Practice Quiz - Thermodynamics

1. Which one of the following phase changes decreases the entropy of the system?

A. melting

B. heating a gas

C. vaporization D. condensation

E. sublimation

2. Calculate ΔG° for the reaction $SiCl_4(g) + 2Mg(s) \rightarrow 2MgCl_2(s) + Si(s)$

Substance: SiCl₄(g) ΔG°_{f} (kJ/mol) -616.98

Mg(s) $MgCl_2(s)$ Si(s)

-591.79 0

A. 566.60 kJ

B. 50.38 kJ

C. 25.19 kJ

D. -25.19 kJ

E. -566.60 kJ

3. "A diamond is forever" is one of the most successful advertising slogans of all time. But is it true? For the reaction shown below, calculate the standard free energy change at 298 K and determine whether or not a diamond is "forever."

 $C(diamond) \rightarrow C(graphite)$

Data: $\Delta H_f^{\circ}(\text{diamond}) = 1.895 \text{ kJ/mol}$; $S^{\circ}(\text{diamond}) = 2.337 \text{ J mol}^{-1} \text{ K}^{-1}$; $S^{\circ}(\text{graphite}) = 5.740 \text{ J mol}^{-1} \text{K}^{-1}$.

A. $\Delta G^{\circ} = 2.19 \text{ kJ}$; forever

B. $\Delta G^{\circ} = -1.90 \text{ kJ}$; not forever

C. $\Delta G^{\circ} = -2.90 \text{ kJ}$; not forever

D. $\Delta G^{\circ} = 1.90 \text{ kJ}$; forever

E. $\Delta G^{\circ} = < -1000 \text{ kJ}$; not forever

4. Sulfuryl dichloride is formed when sulfur dioxide reacts with chlorine. The data refer to 298 K.

 $SO_2(g) + Cl_2(g) \rightarrow SO_2Cl_2(g)$

Substance: $SO_2(g)$ $Cl_2(g)$ $SO_2Cl_2(g)$ ΔH°_{f} (kJ/mol): -296.80 -364.0 ΔG°_{f} (kJ/mol): -300.10 -320.0248.2 S°(J/K·mol): 223.0 3119

What is the value of ΔG° for this reaction at 600 K?

A. -162.8 kJ

B. -40.1 kJ

C. -28.4 kJ

D. 28.4 kJ

E. 162.8 kJ

5. Use the thermodynamic data at 298 K below to determine the $K_{\rm sp}$ for barium carbonate, BaCO₃ at this temperature.

Substance: Ba²⁺(aq) BaCO₃(s) $CO_3^{2-}(aq)$ ΔH°_{f} (kJ/mol): -538.36-1219-676.26 ΔG°_{f} (kJ/mol): -560.7-528.1 -113913 -53.1112 S°(J/K·mol):

A. 5.86

B. 6.30×10^{8}

C. 1.59×10^{-9}

D. 5.47×10^{-21}

E. 2.18×10^{-27}

6. For each of the following pairs, predict which (A or B) will have the greater entropy, and in one sentence indicate your reasoning.

A B
a. 1 mole of HI(g) 1 mole of HBr(g)
b. 1 mole of H2(g) + 1 mole of N2(g)
c. 3 moles of H2(g) + 1 mole of N2(g)
d. 1 mole of CO2(g) 1 mole of H2(g), pressure = 1 atm
e. 1 mole of CO2(g) 1 mole of CO2(aq)
f. 1 mole of HCOOH(I) 1 mole of HCOOH(aq)

7. The complete combustion of liquid benzene is represented by the equation:

$$C_6H_6(l) + 7\frac{1}{2}O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$$

Using the data below, calculate, for this reaction

- a. *ΔH*°
- b. ΔS°
- c. ΔG° at 25°C.

8. The water-gas shift reaction plays an important role in the production of clean fuel from coal.

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

Use the following thermodynamic data to determine the equilibrium constant K_p at 700. K.

Substance: CO(g) $H_2O(g)$ $CO_2(g)$ $H_2(g)$ ΔH°_f (kJ/mol): -110.5 -241.8 -393.5 0 $S^{\circ}(J/mol\cdot K)$: 197.7 188.8 213.7 130.7

9. A chemical reaction has $\Delta H^{\circ} = 42.8 \text{ kJ}$ and $\Delta S^{\circ} = 92.5 \text{ J/K}$, at 25°C. Calculate the temperature at which $\Delta G^{\circ} = 0$. State any approximation involved in your calculation.

10. The formation constant for the reaction $Ag^+(aq) + 2NH_3(aq) \implies Ag(NH_3)_2^+(aq)$ is $K_f = 1.7 \times 10^7$ at 25°C. What is ΔG° at this temperature?

A. -1.5 kJ

B. -3.5 kJ

C. -18 kJ

D. -23 kJ

E. -41 kJ