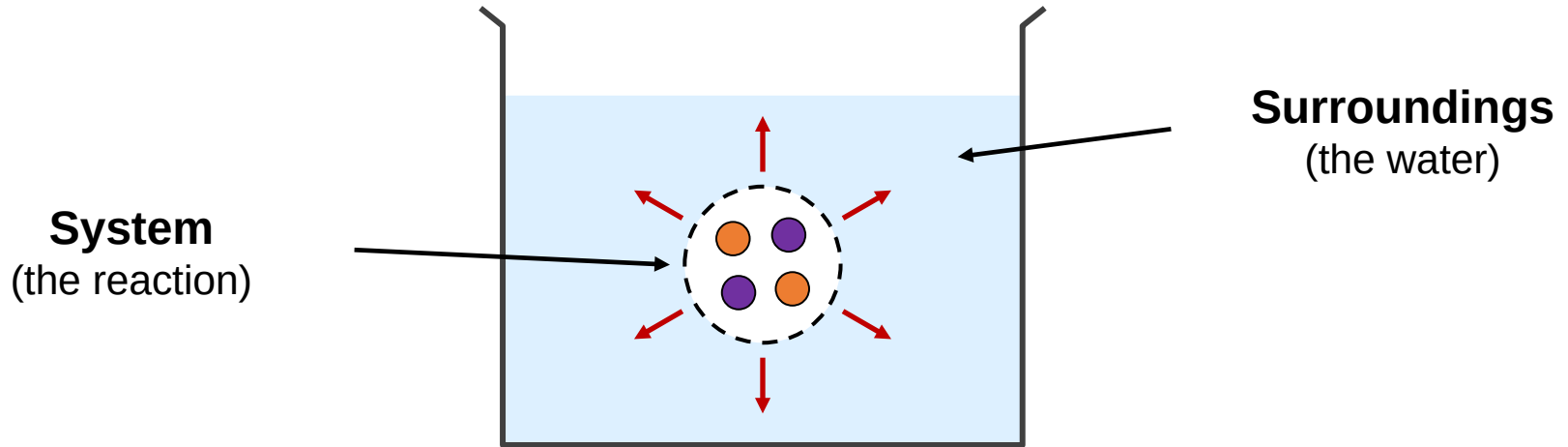


Essential Question

How do we measure the heat of a reaction?

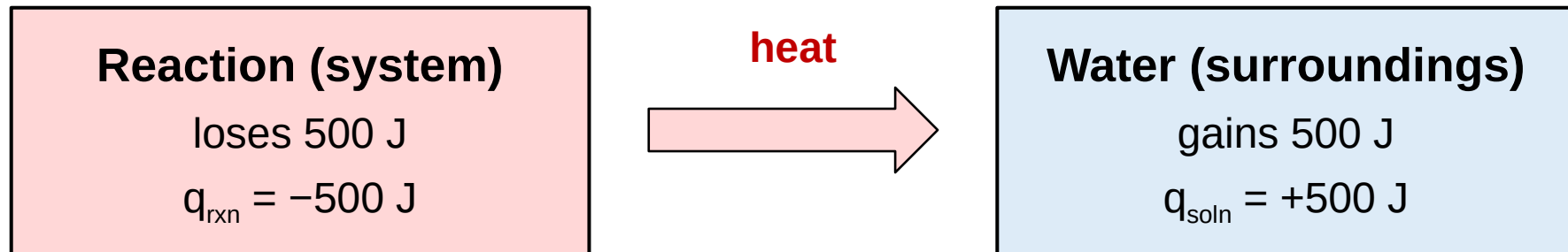
System vs. Surroundings

- **System:** the reaction (the chemicals)
- **Surroundings:** everything else, like the water



Heat Lost = Heat Gained

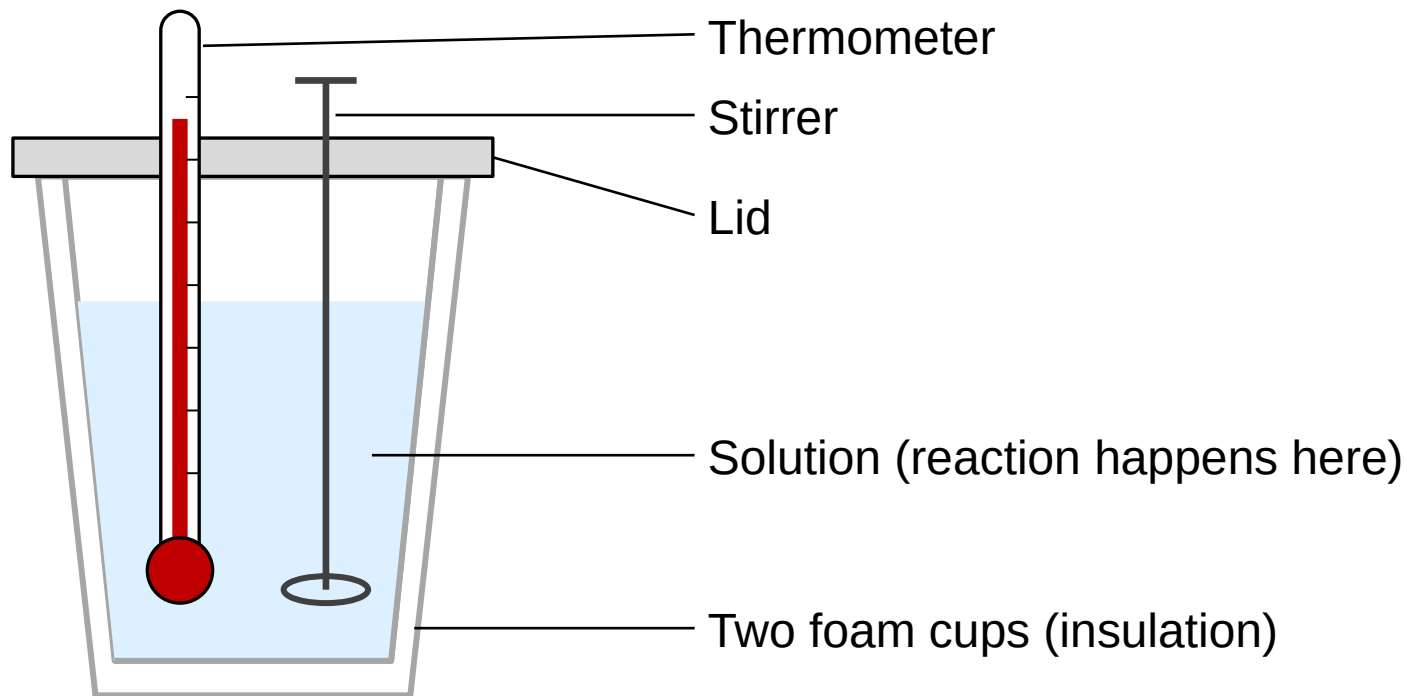
- Energy is **conserved**: never made or destroyed



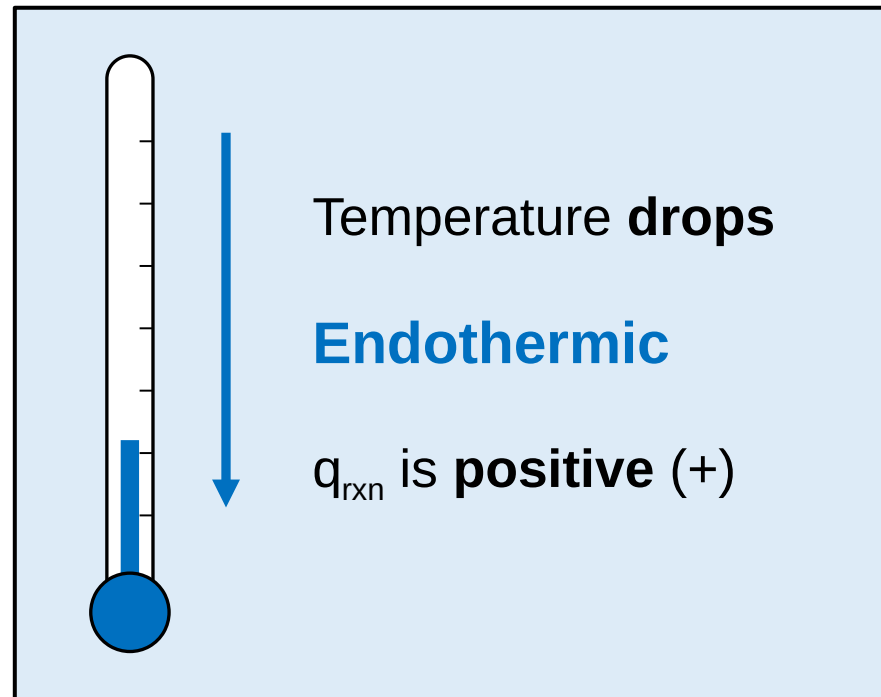
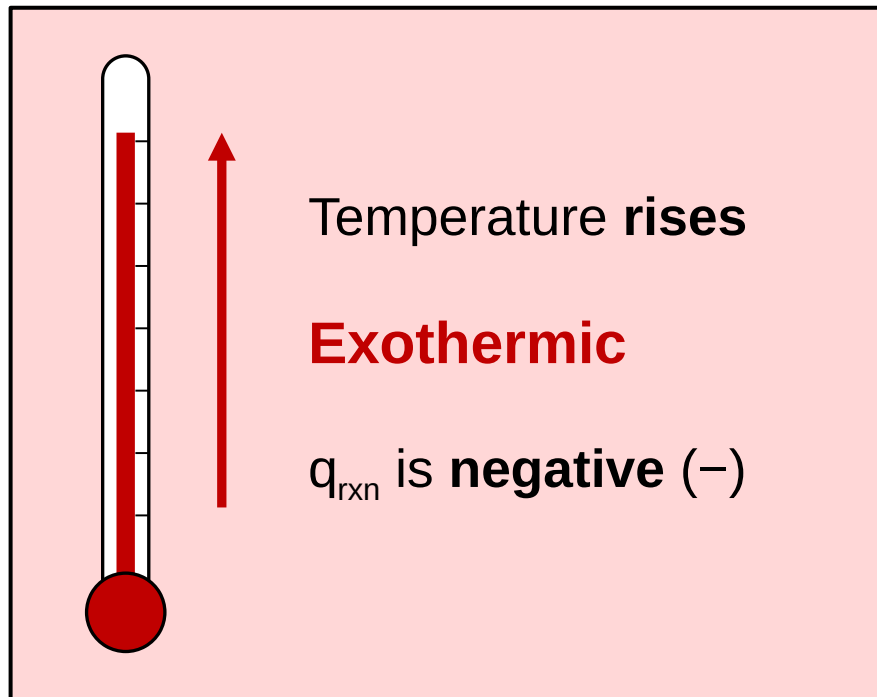
$$q_{\text{rxn}} = -q_{\text{soln}}$$

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

The Coffee-Cup Calorimeter

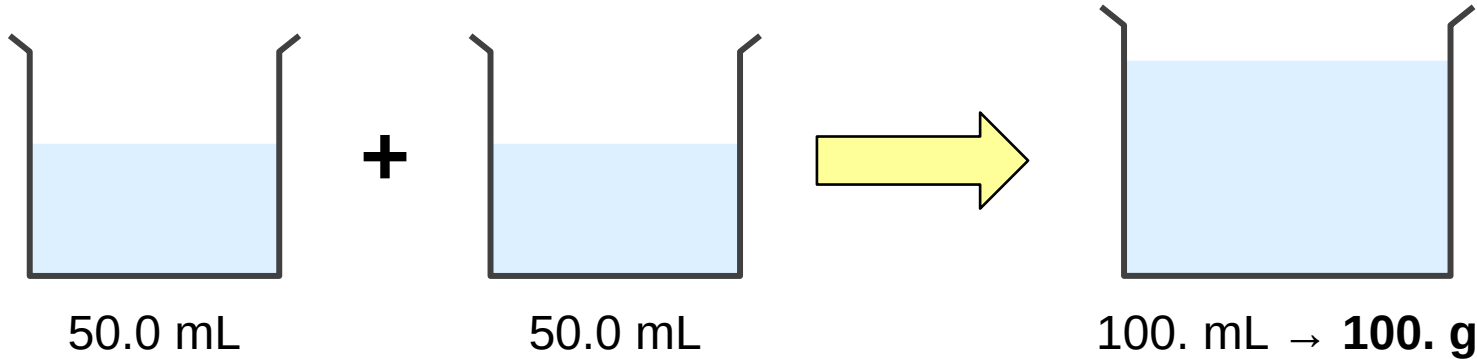


What ΔT Tells You



Treat the Solution Like Water

- $c = 4.18 \text{ J/g}\cdot^{\circ}\text{C}$, the same as water
- Density = 1.00 g/mL , so $1 \text{ mL} \rightarrow 1 \text{ g}$
- Use the **total** mass of the solution



Calorimetry Steps

1. $q_{\text{soln}} = mc\Delta T$

$$\Delta T = T_{\text{final}} - T_{\text{initial}}$$



2. $q_{\text{rxn}} = -q_{\text{soln}}$

Flip the sign



3. $\Delta H = q_{\text{rxn}} \div \text{mol}$

Only if asked; use kJ/mol

Example 1: System or Surroundings?

A hand warmer packet gets hot when you open it.

- (a) What is the system? What are the surroundings?
- (b) Is q for the system positive or negative?
- (c) Is the process exothermic or endothermic?

Example 2: Mixing Water

100. g of water at 80.0 °C is mixed with 200. g of water at 20.0 °C in a calorimeter. Find the final temperature.

$$c = 4.18 \text{ J/g}\cdot^{\circ}\text{C}$$

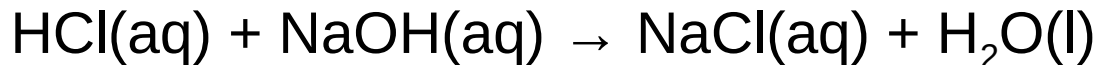
Example 3: Dissolving a Salt

10.0 g of NH_4Cl is dissolved in 50.0 g of water at $23.0\text{ }^\circ\text{C}$ in a coffee-cup calorimeter. The final temperature is $12.0\text{ }^\circ\text{C}$. Find q_{rxn} . Is dissolving endothermic or exothermic?

$$c = 4.18\text{ J/g}\cdot^\circ\text{C}$$

Example 4: Neutralization

50.0 mL of 1.0 M HCl and 50.0 mL of 1.0 M NaOH, both at 21.0 °C, are mixed in a calorimeter. The temperature rises to 27.7 °C. Find ΔH in kJ per mole of water formed (0.050 mol H₂O forms).



$$d = 1.00 \text{ g/mL}, c = 4.18 \text{ J/g}\cdot^\circ\text{C}$$

Big Ideas

- Heat lost = heat gained: $q_{\text{rxn}} = -q_{\text{soln}}$
- Find q_{soln} with $q = mc\Delta T$, then flip the sign
- T up: **exothermic**. T down: **endothermic**.
- $\Delta H = q_{\text{rxn}} \div \text{mol}$, in kJ/mol