CHM 1220 Practice Problems - EXAM 3 (Chapter 18-19)

***Students are responsible for everything we discussed in class and HW**

Question I: Multiple Choices

1. Which thermodynamic function is most related to disorder and probability?
   A. Enthalpy
   B. Internal energy
   C. Entropy
   D. Heat capacity

2. For the process of freezing liquid ethanol at a given temperature and pressure
   A. ΔH is negative and ΔS is negative
   B. ΔH is negative and ΔS is positive
   B. ΔH is positive and ΔS is negative
   D. ΔH is positive and ΔS is positive
   C.

3. A process is carried out at constant pressure. Given that ΔE is positive and ΔH is negative
   A. The system absorbs heat and expands during the process
   B. The system absorbs heat and contracts during the process
   C. The system loses heat and expands during the process
   D. The system loses heat and contracts during the process

4. Choose the statement below that is TRUE.
   A) $K > 1$, $\Delta G°_{rxn}$ is positive.
   B) $K < 1$, $\Delta G°_{rxn}$ is negative.
   C) $\Delta G°_{rxn} = 0$ at equilibrium.
   D) $\Delta G_{rxn} = 0$ at equilibrium.
   E) None of the above statements are true.

5. Which of the following processes have a $\Delta S < 0$?
   A) water freezes
   B) methyl alcohol condenses
   C) propanol (g, at 555 K) → propanol (g, at 400 K)
   D) carbon dioxide(g) → carbon dioxide(s)
   E) All of the above processes have a ΔS < 0.

6. How many moles of electrons, *n*, are transferred in the following reduction-oxidation reaction?

   $2\ MnO_4^-(aq) + 16\ H^+(aq) + 10\ Cl^-(aq) \rightarrow 2\ Mn^{2+}(aq) + 5\ Cl_2(g) + 8\ H_2O(l)$

   A) 2
   B) 4
   C) 5
   D) 10

7.) Which statement is true?
   A) The cathode is positive for a galvanic cell and negative for an electrolytic cell.
   B) Electrons flow through the external circuit to the cathode in a galvanic cell and to the anode in an electrolytic cell.
   C) Oxidation occurs at the anode in a galvanic cell and at the cathode in an electrolytic cell.
   D) Oxidation occurs at the cathode in a galvanic cell and at the anode in an electrolytic cell.

8. Identify the location of reduction in an electrochemical cell.
   A) the anode
   B) the cathode
   C) the electrode
   D) the salt bridge

9. What statement is NOT true about standard electrode potentials?

A) $E°_{cell}$ is positive for spontaneous reactions.

B) Electrons will flow from more negative electrode to more positive electrode.

C) The electrode potential of the standard hydrogen electrode is exactly zero.

D) $E°_{cell}$ is the difference in voltage between the anode and the cathode.

E) The electrode in any half-cell with a greater tendency to undergo reduction is positively charged relative to the standard hydrogen electrode and therefore has a positive E°.

10. Determine which of the following pairs of reactants will result in a spontaneous reaction at 25°C.

A) $Sn^{4+}(aq) + Mn(s)$

B) $Cr^{3+}(aq) + Pb(s)$

C) $Zn(s) + K^{+}(aq)$

D) $Fe(s) + Ba^{2+}(aq)$

E) None of the above pairs will react.

11. Which of the following is the weakest oxidizing agent?

A) $H_2O_2(aq)$

B) $Fe^{3+}(aq)$

C) $ClO_2(g)$

D) $F^-(s)$

E) $Fe(s)$

12. Identify the battery that is in most automobiles.

A) dry-cell battery

B) lithium ion battery

C) lead-acid storage battery

D) NiCad battery

E) fuel cell

13. What is the shorthand notation for a galvanic cell that represents the following galvanic cell reaction?

$$Br_2(l) + 2\ I^-(aq) \rightarrow 2\ Br^-(aq) + I_2(s)$$

A) $I^-(aq)\,|\,I_2(s)\,||Br_2(l)\,|\,Br^-(aq)$

B) $I^-(aq)\,|\,I_2(s)\,||Br_2(l)\,|\,Br^-(aq)\,|\,Pt(s)$

C) $Pt(s)\,|\,I^-(aq)\,|\,I_2(s)\,||Br_2(l)\,|\,Br^-(aq)$

D) $Pt(s)\,|\,I^-(aq)\,|\,I_2(s)\,||Br_2(l)\,|\,Br^-(aq)\,|\,Pt(s)$

Question III -thermochemistry

1. Calculate the $\Delta G°_{rxn}$ using the following information

$$4\ HNO_3(g) + 5\ N_2H_4(l) \rightarrow 7\ N_2(g) + 12\ H_2O(l)$$

$\Delta H°_f$ (kJ/mol)	-133.9	50.6		-285.8
S°(J/mol·K)	266.9	121.2	191.6	70.0

Answer: -3.30×10^3 kJ

Is the reaction spontaneous? If not, then at what temperature does the changeover occur?

2. Use the free energies of formation given below to calculate the equilibrium constant (K) for the following reaction at 298 K.

$2\ HNO_3(aq) + NO(g) \rightarrow 3\ NO_2(g) + H_2O(l)$ K = ?

$\Delta G°_f$ (kJ/mol)	-110.9	87.6	51.3	-237.1

Answer: 1.15×10^{-9}

3. The equilibrium constant K_p for the reaction $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ is 5.62×10^{35} at 25°C. Calculate $G°_f$ for $COCl_2$ at 25°C

-341.7 kJ

4. Calculate ΔG_{rxn} at 298 K under the conditions shown below for the following reaction.

$2\ Hg(g) + O_2(g) \rightarrow 2\ HgO(s)$ $\Delta G° = -180.8$ kJ

P(Hg) = 0.025 atm, $P(O_2)$ = 0.037 atm

-154.4 kJ

Chapter 19 - Electrochemistry

1. What is the Al^{3+}:Ag^{+}concentration ratio in the cell $Al_{(s)} | Al^{3+}_{(aq)} || Ag^{+}_{(aq)} | Ag(s)$ if the measured cell potential is 2.34 V?

Answer: 110:1

2. The standard cell potential (E°) of a voltaic cell constructed using the cell reaction below is 0.76 V:

$$Zn_{(s)} + 2H^{+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + H_{2(g)}$$

With P_{H_2} = 1.0 atm and $[Zn^{2+}]$ = 1.0 M, the cell potential is 0.66 V. The concentration of H^{+} in the cathode compartment is _____ M.

Answer: 2.0×10^{-2}

Sketch a galvanic cell and write a short hand notation for the reaction above

3. Use the tabulated half-cell potentials to calculate ΔG° for the following redox reaction.

$$2\ Al_{(s)} + 3\ Mg^{2+}_{(aq)} \rightarrow 2\ Al^{3+}_{(aq)} + 3\ Mg_{(s)}$$

Answer: $+4.1 \times 10^{2}$ kJ

4. How long must a constant current of 50.0 A be passed through an electrolytic cell containing aqueous Cu^{2+} ions to produce 3.50 moles of copper metal?

3.75 hours

Short answer:

Explain the significance of the standard hydrogen electrode (SHE) in the tabulation of standard reduction potentials of other species.

Why, if we multiply a reaction by 2, don't we multiply its $E°_{red}$ by 2?

Describe the difference between Galvanic cell and electrolytic cell?

Why can't we say that a spontaneous reaction is a fast reaction?

Why can endothermic reactions be spontaneous?

Define the second law and third law of thermodynamics.