84.122- Section 204 Quiz 5 – Thermodynamics Name KEY
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Useful Equation: $\Delta G = \Delta H - T\Delta S$

1. Which of the following processes have a $\Delta S > 0$? (6 pts)

a) $CH_3OH(l) \rightarrow CH_3OH(s)$
b) $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$
c) $CH_4(g) + H_2O\ (g) \rightarrow CO(g) + 3\ H_2(g)$
d) $Na_2CO_3(s) + H_2O(g) + CO_2(g) \rightarrow 2\ NaHCO_3(s)$
e) All of the above processes have a $\Delta S > 0$.

2. Consider a reaction that has a positive ΔH and a positive ΔS. Which of the following statements is TRUE? (6 pts)

$\Delta G = \Delta H - T\Delta S$ (+) (−)

a) This reaction will be spontaneous only at high temperatures.
b) This reaction will be spontaneous at all temperatures.
c) This reaction will be nonspontaneous at all temperatures.
d) This reaction will be nonspontaneous only at high temperatures.
e) It is not possible to determine without more information.

3. Consider a reaction that has a positive ΔH and a negative ΔS. Which of the following statements is TRUE? (6 pts)

$\Delta G = \Delta H - T\Delta S$ (+) (+)

a) This reaction will be spontaneous only at high temperatures.
b) This reaction will be spontaneous at all temperatures.
c) This reaction will be nonspontaneous at all temperatures.
d) This reaction will be nonspontaneous only at high temperatures.
e) It is not possible to determine without more information.

4. The following process, (6 pts)

$H_2O\ (l) \rightarrow H_2O(g)$, has

a) a negative ΔH and a negative ΔS
b) a positive ΔH and a negative ΔS
c) a negative ΔH and a positive ΔS
d) a positive ΔH and a positive ΔS
e) It is not possible to determine without more information

5. Consider the conversion of mercury from a liquid to mercury vapor.

$$Hg(l) \rightarrow Hg(g)$$

$$\Delta H^\circ_{vap} = 60.78 \text{ kJ/mol}; \quad \Delta S^\circ_{vap} = 97.3 \text{ J/K-mol}$$

Use the information provided to estimate the boiling point of mercury. Assume that the enthalpy and entropy of vaporization don't change with temperature. Clearly show your method, including cancellation of units. No credit will be given without a clear method shown. (10 pts)

$$\Delta G = 0 = \Delta H - T\Delta S$$

$$0 = \frac{60.78 \text{ kJ}}{\text{mol}} - T\left(97.3 \frac{\text{J}}{\text{mol}\cdot\text{K}}\right)$$

$$T = \frac{60.78 \text{ kJ/mol}}{.0973 \text{ kJ/mol-K}} =$$

$$= 625 \text{ K} = 352 \text{ °C}$$

a temperature of 625 K or 352 °C

Answer:

6. Identify the substance with a standard free energy of formation equal to zero. (6 pts)

a) $NaCl(s)$
b) $N_2(g)$
c) $NO(g)$
d) $O_3(g)$
e) Cannot be determined from information given.