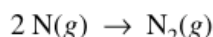


2003

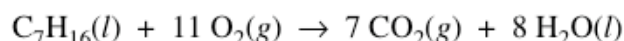
7. Answer the following questions that relate to the chemistry of nitrogen.

(a) Two nitrogen atoms combine to form a nitrogen molecule, as represented by the following equation.

Using the table of average bond energies below, determine the enthalpy change, ΔH , for the reaction.

Bond	Average Bond Energy (kJ mol ⁻¹)
N — N	160
N = N	420
N ≡ N	950

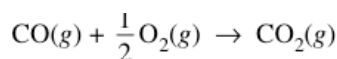
2003B

3. In another experiment, liquid heptane, $\text{C}_7\text{H}_{16}(l)$, is completely combusted to produce $\text{CO}_2(g)$ and $\text{H}_2\text{O}(l)$, as represented by the following equation.The heat of combustion, $\Delta H_{\text{comb}}^\circ$, for one mole of $\text{C}_7\text{H}_{16}(l)$ is -4.85×10^3 kJ.(c) Using the information in the table below, calculate the value of ΔH_f° for $\text{C}_7\text{H}_{16}(l)$ in kJ mol⁻¹.

Compound	ΔH_f° (kJ mol ⁻¹)
$\text{CO}_2(g)$	-393.5
$\text{H}_2\text{O}(l)$	-285.8

(d) A 0.0108 mol sample of $\text{C}_7\text{H}_{16}(l)$ is combusted in a bomb calorimeter.

(i) Calculate the amount of heat released to the calorimeter.

(ii) Given that the total heat capacity of the calorimeter is 9.273 kJ °C⁻¹, calculate the temperature change of the calorimeter.

2006

2. The combustion of carbon monoxide is represented by the equation above.

(a) Determine the value of the standard enthalpy change, $\Delta H_{\text{rxn}}^\circ$, for the combustion of $\text{CO}(g)$ at 298 K using the following information.

7. Answer the following questions about thermodynamics. Skip part (d) for now.

Substance	Combustion Reaction	Enthalpy of Combustion, ΔH_{comb}° , at 298 K (kJ mol ⁻¹)
H ₂ (g)	$\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$	-290
C(s)	$\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$	-390
CH ₃ OH(l)		-730

- (a) In the empty box in the table above, write a balanced chemical equation for the complete combustion of one mole of CH₃OH(l). Assume products are in their standard states at 298 K. Coefficients do not need to be whole numbers.
- (b) On the basis of your answer to part (a) and the information in the table, determine the enthalpy change for the reaction $\text{C}(\text{s}) + \text{H}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_3\text{OH}(\text{l})$.
- (c) Write the balanced chemical equation that shows the reaction that is used to determine the enthalpy of formation for one mole of CH₃OH(l).
- (d) Predict the sign of ΔS° for the combustion of H₂(g). Explain your reasoning.
- (e) On the basis of bond energies, explain why the combustion of H₂(g) is exothermic.