
Worksheet 2: Hess's Law, Heats of Formation, and Entropy

Helpful information for this worksheet:

Substance	ΔH_f° (kJ/mole)	S° (J/mole·K)
C (s, graphite)	?	5.686
CO (g)	-110.5	197.5
CO ₂ (g)	-393.5	213.7
CH ₄ (g)	-74.87	186.1
C ₃ H ₈ (g)	-105	269.9
CH ₃ OH (l)	-238.6	126.8
Cl (g)	121.0	165.1
H ₂ (g)	?	130.6
H ₂ O (l)	-285.840	69.940
H ₂ O (g)	-241.826	188.72
N ₂ (g)	?	191.5
NO (g)	90.29	210.65
NO ₂ (g)	33.2	239.9
N ₂ O ₄ (g)	9.16	304.3
O ₂ (g)	?	205.0
O ₃ (g)	143	238.82

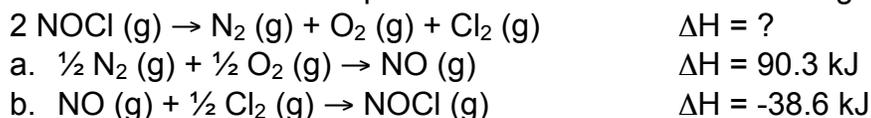
Concept questions: 6.75, 6.81, *6.129, *6.131, *6.133, *6.135, 17.27, 17.29, 17.31, 17.33, 17.45, 17.47, 17.49, *17.107, *17.109, *17.111

Hess's Law and Heats of Formation: 6.77, 6.79, 6.83, 6.85, 6.87, 6.89

Cumulative Problems: 6.97, 6.99, 6.101, 6.111, 6.121

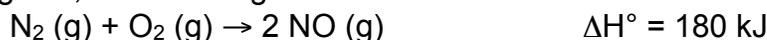
Entropy: 17.51, 17.53

1. Determine ΔH for the decomposition of NOCl from the following data:

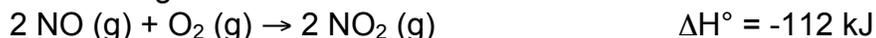


Which of the ΔH_{rxn} values above represent heats of formation?

2. At high temperatures, such as those in the combustion chambers of automobile engines, the following endothermic reaction occurs:

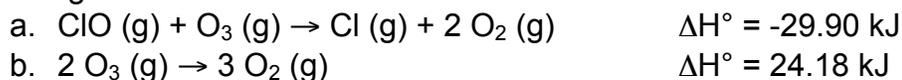


When NO is released into the environment, it may undergo further oxidation to NO₂ in the following exothermic reaction:

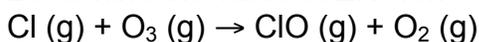


Is the overall reaction for the formation of NO₂ from N₂ and O₂ endothermic or exothermic? What is ΔH° for this reaction?

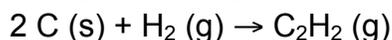
3. The destruction of ozone by chlorofluorocarbons (CFCs) can be described by the following reactions:



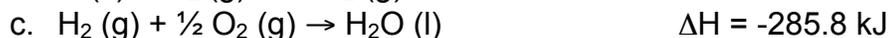
Determine the value of ΔH° for:



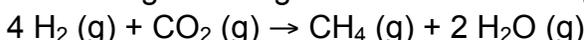
4. Calculate ΔH for the reaction:



given the following three chemical equations and their respective enthalpy changes:



5. Use heats of formation to calculate the enthalpy of reaction for the following methane-generating reaction of methanogenic bacteria:



6. For each of the following compounds, write a balanced formation equation:



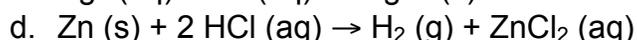
7. In each of the following pairs, which alternative has the greater entropy:

A	B
pound of ice cubes	pint of water
spoonful of sugar in bowl	spoonful of sugar dissolved in coffee
cup of hot water	cup of cold water
$\text{CH}_4 \text{(g)}$	$\text{CF}_4 \text{(g)}$
$\text{H}_2\text{O (g)}$	$\text{NH}_3 \text{(g)}$

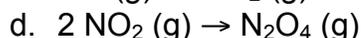
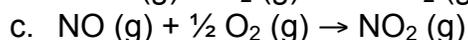
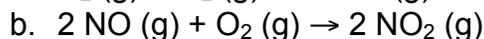
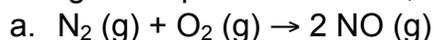
8. Predict the sign of ΔS for each of the following processes

a. a bricklayer builds a wall out of a random pile of bricks

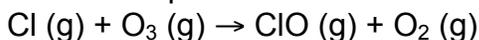
b. rake a yard full of leaves into a single pile



9. Using the standard molar entropies in the Table, calculate ΔS° values for the following atmospheric reactions, which contribute to the formation of chemical smog



10. The following reaction plays a key role in the destruction of ozone in the atmosphere. The standard entropy change (ΔS°) is 19.9 J/K. Use the standard molar entropies to calculate the molar entropy value for ClO.



11. What are the signs of ΔS and ΔH for the sublimation of dry ice at 25°C?

Key:

1. -103.4 kJ

2. + 34 kJ

3. +54.08 kJ

4. +226.8 kJ

5. -165 kJ

6. a. $\frac{1}{2} \text{N}_2 \text{(g)} + 3/2 \text{H}_2 \text{(g)} \rightarrow \text{NH}_3 \text{(g)}$

7. B, B, A, B, B

8. -, -, -, +

9. a. 24.7 J/K, b. -146.4 J/K, c. -73.2 J/K, d. -175.5 J/K

10. $S^\circ = 218.8 \text{ J/mole}\cdot\text{K}$

11. +, +