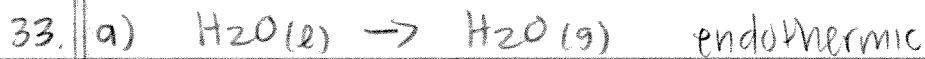


## CHAPTER 17



$\Delta H_{\text{sys}}$  increases, thus  $\Delta S_{\text{surr}}$  decreases  
 $\therefore \Delta S_{\text{surr}}$  is negative



$\Delta H_{\text{sys}}$  decreases, thus  $\Delta S_{\text{surr}}$  increases  
 $\therefore \Delta S_{\text{surr}}$  is positive

41. a) volume decreased, thus decrease in distribution

of E -  $\therefore$  entropy decreases and  $\Delta S^\circ$  is negative.



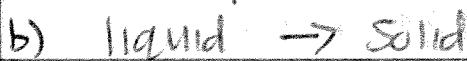
liquid has less entropy than gas

$\therefore$  entropy decreases and  $\Delta S^\circ$  is negative



4 mol gas have much more entropy than 11 mol liquid

$\therefore$  entropy increases and  $\Delta S^\circ$  is positive.



solids have less entropy than liquids

$\therefore$  entropy decreases and  $\Delta S^\circ$  is negative

43. a) C graphite (s), it is less ordered in structure than diamond.

b)  $\text{C}_2\text{H}_5\text{OH(g)}$ , gases have more disorder than liquids

c)  $\text{CO}_2\text{(g)}$ , gases have more disorder than solids.

## CHAPTER 17



3 mol gas  $\rightarrow$  2 mol gas  $\Delta S^\circ$  is negative

$$\Delta S^\circ = [(3)(32 \text{ J/mol}\cdot\text{K}) + (2)(189 \text{ J/mol}\cdot\text{K})]$$

$$- [(2)(206 \text{ J/mol}\cdot\text{K}) + (1)(248 \text{ J/mol}\cdot\text{K})]$$

$$\Delta S^\circ = [474 \text{ J/mol}\cdot\text{K}] - [660 \text{ J/mol}\cdot\text{K}] = [-186 \text{ J/mol}\cdot\text{K}]$$



2 mol gas  $\rightarrow$  3 mol gas  $\Delta S^\circ$  is positive

$$\Delta S^\circ = [(2)(248 \text{ J/mol}\cdot\text{K}) + (1)(205 \text{ J/mol}\cdot\text{K})]$$

$$- [(2)(257 \text{ J/mol}\cdot\text{K})]$$

$$\Delta S^\circ = 701 \text{ J/mol}\cdot\text{K} - 514 \text{ J/mol}\cdot\text{K} = [187 \text{ J/mol}\cdot\text{K}]$$



3 mol gas  $\rightarrow$  3 mol gas  $\Delta S^\circ = ?$

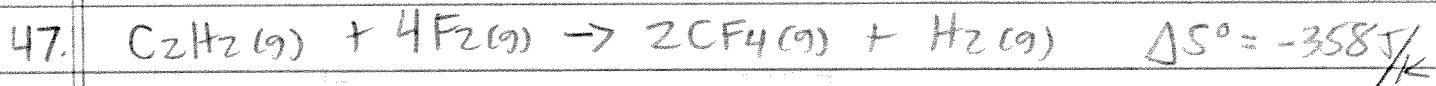
Too hard to predict

$$\Delta S^\circ = [(2)(27 \text{ J/mol}\cdot\text{K}) + (3)(189 \text{ J/mol}\cdot\text{K})]$$

$$- [(1)(90 \text{ J/mol}\cdot\text{K}) + (3)(131 \text{ J/mol}\cdot\text{K})]$$

$$\Delta S^\circ = [621 \text{ J/mol}\cdot\text{K}] - [483 \text{ J/mol}\cdot\text{K}] = [138 \text{ J/mol}\cdot\text{K}]$$

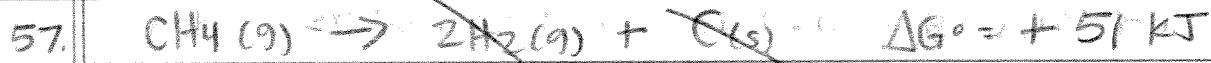
## CHAPTER 17



$$-358 \text{ J/mol}\cdot\text{K} = [(2)S^\circ_{\text{CF}_4} + (1)(131 \text{ J/mol}\cdot\text{K})] \\ - [(1)(201 \text{ J/mol}\cdot\text{K}) + (4)(203 \text{ J/mol}\cdot\text{K})]$$

$$655 \text{ J/mol}\cdot\text{K} = (2)S^\circ_{\text{CF}_4} + 131 \text{ J/mol}\cdot\text{K}$$

$$\boxed{S^\circ_{\text{CF}_4} = 262 \text{ J/mol}\cdot\text{K}}$$



$$\Delta G^\circ = 51 \text{ kJ} - 474 \text{ kJ} - 394 \text{ kJ} = \boxed{-817 \text{ kJ}}$$



a)  $\Delta G^\circ = [(2)(0 \text{ kJ/mol}) + (3)(-229 \text{ kJ/mol})] \\ - [(1)(-740 \text{ kJ/mol}) + (3)(0)]$

$$\boxed{\Delta G^\circ = -53 \text{ kJ/mol}}$$

b) Since  $\Delta G^\circ$  is positive, the rxn is not spontaneous (not thermodynamically favorable) at 298 K.

## CHAPTER 17



$$\Delta G^\circ = [(1)(52 \text{ kJ/mol}) + (1)(0)] - [(1)(87 \text{ kJ/mol}\cdot\text{K}) + (1)(163 \text{ kJ/mol}\cdot\text{K})]$$

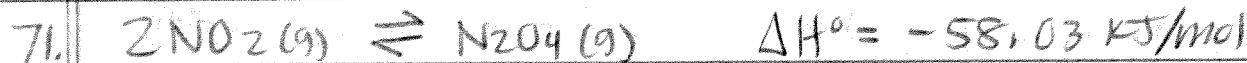
$$\boxed{\Delta G^\circ = -198 \text{ kJ/mol}}$$

$$\Delta G^\circ = -RT\ln K$$

$$-198000 \text{ J} = -8.31 \frac{\text{J}}{\text{mol}\cdot\text{K}} (298 \text{ K}) \ln K$$

$$\ln K = 79.955$$

$$K = e^{79.955} = \boxed{5.30 \times 10^{34}}$$



$$\Delta S^\circ = -176.6 \text{ J/mol}\cdot\text{K}$$

$$\Delta G = \Delta H - T\Delta S$$

$$\text{At } 25^\circ\text{C} \quad \Delta G = -58.03 \text{ kJ/mol} - 298 \text{ K} (-0.1766 \text{ kJ/mol}\cdot\text{K})$$

$$\Delta G = -5.4032 \text{ kJ/mol}$$

$$\Delta G = -RT\ln K$$

$$-5403.2 \text{ J/mol} = -8.31 \text{ J/mol}\cdot\text{K} (298 \text{ K}) \ln K$$

$$\ln K = 2.18189$$

$$K = e^{2.18189} = \boxed{8.84}$$

$$\text{At } 100.0^\circ\text{C} \quad \Delta G = -58.03 \text{ kJ/mol} - 373 \text{ K} (-0.1766 \text{ kJ/mol}\cdot\text{K}) = 7.84 \text{ kJ/mol}$$

$$\Delta G = -RT\ln K$$

$$7841.8 \text{ J/mol} = -8.31 \text{ J/mol}\cdot\text{K} (373 \text{ K}) \ln K \therefore K = e^{-2.5299} = \boxed{0.0797}$$

## CHAPTER 17



a)  $\Delta G = -RT \ln K$

$$-30500 \text{ J} = -8.31 \text{ J/mol}\cdot\text{K} (298 \text{ K}) \ln K$$

$$\ln K = 12.316$$

$$K = e^{12.316} = \boxed{2.23 \times 10^5}$$



$$\begin{aligned} \Delta G^\circ &= [(6)(-394 \text{ kJ/mol}) + (6)(-237 \text{ kJ/mol})] \\ &\quad - [(1)(-911 \text{ kJ/mol}) + (6)(0)] \end{aligned}$$

$$\Delta G^\circ = -2875 \text{ kJ/mol}$$

$$1 \text{ mol C}_6\text{H}_{12}\text{O}_6(\text{s}) = 2875 \text{ kJ}$$

$$\therefore \frac{2875 \text{ kJ}}{30.5 \text{ kJ}} \frac{1 \text{ mol ATP}}{1 \text{ mol ATP}} = 94.3 \text{ mol ATP}$$

$\therefore 1 \text{ molecule of C}_6\text{H}_{12}\text{O}_6(\text{s}) = 94.3 \text{ molecules ATP}$