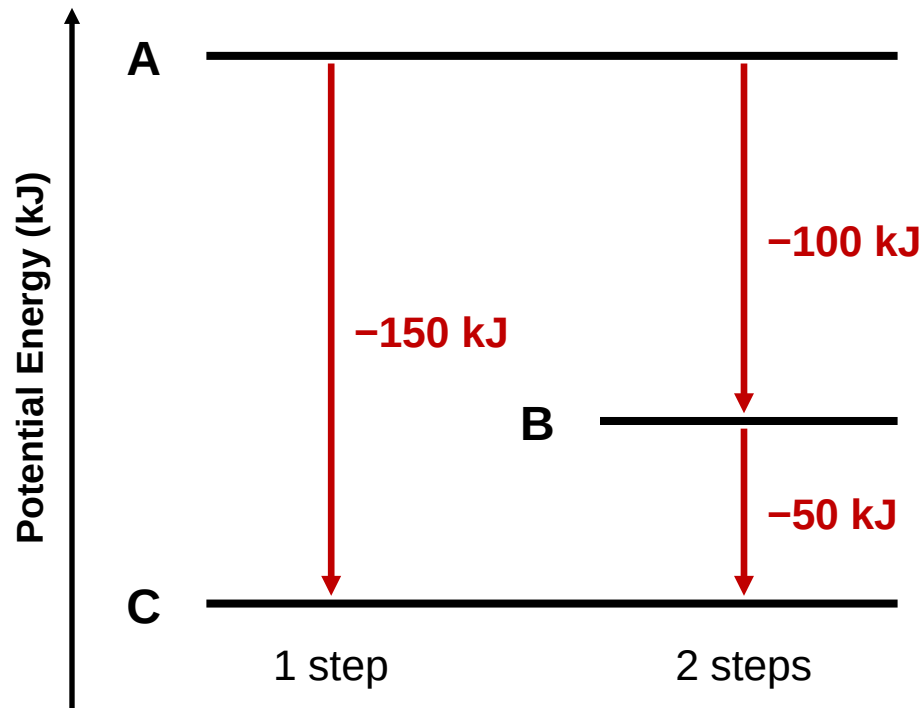


Essential Question

How can we find ΔH without measuring it?

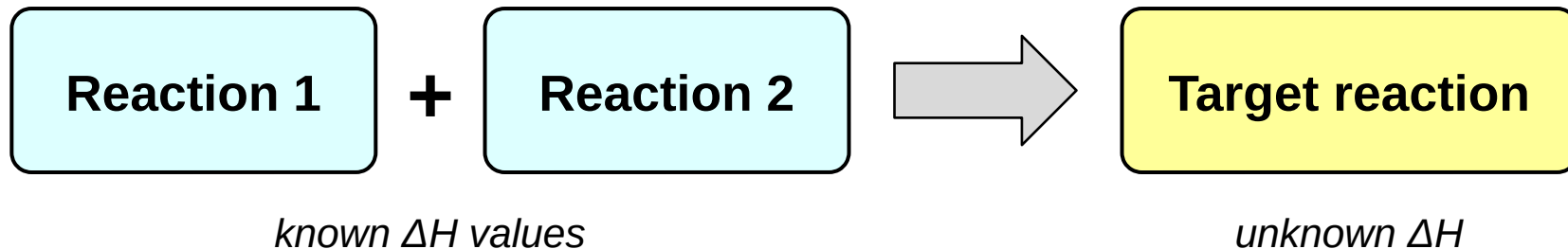
What Hess's Law Says

- Only start and end matter
- The path does not matter



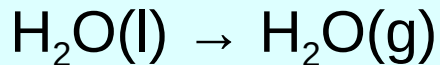
Why Is Hess's Law Useful?

- Some ΔH values are hard to measure
- Build them from reactions we **can** measure

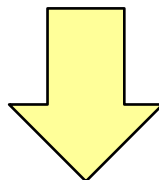


Rule 1: Reverse It, Flip the Sign

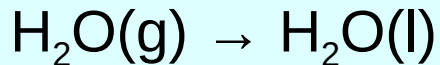
- Reverse the equation → change the sign of ΔH



$$\Delta H = +44.0 \text{ kJ}$$



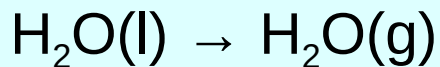
reverse



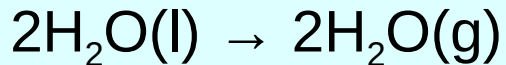
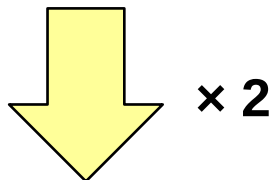
$$\Delta H = -44.0 \text{ kJ}$$

Rule 2: Multiply It, Multiply ΔH

- Multiply the equation $\rightarrow$ multiply ΔH by the same number



$$\Delta H = +44.0 \text{ kJ}$$



$$\Delta H = +88.0 \text{ kJ}$$

Fractions work too, like $\times \frac{1}{2}$

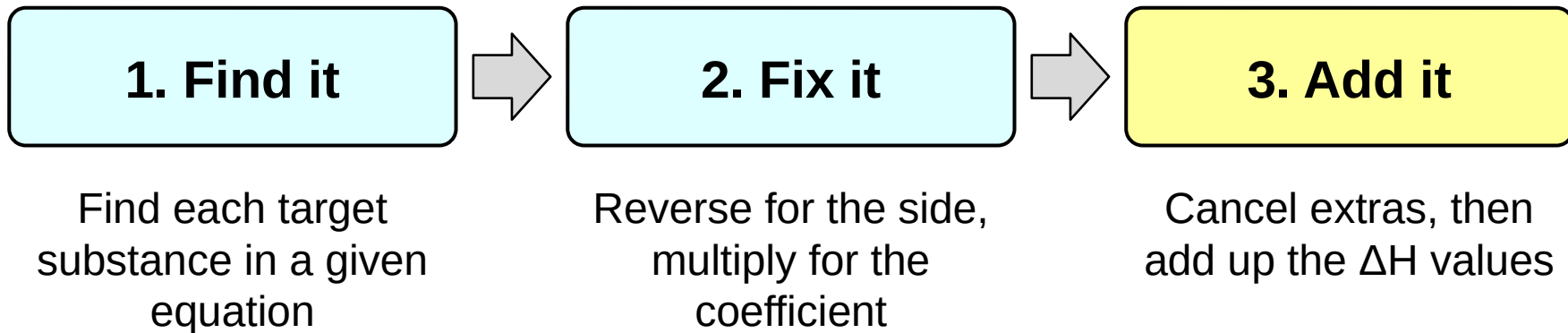
Rule 3: Add Them Up

- Add the equations, cancel, and add the ΔH values



Same thing on both sides? Cross it out.

Strategy: Match the Target

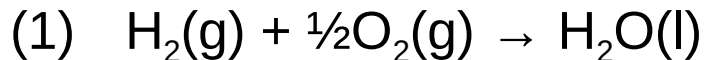


Last step: check that you got the target exactly

Example 1: Flip and Multiply

Find ΔH for: $2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$

Given:

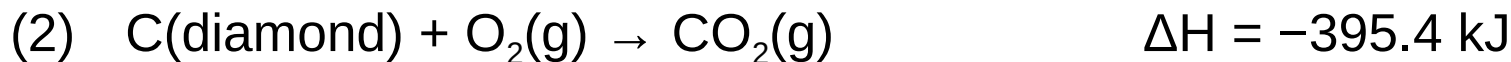
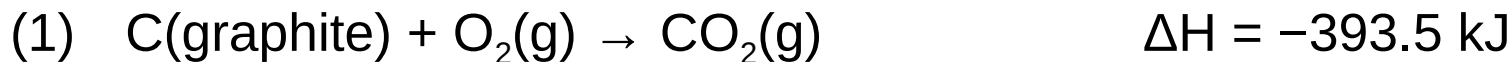


$$\Delta H = -285.8 \text{ kJ}$$

Example 2: Graphite to Diamond

Find ΔH for: **C(graphite) $\rightarrow$ C(diamond)**

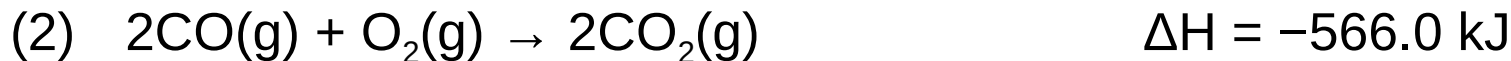
Given:



Example 3: Making Carbon Monoxide

Find ΔH for: $2\text{C(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{CO(g)}$

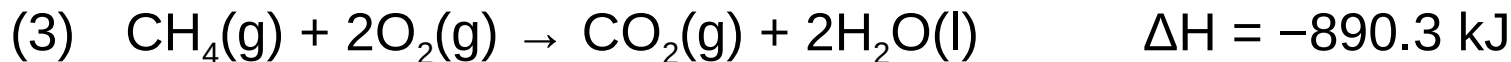
Given:



Example 4: Forming Methane

Find ΔH for: $\text{C(s)} + 2\text{H}_2\text{(g)} \rightarrow \text{CH}_4\text{(g)}$

Given:



Big Ideas

- ΔH depends only on the **start** and **end**
- **Reverse** an equation $\rightarrow$ change the sign of ΔH
- **Multiply** an equation $\rightarrow$ multiply ΔH too
- **Add** the equations, cancel, and add the ΔH values