ANSWER KEY. Final answers are in bold.

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6.8 Enthalpy of Formation

AP Chemistry | ANSWER KEY

Show work with units. $\Delta H°_{rxn} = \Sigma\, n\Delta H°_f(\text{products}) - \Sigma\, n\Delta H°_f(\text{reactants})$. Elements in their standard states have $\Delta H°_f = 0$.

$\Delta H°_f$ (kJ/mol)	$NH_3(g)$ −45.9	NO(g) +90.3	$H_2O(g)$ −241.8	$H_2O(l)$ −285.8	$CO_2(g)$ −393.5
	$C_3H_8(g)$ −103.8	$SO_2(g)$ −296.8	$Fe_2O_3(s)$ −824.2	$Al_2O_3(s)$ −1675.7	

1. Write the balanced formation equation, with states, for each substance. (Use C(s, graphite) for carbon.)

(a) $NH_3(g)$
(b) $C_2H_5OH(l)$
(c) $CO_2(g)$

(a) **$\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightarrow NH_3(g)$**

(b) **$2C(s, \text{graphite}) + 3H_2(g) + \frac{1}{2}O_2(g) \rightarrow C_2H_5OH(l)$**

(c) **$C(s, \text{graphite}) + O_2(g) \rightarrow CO_2(g)$**

Each equation forms exactly 1 mol of the product from elements in their standard states.

2. Calculate $\Delta H°$ for $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$.

$\Delta H°_{rxn} = \Sigma\, n\Delta H°_f(\text{products}) - \Sigma\, n\Delta H°_f(\text{reactants})$

$= [4(+90.3) + 6(-241.8)] - [4(-45.9) + 5(0)] = (-1089.6) - (-183.6)$ kJ

$\Delta H° = -906.0$ kJ/mol$_{rxn}$

3. Calculate $\Delta H°$ for the combustion of propane: $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$.

$= [3(-393.5) + 4(-285.8)] - [(-103.8) + 5(0)] = (-2323.7) - (-103.8)$ kJ

$\Delta H° = -2219.9$ kJ/mol$_{rxn}$

4. Calculate $\Delta H°$ for the thermite reaction: $Fe_2O_3(s) + 2Al(s) \rightarrow Al_2O_3(s) + 2Fe(s)$.

$= [(-1675.7) + 2(0)] - [(-824.2) + 2(0)]$

$\Delta H° = -851.5$ kJ/mol$_{rxn}$

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5. For $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$, $\Delta H° = -197.8\ kJ/mol_{rxn}$. Use the table to find $\Delta H°_f$ of $SO_3(g)$.

$-197.8 = [2\Delta H°_f(SO_3)] - [2(-296.8) + 0]$

$2\Delta H°_f(SO_3) = -197.8 + 2(-296.8) = -791.4\ kJ$

$\Delta H°_f(SO_3) = -395.7\ kJ/mol$

6. Is $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ a formation reaction for water? Explain. Use $\Delta H°_f[H_2O(l)]$ to find $\Delta H°$ for this reaction.

No. A formation equation makes exactly 1 mol of product. This equation makes 2 mol.

$\Delta H° = 2\ mol \times (-285.8\ kJ/mol) =$ **$-571.6\ kJ/mol_{rxn}$** (the formation equation is $H_2(g) + ½O_2(g) \rightarrow H_2O(l)$, $\Delta H°_f = -285.8\ kJ/mol$).

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