

# Non Sibi High School

Andover's Chem 300: Accelerated/Honors Chemistry

## Chapter 14, Review Quiz 1 Answers

### 1

Predict the sign of  $\Delta S$  for each process:

- Solid naphthalene dissolves in benzene.
- Bromine vapor condenses.
- $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{l})$
- Neon gas cools from  $250^\circ\text{C}$  to room temperature.
- Solid arsenic sublimates.

- Solid to solution, so  $\Delta S > 0$ .
- Gas to liquid, so  $\Delta S < 0$ .
- Although the total moles increase ( $4 + 5 \rightarrow 4 + 6$ ), the moles of gas decrease ( $4 + 5 \rightarrow 4$ ). Therefore,  $\Delta S < 0$ .
- Temperature decreases, so  $\Delta S < 0$ .
- Solid to gas, so  $\Delta S > 0$ .

### 2

Predict the sign of  $\Delta S^\circ$  and then calculate  $\Delta S^\circ$  for the reaction  $2\text{H}_2\text{S}(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + 2\text{SO}_2(\text{g})$  using the following information:

Compound	$S^\circ$ (J/mol · K)
$\text{H}_2\text{O}(\text{l})$	70.
$\text{H}_2\text{S}(\text{g})$	206
$\text{O}_2(\text{g})$	205
$\text{SO}_2(\text{g})$	248

$\Delta S^\circ$  is expected to be negative because the moles of gas decrease during the reaction ( $2 + 3 \rightarrow 2$ ).

$$\Delta S^\circ = 2(70.) + 2(248) - 2(206) - 3(205) = -391 \text{ J/mol} \cdot \text{K}$$

### 3

For a certain reaction at 135°C,  $\Delta H = -58 \text{ kJ/mol}$  and  $\Delta S = -185 \text{ J/mol}\cdot\text{K}$ . Calculate  $\Delta G$  for the reaction at 135°C and determine if the reaction is spontaneous at this temperature.

$$\Delta G = -58 \text{ kJ/mol} - (135 + 273) \text{ K} \left( -\frac{185}{1000} \text{ kJ/mol}\cdot\text{K} \right) = 17 \text{ kJ/mol} > 0 = \text{nonspontaneous}$$

### 4

Determine whether reactions with the following  $\Delta H$  and  $\Delta S$  values will be spontaneous at all temperatures, nonspontaneous at all temperatures, spontaneous at high temperatures only, or spontaneous at low temperatures only. Also indicate the driving force for each spontaneous reaction:

- $\Delta H = 82 \text{ kJ/mol}$ ,  $\Delta S = 68 \text{ J/mol}\cdot\text{K}$
  - $\Delta H = -326 \text{ kJ/mol}$ ,  $\Delta S = 175 \text{ J/mol}\cdot\text{K}$
  - $\Delta H = 592 \text{ kJ/mol}$ ,  $\Delta S = -326 \text{ J/mol}\cdot\text{K}$
  - $\Delta H = -97 \text{ kJ/mol}$ ,  $\Delta S = -55 \text{ J/mol}\cdot\text{K}$
- spontaneous at high T only, entropy driven
  - spontaneous at all T, both enthalpy and entropy driven
  - nonspontaneous at all T
  - spontaneous at low T only, enthalpy driven

### 5

For a reaction with  $\Delta H = -52.6 \text{ kJ/mol}$  and  $\Delta S = -125 \text{ J/mol}\cdot\text{K}$ , estimate the cutoff temperature in °C at which the reaction changes from spontaneous to nonspontaneous and also specify if the reaction is spontaneous above or below this cutoff temperature.

$$\Delta G = 0 = -52.6 \text{ kJ/mol} - T \left( -\frac{125}{1000} \text{ kJ/mol}\cdot\text{K} \right)$$
$$T = 421 \text{ K}$$

Reaction is spontaneous below cutoff temperature  $421 \text{ K} - 273 = 148^\circ\text{C}$ .

### 6

Calculate  $\Delta G^\circ$  for the reaction  $\text{N}_2\text{H}_4(\text{l}) + 2\text{H}_2\text{O}_2(\text{l}) \longrightarrow \text{N}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$  using the following information:

Compound	$\Delta G_f^\circ$ (kJ/mol)
H <sub>2</sub> O(g)	-228.6
H <sub>2</sub> O <sub>2</sub> (l)	-120.4
N <sub>2</sub> H <sub>4</sub> (l)	149.3

$$\Delta G^\circ = 1(0) + 4(-228.6) - 1(149.3) - 2(-120.4) = -822.9 \text{ kJ/mol}$$



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