

The Advanced Placement Examination in Chemistry

Part II - Free Response Questions & Answers 1970 to 2008 Thermodynamics

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Questions With ANSWERS

1979 B

Compound	ΔH_f° (kilocalories/mole)	S° (calories/mole K)
$\text{H}_2\text{O}(l)$	-68.3	16.7
$\text{CO}_2(g)$	-94.1	51.1
$\text{O}_2(g)$	0.0	49.0
C_3H_8	?	64.5

When 1.000 gram of propane gas, C_3H_8 , is burned at 25°C and 1.00 atmosphere, $\text{H}_2\text{O}(l)$ and $\text{CO}_2(g)$ are formed with the evolution of 12.03 kilocalories.

- Write a balanced equation for the combustion reaction.
- Calculate the molar enthalpy of combustion, $\Delta H_{\text{comb}}^\circ$, of propane.
- Calculate the standard molar enthalpy of formation, ΔH_f° , of propane gas.
- Calculate the entropy change, $\Delta S_{\text{comb}}^\circ$, for the reaction and account for the sign $\Delta S_{\text{comb}}^\circ$.

Answer:



(b)
$$\Delta H_{\text{comb}}^\circ = \frac{-12.03 \text{ kcal}}{1.000 \text{ g}} \times \frac{44.10 \text{ g}}{1 \text{ mol}} = -530.5 \text{ kcal/mol}$$

This answer should be **-529.3 kcal/mol**

(c)
$$\Delta H_{\text{comb}}^\circ = 3\Delta H_f^\circ \text{CO}_2 + 4\Delta H_f^\circ \text{H}_2\text{O} - \Delta H_f^\circ \text{C}_3\text{H}_8$$

$$-529.3 \text{ kcal} = [3(-94.1) + 4(-68.3) - X] \text{ kcal}$$

$$\Delta H_f^\circ = -26.2 \text{ kcal/mol}$$

(d)
$$\Delta S_{\text{comb}}^\circ = [3S_{\text{CO}_2} + 4S_{\text{H}_2\text{O}}] - [S_{\text{C}_3\text{H}_8} + 5S_{\text{O}_2}] = [3(51.1) + 4(16.7)] - [64.5 + 5(49.0)]$$

$$= -89.4 \text{ cal/mol}\cdot\text{K}$$

Entropy decreases due to loss of highly disordered gaseous species upon combustion.

2008 Ap Chemistry Answers

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