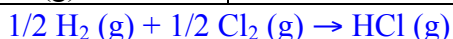


LECTURE 16

1. Write a balanced chemical equation for the formation reaction of HCl(g). For the formation of HCl, determine ΔH_r° , ΔS_r° , and ΔG_r° from data below.

Selected thermodynamic data at 25°C from Appendix 2A (Atkins and Jones)

Substance	Mass (g/mol)	ΔH_f° (kJ/mol)	ΔG_f° (kJ/mol)	S° (J/Kmol)
Al(s)	26.98	0	0	28.33
Al ₂ O ₃ (s)	101.96	-1676	-1582	50.92
AlCl ₃ (s)	133.33	-704.2	-628.8	110.67
Cl ₂ (g)	70.90	0	0	223.07
HCl(g)	36.46	-92.31	-95.3	186.76
H ₂ (g)	2.0158	0	0	130.7
H ₂ O ₂ (l)	34.02	-187.8	-120.35	109.6
N ₂ (g)	28.02	0	0	191.61
NO(g)	30.01	90.25	86.55	210.76
O ₂ (g)	32.00	0	0	205.14
O ₃ (g)	48.00	142.7	163.2	238.93



$$\Delta H_r^\circ = -92.31 \text{ kJ}\cdot\text{mol}^{-1}$$

$$\Delta S_r^\circ = 10.04 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$$

$$\Delta G_r^\circ = -95.30 \text{ kJ}\cdot\text{mol}^{-1}$$

2. For the reaction: $\text{NH}_4\text{NO}_3(\text{s}) \rightarrow \text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq})$, $\Delta H_r^\circ = +28. \text{ kJ/mol}$ and $\Delta S_r^\circ = +109. \text{ JK}^{-1}\text{mol}^{-1}$. State whether the reaction will be spontaneous at all temperatures and explain your answer briefly.

No. The reaction will only be spontaneous at **temperatures above 257 K**.

3. ΔS° is $125 \text{ JK}^{-1}\text{mol}^{-1}$ for the reaction $2\text{H}_2\text{O}_2(\text{l}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$. Using the data in table above, calculate S° for $\text{H}_2\text{O}(\text{l})$.

$$69.5 \text{ JK}^{-1}\text{mol}^{-1}$$

4. Which of the following statements are true?

- (a) ΔG tells you nothing about the rate of the reaction.
- (b) If $\Delta G_f^\circ < 0$, a compound is thermodynamically stable relative to its elements.
- (c) ΔH_r° is negative when bonds are stronger in the product than in the reactants.
- (d) Both a and b
- (e) Both b and c
- (f) All of the above.

Answer is f.

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