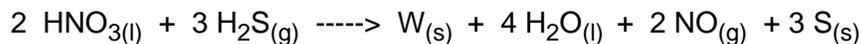


# Thermochemistry and Thermodynamics Worksheet 4

1. For the reaction  $A_{(g)} \rightleftharpoons B_{(g)} + C_{(g)}$ ,  $K_p = 2 \times 10^{-4}$  at  $25^\circ\text{C}$ . A mixture of the three gases at  $25^\circ\text{C}$  is placed in a reaction flask and the initial pressures are:  $P_A = 2 \text{ atm}$ ,  $P_B = 0.5 \text{ atm}$ , and  $P_C = 1 \text{ atm}$ . At the instant of mixing, which of the following is true for the reaction in the forward direction.
- (A)  $\Delta G < 0$
  - (B)  $\Delta G > 0$
  - (C)  $\Delta S = 0$
  - (D)  $\Delta G^\circ = 0$
  - (E)  $\Delta G^\circ < 0$
2. Which choice would definitely be non-spontaneous for the following changes in enthalpy ( $\Delta H$ ) and entropy ( $\Delta S$ )?
- (A)  $+\Delta H$  and  $+\Delta S$
  - (B)  $+\Delta H$  and  $-\Delta S$
  - (C)  $-\Delta H$  and  $+\Delta S$
  - (D)  $-\Delta H$  and  $-\Delta S$
  - (E)  $\Delta H = 0$  and  $+\Delta S$
3. A catalyst is added to a system in equilibrium, which of the following events occurs?
- (A) The equilibrium shifts to the right.
  - (B) The equilibrium shifts to the left.
  - (C) There is no effect on equilibrium.
  - (D)  $\Delta H$  increases.
  - (E)  $\Delta H$  decreases.
4. Given the reaction:  $N_{2(g)} + 3 H_{2(g)} \rightleftharpoons 2 NH_{3(g)}$   $\Delta H = -24 \text{ kCal}$   
Which change will increase the equilibrium concentration of  $NH_3$ ?
- (A) A decrease in the total pressure.
  - (B) A decrease in  $[N_2]$ .
  - (C) A decrease in the temperature of the reaction chamber.
  - (D) An increase in the volume of the reaction chamber.
5. For a given chemical system, the value of the equilibrium constant  $K$  will depend on temperature unless:
- (A)  $\Delta G^\circ > 0$
  - (B)  $\Delta H^\circ = 0$
  - (C)  $\Delta S^\circ = 0$
  - (D)  $\Delta G^\circ < 0$
  - (E)  $\Delta n = 0$  (no change in the number of moles)

# Thermochemistry and Thermodynamics Worksheet 4

6. The following chemical reaction occurs at 25°C:



You are given the following thermodynamic data:

| Species                    | $\Delta H_f^\circ$ (kJ/mol) | $\Delta G_f^\circ$ (kJ/mol) |
|----------------------------|-----------------------------|-----------------------------|
| $\text{HNO}_{3(l)}$        | -174.1                      | -80.8                       |
| $\text{H}_2\text{S}_{(g)}$ | -20.6                       | -33.6                       |
| $\text{H}_2\text{O}_{(l)}$ | -285.8                      | -237.2                      |
| $\text{NO}_{(g)}$          | 90.2                        | 86.6                        |

(A) What is the value of the standard Gibbs Free Energy for the system represented above?

(B) What is the value of the equilibrium constant for the system represented above? ( $R = 8.314 \text{ J/K}$ )

(C) Calculate  $\Delta S^\circ$  at 25°C.

7.  $K_{\text{eq}} = 36$  at 300°C for the reaction:  $\text{A}_{2(g)} + \text{B}_{2(g)} \rightleftharpoons 2 \text{AB}_{(g)}$

(A) Calculate the  $\Delta G^\circ$  at 300°C for this reaction. ( $R = 8.314 \text{ J/K}$ )

(B) What is  $\Delta H$  for the reaction if  $\Delta S^\circ$  at 300°C is  $20.0 \text{ J/mol}\cdot\text{K}$ ?

(C) Calculate  $K_{\text{eq}}$  for the reaction:  $\text{AB}_{(g)} \rightleftharpoons 1/2 \text{A}_{2(g)} + 1/2 \text{B}_{2(g)}$