ANSWER KEY. Final answers are in bold.

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6.7 Bond Enthalpies

AP Chemistry | ANSWER KEY

Show work with units. ΔH = (bond enthalpies broken) − (bond enthalpies formed).

Bond enthalpies (kJ/mol)	H−H 436	C−H 413	O−H 463	N−H 391	O=O 495
	C−C 348	C=C 614	C≡C 839	C=O (in CO_2) 799	N≡N 941

1. Estimate ΔH for $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ using bond enthalpies.

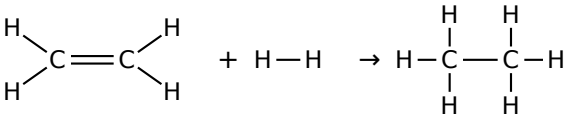
Bonds broken: 2 H−H + 1 O=O = 2(436) + 495 = 1367 kJ

Bonds formed: 4 O−H = 4(463) = 1852 kJ

ΔH = broken − formed = 1367 kJ − 1852 kJ = **−485 kJ/mol$_{rxn}$**

2. Draw the Lewis structures, then estimate ΔH for $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$.

Lewis structures:



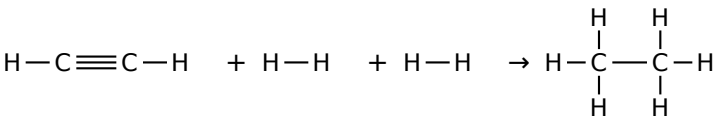
Bonds broken: 1 C=C + 4 C−H + 1 H−H = 614 + 4(413) + 436 = 2702 kJ

Bonds formed: 1 C−C + 6 C−H = 348 + 6(413) = 2826 kJ

ΔH = 2702 kJ − 2826 kJ = **−124 kJ/mol$_{rxn}$**

3. Draw the Lewis structures, then estimate ΔH for $C_2H_2(g) + 2H_2(g) \rightarrow C_2H_6(g)$.

Lewis structures:



Bonds broken: 1 C≡C + 2 C−H + 2 H−H = 839 + 2(413) + 2(436) = 2537 kJ

Bonds formed: 1 C−C + 6 C−H = 348 + 6(413) = 2826 kJ

ΔH = 2537 kJ − 2826 kJ = **−289 kJ/mol$_{rxn}$**

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4. The measured ΔH for $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ is −484 kJ/mol_{rxn}. Use this value with the H−H and O−H bond enthalpies to calculate the O=O bond enthalpy.

ΔH = (broken) − (formed): −484 = [2(436) + E(O=O)] − 4(463)

E(O=O) = −484 + 1852 − 872 = **496 kJ/mol** (close to the table value of 495 kJ/mol)

5. A student writes, “Energy is released when a bond breaks.” Correct this statement.

Breaking a bond always absorbs energy (endothermic). Forming a bond releases energy (exothermic).

6. A C=C bond enthalpy is 614 kJ/mol and a C−C bond enthalpy is 348 kJ/mol. Is a C=C bond twice as strong as a C−C bond? What does this tell you about using bond enthalpies?

No. Twice 348 is 696 kJ/mol, which is more than 614 kJ/mol. The second bond in a double bond is weaker than the first, so a double bond is not two single bonds. Always use the value for the actual bond.

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