Bond energies: count before calculating

Student activity • observation and reasoning

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The question

Have you counted every bond in the balanced equation?

Estimate reaction enthalpies using supplied average bond energies. Audit atom balance, bond multiplicities, units and the limitations of mean gas-phase values.

Equipment

- Booklet, pencil, periodic table and optional molecular model kit

Desk activity only; keep small model pieces away from mouths.

Course coverage: Chemistry only: 3.7C. Supplied approximate mean bond energies; no laboratory work.

Plan, model or apparatus sketch

Draw a labelled structure or model to explain your reasoning for this lesson.

Method and reasoning

Read the whole sequence before starting

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1. Balance $H_2 + Cl_2 \rightarrow HCl$ and draw all reactant/product bonds.

2. Use the supplied H–H, Cl–Cl and H–Cl energies to calculate breaking and making totals.

3. Balance $CH_4 + O_2 \rightarrow CO_2 + H_2O$. Count four C–H, two O=O, two C=O and four O–H bonds for one CH_4 reaction.

4. Compute ΔH=breaking−making for the methane equation and show units.

5. Explain why a coefficient multiplies the number of bonds and a double bond uses the supplied double-bond energy once.

6. Evaluate why a mean-bond-energy estimate need not equal a measured standard enthalpy, especially if product water is liquid.

Cleanup

- Return shared equipment and retain corrected reasoning.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Supplied rounded practice bond energies, kJ mol^{-1}: H–H 436; Cl–Cl 243; H–Cl 432; C–H 413; O=O 498; C=O in CO_2 805; O–H 463. Treat these as gas-phase mean-energy estimates, not exact bond dissociation values for every molecular environment. Water for the bond model is gaseous.

Task	My structure / working	Reason / correction
H_2 / Cl_2 bond count		
CH_4 / O_2 bond count		
Energy totals / ΔH		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Balance hydrogen reacting with chlorine.

2. Calculate its estimated ΔH.

3. Count all bonds broken in complete combustion of one CH_4.

4. Count all bonds formed in its products.

5. Calculate the methane estimate with the supplied numbers.

6. Explain two reasons for disagreement with a measured value.