvin scale: gas pressure is proportional to T(K) at constant volume

Example: Compare pressures of gas at 0°C and 40°C

$\frac{P_1}{P_2} = \frac{T_1}{T_2}$ $\quad P_2 = \frac{P_1 T_2}{T_1}$ → ∞ if plug in $T_1 = 0°C$

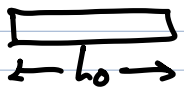
⇒ must convert to kelvin

$P_2 = P_1 \frac{T_2}{T_1} = 1atm \frac{(313K)}{(273K)} = 1.146\ atm$

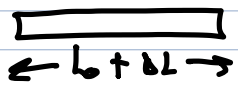
Linear expansion

For moderate T changes, experiments show that materials expand proportionally to ΔT: $\Delta L \propto \Delta T$

Constant of proportionality is α



$$L_0 + \Delta L = L_0 + L_0 \alpha \Delta T$$



Same holds for volume: $\Delta V / V_0 = \beta \Delta T$ or $V_0 + \Delta V = V_0 + V_0 \beta \Delta T$

Demo

Q: In which way will the Brass/Iron strip bend?

A: $\alpha_{Brass} = 2.0 \cdot 10^{-5} K^{-1}$

$\alpha_{iron} = 1.2 \cdot 10^{-5} K^{-1}$

} α_{Brass} larger, so strip bends away from brass.

Concept Q 502.html [A]