CHEM 1474      Test 4      Fall 2008

SHORT ANSWER: 2 points each. Fill in the blank with the most correct answer.

1. A(n) __________ process occurs without a constant input of energy.

2. A(n) __________ process cannot be restored to its original state simply by changing the direction of the original process.

3. Entropy __________ is the energy term that relates to the number of microstates for a system.

4. The __________ Law of Thermodynamics states that at zero kelvin, a perfectly crystalline solid will have the term from #3 = 0

5. Gibbs __________ Free Energy is used to predict the spontaneity of a process.

6. If \( \Delta G^\circ \) is __________ (less than/greater than/equal to) zero, then \( K_{eq} < 1 \).

7. Reduction __________ is the gain of electrons during a 'half' reaction.

8. A(n) __________ cell is constructed such that electrons will flow spontaneously between the electrodes.

9. A(n) __________ agent is oxidized during a redox reaction.

10. Oxidation __________ occurs at the anode of any electrochemical cell.

11. The __________ equation allows the calculation of the cell potential for a redox reaction that is not under standard conditions.

12. Corrosion __________ is the undesirable redox reaction of certain metals being converted to unwanted products.

13. A(n) __________ which is made up of a more active metal is often used in highly reactive environments (on ships, in water heaters, for pipelines) to minimize or eliminate the effects of #12.

14. A(n) __________ is a self-contained system with two or more voltaic cells connected in series.

15. Electrolysis __________ is the use of electricity to force a non-spontaneous reaction to occur.
PROBLEMS (15 points each). Show your work and circle your answers where appropriate for full credit.

16. Calculate $\Delta H^\circ$, $\Delta S^\circ$, and $\Delta G^\circ$ for the following reaction at 25°C:

$$\text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g)$$

$$\Delta H^\circ_{\text{rxn}} = -92.38 \text{ kJ}$$
$$\Delta S^\circ_{\text{rxn}} = -198.24 \text{ J/K}$$
$$\Delta G^\circ_{\text{rxn}} = -33.32 \text{ kJ}$$

17. Balance the following redox equations. Add H$_2$O, H$^+$, and/or OH$^-$ as necessary. Solution conditions that are acidic (A) or basic (B) will be shown following the reaction.

(A) $\text{As}_2\text{O}_3(s) + \text{NO}_3(aq) \rightarrow \text{H}_3\text{AsO}_4(aq) + \text{N}_2\text{O}(aq)$

$$5\text{H}_2\text{O} + 2\text{As}_2\text{O}_3 + 2\text{H}^+ + 2\text{NO}_3^- \rightarrow 4\text{H}_3\text{AsO}_4^+ + \text{N}_2\text{O}$$

(B) $\text{H}_2\text{O}_2(aq) + \text{Cl}_2\text{O}_7(aq) \rightarrow \text{ClO}_3(aq) + \text{O}_2(g)$

$$20\text{H}^- + 4\text{H}_2\text{O}_2 + \text{Cl}_2\text{O}_7 \rightarrow 4\text{O}_2 + 2\text{ClO}_3^- + 5\text{H}_2\text{O}$$
18. Determine the approximate boiling point in °C for \( \text{PCl}_3 \). Explain why this is an ‘approximate’ value.

\[ 60^\circ \text{C} \]

We assume \( \Delta H^\circ \) and \( \Delta S^\circ \) do not vary with temperature.

19. Calculate the standard cell potential for the reaction of silver ion and zinc to form silver and zinc ion:

\[ 2\text{Ag}^+ + \text{Zn} \rightarrow 2\text{Ag} + \text{Zn}^{2+} \]

\[ E^\circ = 1.562 \text{ V} \]

Calculate the cell potential if \([\text{Zn}^{2+}] = 2.53 \times 10^{-3} \text{M}\) and \([\text{Ag}^+] = 5.75 \times 10^{-2} \text{M}\)

\[ 1.565 \text{ V} \]

20. When a gold ring is ‘sized’, it is not uncommon for the goldsmith to place a thin coating of gold over the repaired area to restore a seamless appearance. Calculate the mass of \( \text{Au}^{3+} \) deposited on a ring if a current of 2.20A is used for 15.0 seconds for this process.

\[ 0.0225 \text{g Au} \]