

Essential Question

How can we measure energy we can't see?

Specific Heat Capacity

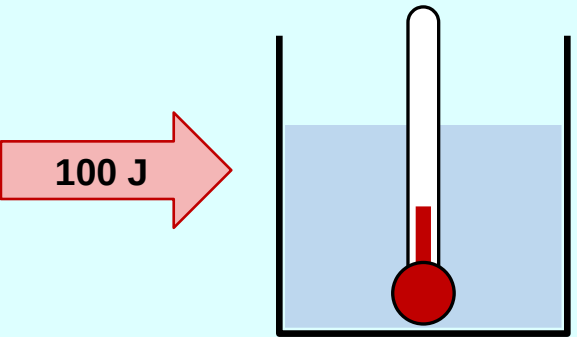
- Energy to raise 1 g by 1°C
- Units: J/(g·°C)
- High $c \rightarrow$ slow to heat up

Substance	c (J/(g·°C))
Water	4.18
Aluminum	0.897
Iron	0.449
Copper	0.385

Water has a very high specific heat

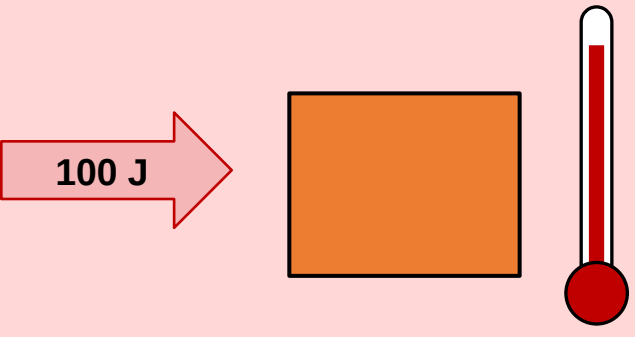
Same Heat, Different ΔT

10 g Water



$c = 4.18 \text{ J/(g}\cdot^{\circ}\text{C)}$
 $\Delta T = +2.4^{\circ}\text{C}$

10 g Copper



$c = 0.385 \text{ J/(g}\cdot^{\circ}\text{C)}$
 $\Delta T = +26^{\circ}\text{C}$

- Low $c \rightarrow$ big temperature change

Heat Capacity and Calorimetry

$$q = mc\Delta T$$

$$q = mc\Delta T$$

q

heat
 J

m

mass
 g

c

specific heat
 $J/(g \cdot ^\circ C)$

ΔT

$T_{\text{final}} - T_{\text{initial}}$
 $^\circ C$

ΔT is negative when the temperature drops

The Sign of q

$$q > 0$$

T rises

system absorbs energy

heating

$$q < 0$$

T falls

system releases energy

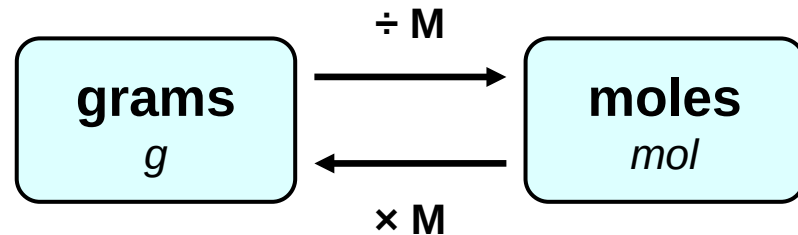
cooling

- Heating raises a system's energy, cooling lowers it

Molar Heat Capacity

- C: energy to raise 1 mol by 1°C
- Units: J/(mol·°C)
- Water: 75.3 J/(mol·°C)

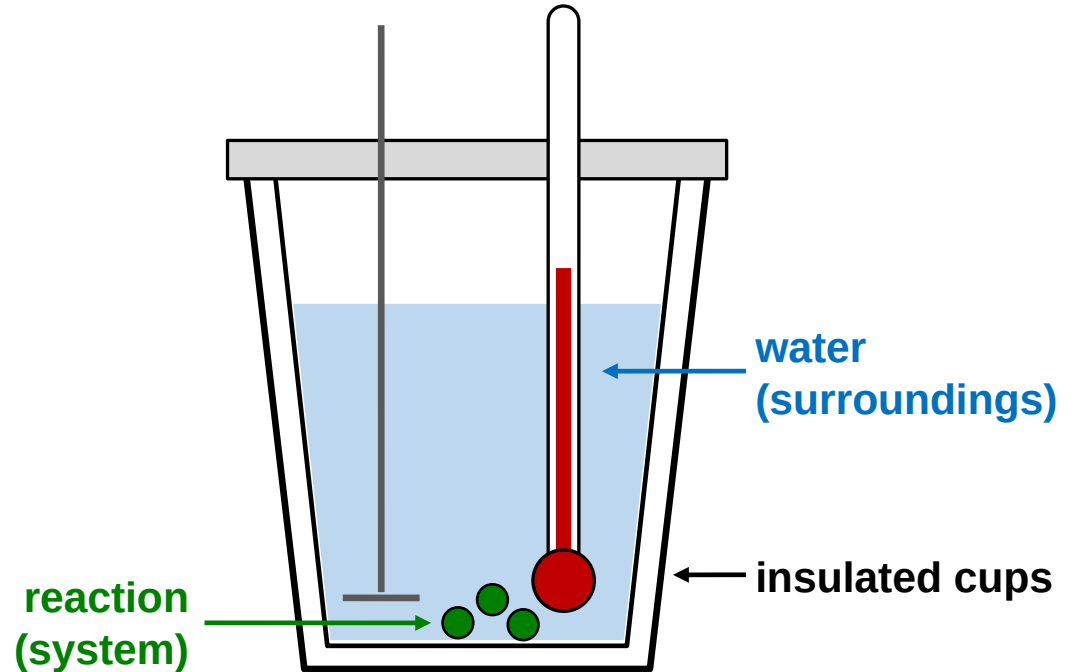
$$q = nC\Delta T$$



$$4.18 \text{ J/(g}\cdot\text{°C)} \times 18.02 \text{ g/mol} \\ = 75.3 \text{ J/(mol}\cdot\text{°C)}$$

Calorimetry

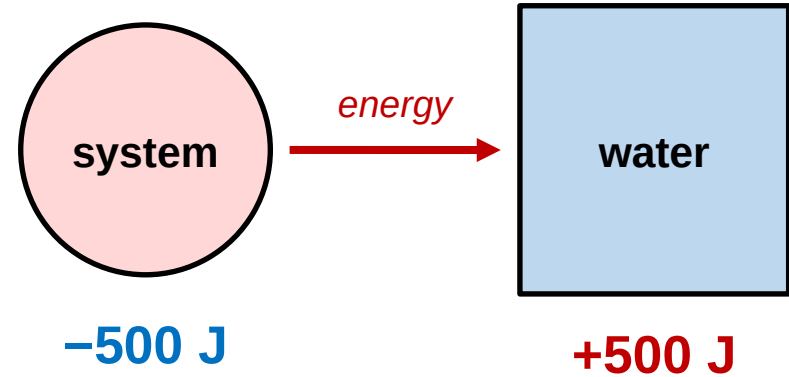
- Measure ΔT of the water
- Insulation keeps energy in
- Stirrer evens out T



Energy Is Conserved

$$q_{\text{system}} = -q_{\text{surroundings}}$$

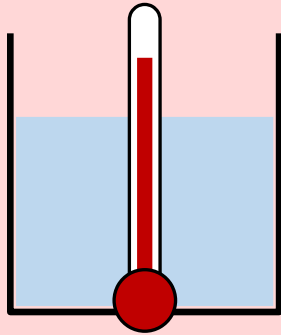
- First law: energy is not created or destroyed
- Lost by one = gained by other



$$q_{\text{system}} + q_{\text{surroundings}} = 0$$

Dissolving in a Calorimeter

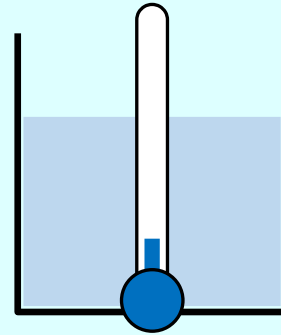
Water T ↑



dissolving is exothermic

system released energy

Water T ↓

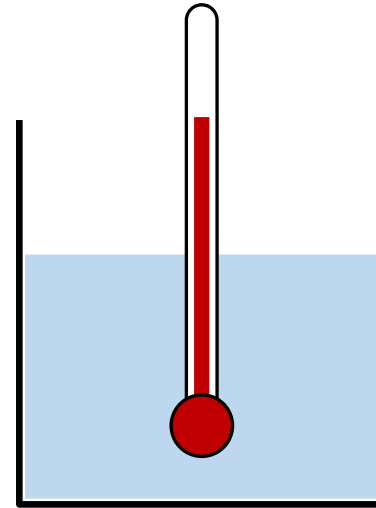


dissolving is endothermic

system absorbed energy

Example: Heating Water

How much heat is needed to raise the temperature of 250. g of water from 20.0°C to 85.0°C?

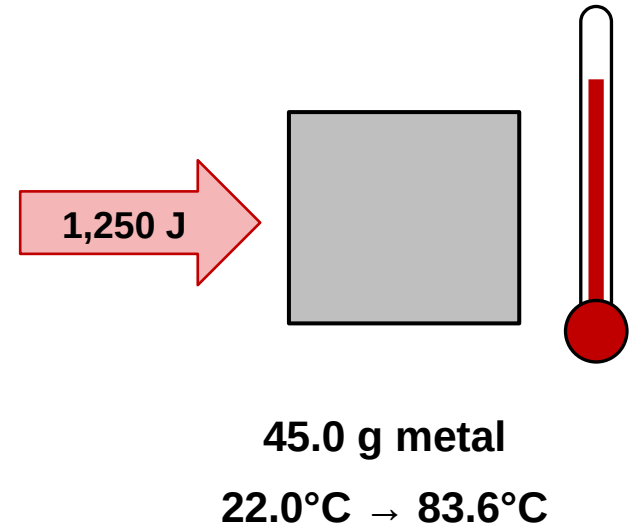


250. g water

20.0°C → 85.0°C

Example: Find Specific Heat

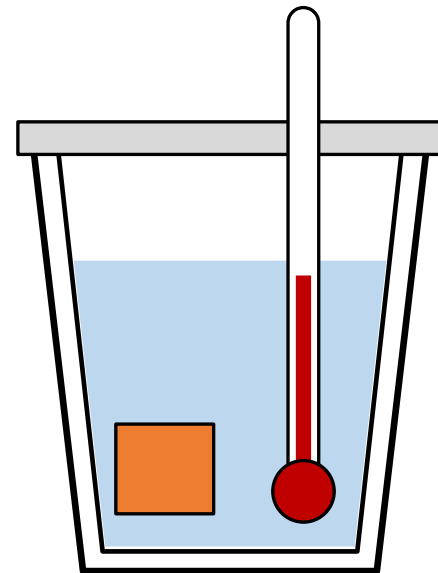
A 45.0 g piece of metal absorbs 1,250 J of heat. Its temperature rises from 22.0°C to 83.6°C. Calculate the specific heat of the metal.



Example: Metal in a Calorimeter

A 200.0 g piece of copper at 100.0°C is placed in 50.0 g of water at 20.0°C in a calorimeter. The final temperature is 41.5°C. Calculate the specific heat of copper.

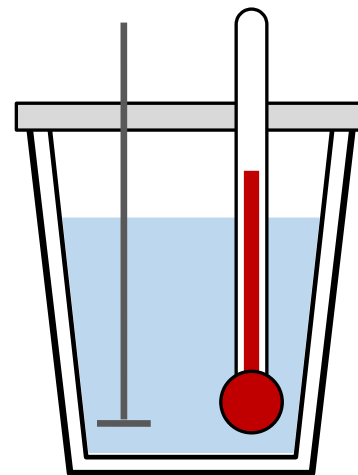
	Copper	Water
m	200.0 g	50.0 g
T_{initial}	100.0°C	20.0°C
T_{final}	41.5°C	41.5°C



copper block in water

Big Ideas

- $q = mc\Delta T$
- Low $c \rightarrow$ big ΔT
- Calorimeter measures ΔT of water
- $q_{\text{system}} = -q_{\text{surroundings}}$



$$q = mc\Delta T$$