

**Quiz: Ch 19 & 20**  
**Thermodynamics & Electrochemistry**  
**Version B**

**Name:**  
**Date:** Pd: 6 7

**Show your work for all questions; answer all parts of all questions. No work = no credit.**

1. State the 3<sup>rd</sup> Law of Thermodynamics.
2. Are all endothermic reactions non-spontaneous? Why, or why not?

3. Given the following data for white phosphorus and red phosphorus at 298K.

$$S^\circ (\text{P}_4, \text{s, white}) = 41.1 \text{ J}/(\text{mol K})$$

$$S^\circ (\text{P}_4, \text{s, red}) = 22.9 \text{ J}/(\text{mol K})$$

$$\Delta H_f^\circ \text{P}_4\text{O}_6 (\text{s, from white phosphorus}) = -1.64 \text{ kJ/mol}$$

$$\Delta H_f^\circ \text{P}_4\text{O}_6 (\text{s, from red phosphorus}) = -1.62 \text{ kJ/mol}$$

Consider the change:  $\text{P}_4 (\text{s, white}) \rightarrow \text{P}_4 (\text{s, red})$  at 298K and 1 atm.

- a. What are the values of  $\Delta S^\circ$  and  $\Delta H^\circ$  for the conversion of white phosphorus to red?
- b. Perform a calculation to show whether it is thermodynamically feasible (practical) to produce red phosphorous from white at 298K and 1 atm. Then explain how you know if it is feasible or not.
- c. For the reaction, calculate the equilibrium constant  $K_{\text{eq}}$  at 298K.

4. A voltaic cell is constructed that consists of a 10.0 g silver metal electrode in a solution of 1.0 M  $\text{AgNO}_3$ , connected by a wire and a salt bridge to a 10.0 g cadmium (Cd) metal electrode in a 1.0 M solution of  $\text{Cd}(\text{NO}_3)_2$ .

Write the balanced half reaction that would occur at the:

a. Cathode

b. Anode

c. Write the overall, balanced cell reaction and calculate  $E^\circ_{\text{cell}}$ .

d. Calculate  $E_{\text{cell}}$  at 25°C when  $[\text{Ag}^{1+}] = 1.0 \times 10^{-2} \text{ M}$  and  $[\text{Cd}^{2+}] = 1.0 \times 10^{-5} \text{ M}$ .

e. Calculate the mass of the cadmium electrode if this cell produces a 2.50 Amp current for 1.00 hour.