

23) a, b and c are spontaneous
d - non spontaneous

27) a) H_2 @ $100^\circ C$ and 0.5 atm

↳ higher temp and lower pressure means greater volume and more positional probability

b) N_2 @ STP has more volume

c) $H_2O(g)$ has greater positional probability than $H_2O(s)$

28) a) to boil a liquid, energy is required

- this is endothermic

- energy flows from surroundings to system so entropy of surroundings decreases

b) - this is exothermic

- energy flows from system to surroundings
- entropy of surroundings increases

$$\begin{aligned}
 31) \quad a) \quad \Delta G &= \Delta H - T \Delta S \\
 &= 25,000 \text{ J} - (300. \text{ K}) \left(5.0 \frac{\text{J}}{\text{K}} \right) \\
 &= 24,000 \text{ J} \quad \text{non spontaneous}
 \end{aligned}$$

$$\begin{aligned}
 b) \quad \Delta G &= \Delta H - T \Delta S \\
 &= (25,000 \text{ J}) - (300. \text{ K}) \left(100 \frac{\text{J}}{\text{K}} \right) \\
 &= -5000 \text{ J} \quad \text{spontaneous}
 \end{aligned}$$

$$c) \quad \Delta H - T \Delta S + \Delta G \text{ always - } \\
 \text{spontaneous}$$

$$\begin{aligned}
 d) \quad \Delta G &= \Delta H - T \Delta S \\
 &= (-1.0 \times 10^4 \text{ J}) - (200. \text{ K}) \left(-40. \frac{\text{J}}{\text{K}} \right) \\
 &= -2000 \text{ J} \quad \text{spontaneous}
 \end{aligned}$$

$$33) \quad @ \text{ boiling pt} \quad \Delta G = 0$$

$$\Delta H = T \Delta S \quad \text{so} \quad \Delta S = \frac{\Delta H}{T}$$

$$\Delta S = \frac{27.5 \frac{\text{kJ}}{\text{mol}}}{308 \text{ K}} = 8.93 \times 10^{-2} \frac{\text{kJ}}{\text{mol} \cdot \text{K}} = 89.3 \frac{\text{J}}{\text{mol} \cdot \text{K}}$$



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

$$= \left(5650 \frac{\text{J}}{\text{mol}} \right) - (200. \text{K}) \left(28.9 \frac{\text{J}}{\text{mol} \cdot \text{K}} \right)$$

$$= - 130 \frac{\text{J}}{\text{mol}}$$

yes NH_3 will melt @ 200 K

b) @ m.p. $\Delta G = 0$

$$T = \frac{\Delta H}{\Delta S} = \frac{5650 \frac{\text{J}}{\text{mol}}}{28.9 \frac{\text{J}}{\text{mol} \cdot \text{K}}} = 196 \text{ K}$$