Heat and mechanical work

\[ Q \longleftrightarrow \Delta T = (T_f - T_i) \quad \text{calorimeter} \]

**Definition**: 1 calorie is the amount of heat which raises the temperature of 1 g water by 1 °C. (1 Cal = 1000 cal = 1 kcal)

(Reminder: 1 g is the mass of 1 cm³ water of temperature 4°C.)

**Question**: what is the relation between heat \( Q \) and mechanical work \( W = F \cdot d \)?

James Prescott Joule (1818-1899):

- 1840: \( W = V \cdot I \cdot t \) (Joule - heat)
- 1843: 1 cal = 4.186 J
Heat capacity, specific heat

\[ Q = C \cdot \Delta T = C \cdot (T_f - T_i) \]

\[ C = \frac{Q}{\Delta T} \quad [C] = \frac{\text{J}}{\text{K}} \]

**C**: heat capacity: amount of heat needed to raise the temperature of the object by 1 K. (The object is complex or composite.)

Homogeneous objects: \( Q = C \cdot m \cdot \Delta T \)

\[ C = \frac{Q}{m \cdot \Delta T} = \frac{C}{m} \quad [C] = \frac{\text{J}}{\text{kg} \cdot \text{K}} \]

**C**: specific heat: amount of heat needed to raise the temperature of a unit mass of material.

- **water**: 1 cal/°C = 4186 J/kgK
- **Al**: 0.215 cal/°C = 900 J/kgK
- **Cu**: 0.0923 cal/°C = 386 J/kgK

Molar (specific) heat: \( C_m = \frac{C}{n} \)
Heats of transformations

\[ T_b = 100^\circ C \]
\[ T_m = 0^\circ C \]

\text{melting} \quad \text{(solid-liquid phase transformation)}
\[ Q = L_F \cdot m \quad i \quad L_F = \frac{Q}{m} \quad i \quad [L_F] = \frac{J}{kg} \]
\text{heat of fusion}

\text{boiling} \quad \text{(liquid-gas phase transition)}
\[ Q = L_v \cdot m \quad i \quad L_v = \frac{Q}{m} \quad i \quad [L_v] = \frac{J}{kg} \]
\text{heat of vaporization}

water: \[ L_F = 333 \quad \frac{kJ}{kg} \quad i \quad L_v = 2256 \quad \frac{kJ}{kg} \]