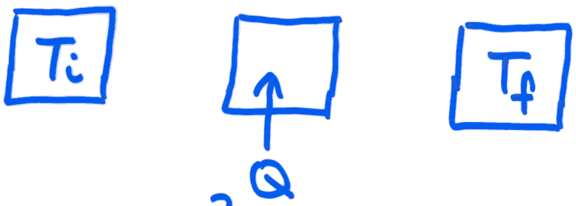
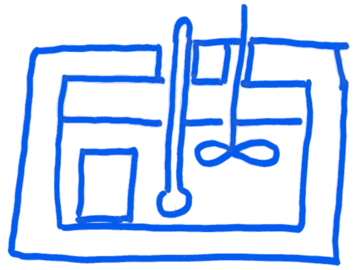
Heat and mechanical work





$$Q \overset{?}{\longleftrightarrow} \Delta T = (T_f - T_i)$$

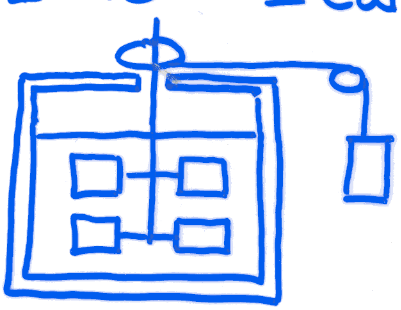
calorimeter

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 cm^3 water of temperature 4 °C.)

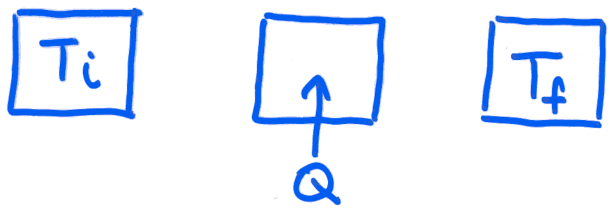
Question: what is the relation between heat Q and mechanical work $W = F \cdot d$?

James Prescott Joule (1818–1899):

1840: $W = V \cdot I \cdot t$ (Joule-heat)
1843: 1 cal = 4.186 J



Heat capacity, specific heat



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

$$C = \frac{Q}{\Delta T} \qquad [C] = \frac{J}{K}$$

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 : $Q = c\, m\, \Delta T$

$$c = \frac{Q}{m \Delta T} = \frac{C}{m} \qquad [c] = \frac{J}{kg\,K}$$

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

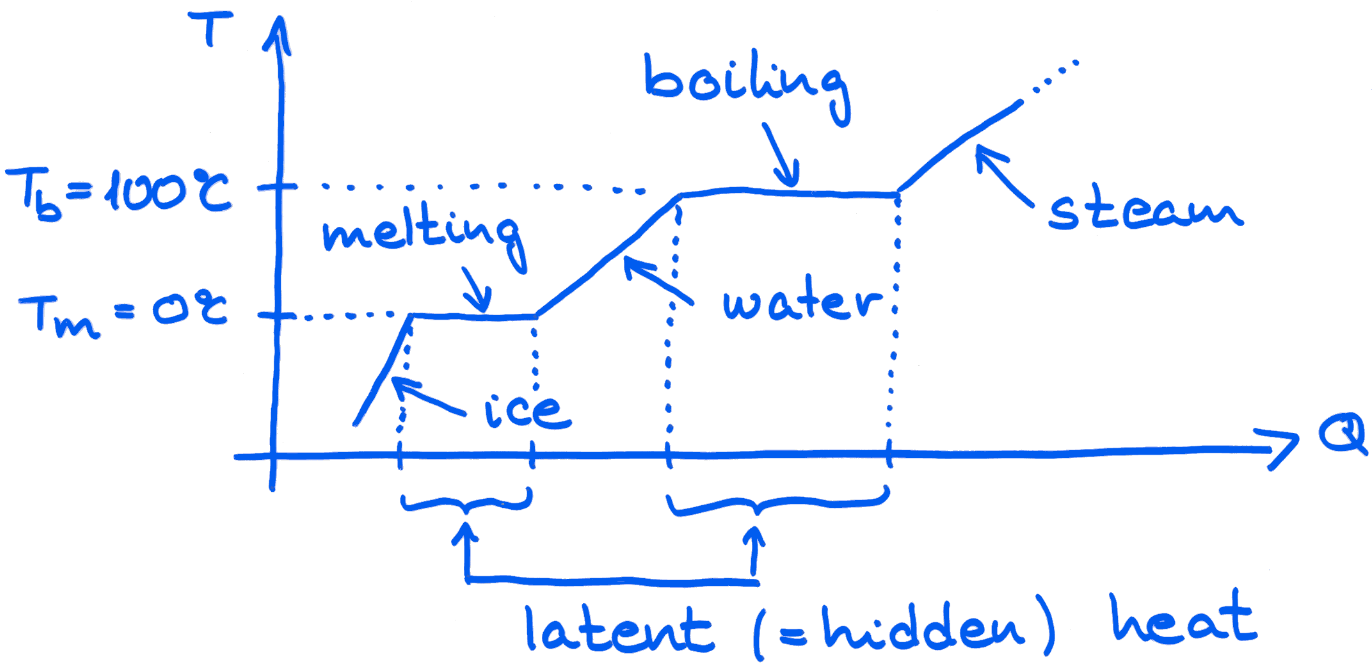
water : $1\ cal/g°C = 4186\ J/kgK$

Al : $0.215\ cal/g°C = 900\ J/kgK$

Cu : $0.0923\ cal/g°C = 386\ J/kgK$

Molar (specific) heat : $C_m = \frac{C}{n}$

Heats of transformations



melting
solidification } : solid-liquid phase transformation / transition

$$Q = L_F \cdot m \; ; \; L_F = \frac{Q}{m} \; ; \; [L_F] = \frac{J}{kg}$$

↑ heat of fusion

boiling
condensation } : liquid-gas phase tr.

$$Q = L_V \cdot m \; ; \; L_V = \frac{Q}{m} \; ; \; [L_V] = \frac{J}{kg}$$

↑ heat of vaporization

water: $L_F = 333 \frac{kJ}{kg}$; $L_V = 2256 \frac{kJ}{kg}$