PX1412SPG15

PRACTICE FINAL EXAM / CHEM1412 / SPRING 2015

1. What is the thermodynamic quantity that provides the criterion for the spontaneity of a chemical reaction?
   a. ΔS
   b. ΔH
   c. ΔU
   d. ΔG
   e. $T\Delta S$

2. What is equal to ΔH at equilibrium?
   a. ΔS
   b. ΔH
   c. ΔU
   d. ΔG
   e. $T\Delta S$

3. Which of the following must have a negative value for an exothermic reaction?
   a. enthalpy change
   b. entropy change
   c. free energy change
   d. electrode cell potential
   e. equilibrium constant

4. Thermodynamics is applied to learn a reaction's
   a. pathway.
   b. mechanism.
   c. stoichiometry.
   d. rate.
   e. feasibility.

5. For which of the following processes would the enthalpy changes be expected to be exothermic?

   1. $Cl^-(g) \Rightarrow Cl(g) + e$
   2. $CO_2(s) \Rightarrow CO_2(g)$
   3. $Na(g) \Rightarrow Na^+(g) + e$
   4. $2Cl(g) \Rightarrow Cl_2(g)$

   a. 1 only
   b. 4 only
   c. 1 and 2 only
   d. 2 and 3 only
   e. 2, 3, and 4

6. Which of the following processes is endothermic?
   a. $H_2O(g) \Rightarrow H_2O(l)$
   b. $Al^{3+}(g) + 3e^- \Rightarrow Al(s)$
   c. $NH_3(g) + HCl(g) \Rightarrow NH_4Cl(s)$
   d. $2H_2O(l) \Rightarrow 2H_2(g) + O_2(g)$
   e. $C(s) + O_2(g) \Rightarrow CO_2(g)$

7. çH and çU are nearly the same in all the following processes **EXCEPT**
   a. $2SO_2(g) + O_2(g) \Rightarrow 2SO_3(g)$.
   b. $N_2(g) + O_2(g) \Rightarrow 2NO(g)$.
   c. $CuO(s) + H_2(g) \Rightarrow Cu(s) + H_2O(g)$.
   d. $CH_4(g) + Cl_2(g) \Rightarrow CH_3Cl(g) + HCl(g)$.
   e. $C_6H_6(s) \Rightarrow C_6H_6(l)$.

8. The heat of vaporization of Freon, CCl_2F_2, is 17.2 kJ/mol at 25øC. What is the change of entropy for one mole of liquid Freon when it vaporizes at 25øC?
   a. 57.7 J/(mol-K)
   b. 0.688 J/(mol-K)
   c. 5.13 Á 10^3 kJ/(mol-K)
   d. 3.16 J/(mol-K)
   e. 2.39 Á 10^2 J/(mol-K)

9. Which of the following is true when one mole of $CO_2(g)$ changes to dry ice?

   1. The entropy decreases.
   2. The entropy increases.
   3. The enthalpy increases.
   4. The enthalpy decreases.

   a. 1 only
   b. 2 only
   c. 1 and 3 only
   d. 2 and 3 only
   e. 1 and 4 only

10. The heat of vaporization of ammonia is 23.4 kJ/mol. Its boiling point is -33° C. The change in entropy for the vaporization of methanol in J/(mol-K) is
    a. -23.4.
    b. 0.00975.
    c. 0.0234.
    d. 23.4.
    e. 97.5.

11. For a reaction if $\Delta G^o = 0$, then
    a. $\Delta S^o = 0$.
    b. $\Delta H^o = 0$.
    c. $\Delta G^o = 0$.
    d. K = 1.
    e. K = 0.

12. For the reaction $3C(s) + 4H_2(g) \Rightarrow C_3H_8(g)$,

    $\Delta S = -269$ J/(mol ú K)

    $\Delta H = 103.8$ kJ/mol

    Calculate the equilibrium constant at 25øC for the reaction above.
    a. 1.0
    b. 1.4×10^4
    c. 1.0×10^{17}
    d. 3.7×10^{19}
    e. 2.1×10^{32}

13. Calculate the heat of formation of nitrous oxide in kJ/mol from the following information:

    $2N_2O(g) \Rightarrow 2N_2(g) + O_2(g) + 164$ kJ
    a. -164 kJ
    b. -82 kJ
    c. -41 kJ
    d. 82 kJ
    e. 164 kJ

14. For a reaction system that is at equilibrium, which of the following must always be true?
    a. $\Delta G = 0$
    b. $\Delta H = 0$
    c. $\Delta U = 0$
    d. $\Delta S = 0$
    e. q = 0

15. What is the minimum temperature required for the spontaneous conversion of $CCl_4(l)$ to $CCl_4(g)$ when ΔH^o is 573 kJ/mol and ΔS^o is 1.64 kJ/(mol ú K)?
    a. 76 °C
    b. 89 °C
    c. 189 °C
    d. 215 °C
    e. 349 °C

16. Which of the following is **TRUE** for a galvanic cell?

1. The electron flow is from the negative electrode to the positive electrode.
2. The electron flow is from the anode to the cathode.
3. The electron flow is from oxidizing agent to the reducing agent through an external circuit.

a. 1 only
b. 2 only
c. 3 only
d. 1 and 2 only
e. 1, 2, and 3

17. The cathode in a galvanic cell and in an electrolytic (electrolysis) cell is
a. positive in both cells.
b. the site of oxidation and reduction, respectively.
c. the site of reduction and oxidation, respectively.
d. the site of oxidation.
e. the site of reduction.

18. In the voltaic cell that is represented as

$$[Ni/Ni^{2+}(Pt)\|Fe^{3+}/Fe^{2+}]$$

the electron flow will be from
a. Pt to Ni^{2+}.
b. Pt to Ni.
c. Fe^{2+} to Ni^{2+}.
d. Ni^{2+} to Fe^{2+}.
e. Ni to Fe^{3+}.

19. In an electrochemical cell, which statement is **ALWAYS** true of the cathode?
a. It is considered the "negative" electrode.
b. It is considered the "positive" electrode.
c. Reduction occurs here.
d. Metal is plated out here.
e. Negative ions flow toward the cathode.

20. What is the cell reaction for the voltaic cell $Cr(s)/Cr^{3+}(aq)//Cl^-(aq)/Cl_2(g)/(Pt)$?

    a. $Cr(s) + 2Cl^-(aq) \Rightarrow Cl_2(g) + Cr^{3+}(aq)$

    b. $2Cr^{3+}(aq) + 6Cl^-(aq) \Rightarrow 2Cr(s) + 3Cl_2(g)$

    c. $Cr(s) + 3Cl_2(g) \Rightarrow Cr^{3+}(s) + 2Cl^-(aq)$

    d. $2Cr(s) + 3Cl_2(g) \Rightarrow 2Cr^{3+}(aq) + 6Cl^-(aq)$

    e. none of these

21. The numerical value of the Faraday constant is given as 96,500. This value represents

    a. the number of coulombs of charge carried by one mole of electrons.

    b. the number of electrons corresponding to one coulomb of charge.

    c. the number of electrons corresponding to one mole of electric charge.

    d. the number of ions discharged by the passage of one mole of electrons.

    e. 96,500 amp/s

22. When Au is obtained by electrolysis from $NaAuCl_4$, the minimum number of coulombs required to produce 1.00 mol of gold is

    a. 48,250.

    b. 96,500.

    c. 193,000.

    d. 290,000.

    e. 579,000.

23. In the electrolysis of a basic solution, oxygen can be produced by the half-reaction

    $$4OH^- \Rightarrow O_2 + 2H_2O + 4e^-$$

    How many moles of O_2 can be produced from a solution that was electrolyzed for 6.00 hr using a current of 8.00 A?

    a. 1.49×10^{-2}

    b. 4.48×10^{-2}

    c. 0.224

    d. 0.448

    e. 0.896

24. Consider the following standard electrode potentials:

$Ag^+(aq) + e^- \Rightarrow Ag$ $\quad E^\circ = 0.80$ V

$Mn^{2+} + 2e^- \Rightarrow Mn$ $\quad E^\circ = -1.18$ V

for the standard cell

$Mn/Mn^{2+}(aq)//Ag^+(aq)/Ag$

Which of the following statements are true?

1. The cell voltage will be 1.98 V.
2. The one cell reaction is $Ag \Rightarrow Ag^+ + e^-$.
3. The overall cell potential will decrease with time.

a. 1 only
b. 2 only
c. 3 only
d. 2 and 3 only
e. 1 and 3 only

25. Calculate the maximum electrical work obtainable when 7.10 g of $Cl_2(g)$ are consumed in the reaction $Cd(s) + Cl_2(g) \Rightarrow Cd^{2+}(aq) + 2Cl^-(aq)$. ($E^\circ_{cell} = 1.76$ V.)

a. -3.40×10^6 J
b. -3.40×10^4 J
c. -1.70×10^4 J
d. -5.10×10^5 J
e. -1.10×10^4 J

26. Calculate E^0 for the cell reaction $2Cr + 3Sn^{4+} \Rightarrow 3Sn^{2+} + 2Cr^{3+}$.

$Cr^{3+} + 3e^- \Rightarrow Cr$ $\quad E^\circ = -0.74$ V

$Sn^{4+} + 2e \Rightarrow Sn^{2+}$ $\quad E^\circ = 0.15$ V

a. 1.93 V
b. 0.89 V
c. 0.59 V
d. 0.45 V
e. -0.59 V

27. For a certain reaction, ΔH^{o} = -76.0 kJ and ΔS^{o} = -234 J/K. If n = 3, calculate E^{o} for the reaction at 25°C.
    a. 0.022 V
    b. 0.032 V
    c. 0.065 V
    d. 0.096 V
    e. 0.192 V

28. At 25 °C, calculate the voltage of the cell

    $2Ag^{+}(aq)(0.10\ M) + Cu(s) \Rightarrow Cu^{2+}(aq)(0.010\ M) + 2Ag(s)$

    if E°_{cell} = 0.460 V.
    a. 0.282 V
    b. 0.371 V
    c. 0.430 V
    d. 0.460 V
    e. 0.519 V

29. What is the value of the reaction quotient, Q, for the cell that is constructed from the two half-reactions

    $Zn^{2+} + 2e^{-} \Rightarrow Zn$ -0.76 V

    $Ag^{+} + e^{-} \Rightarrow Ag$ 0.80 V

    when the Zn^{2+} concentration is 0.0100 M and the Ag^{+} concentration is 1.25 M?
    a. 156
    b. 125
    c. 1.25×10^{-2}
    d. 8.00×10^{-3}
    e. 6.40×10^{-3}

30. Calculate the equilibrium constant K at 25°C for the reaction

    $Sn + Pb^{2+}(aq) \Rightarrow Sn^{2+}(aq) + Pb(s)$

    where E°_{cell} equals 0.014.
    a. 1.7
    b. 3.0
    c. 4.8
    d. 8.8
    e. 12

31. In Galvanic Cells, electrons flow from
    a. cathode to anode
    b. anode to cathode
    c. positive electrode to negative electrode
    d. the more positive electrode potential to the more negative electrode potential

32. What is the reduction potential for the half-reaction $Al^{3+}(aq) + 3e^- \Rightarrow Al(s)$ at 25°C if $[Al^{3+}] = 0.10$ M and $E^o = -1.66$ V?
    a. -1.84
    b. -1.60
    c. -1.68
    d. -1.66
    e. -1.72

33. What reaction occurs at the anode during the electrolysis of aqueous $CuSO_4$?
    a. $2H_2O + 2e^- \Rightarrow H_2 + 2OH^-$
    b. $Cu \Rightarrow Cu^{2+} + 2e^-$
    c. $2H_2O \Rightarrow O_2 + 4H^+ + 4e^-$
    d. $2H^+ + 2e^- \Rightarrow H_2$
    e. $Cu^{2+} + 2e^- \Rightarrow Cu$

34. A current of 10. amperes is passed through molten magnesium chloride for 12.0 hours. How many moles of magnesium metal could be produced via this electrolysis?
    a. 2.2
    b. 1.1
    c. 0.56
    d. 0.37
    e. 0.22

35. The following reaction occurs in basic solution:

    ____ H_2O + ____ MnO_4^- + ____ ClO^- => ____ MnO_2 + ____ ClO_4^- + ____ OH^-

    Balance the equation and then add together all the coefficients in the balanced equation. The sum of these coefficients is
    a. 6.
    b. 9.
    c. 10.
    d. 12.
    e. 20.

36. The silicate ion can be reduced to silicon in basic solution. Each mole of silicate ions requires four moles of electrons. When the half-reaction

$$SiO_3^{2-}(aq) \Rightarrow Si(s)$$

is balanced, it has

a. 3 H_2O on the left and 6 OH^- on the right.

b. 4 H_2O on the left and 8 OH^- on the right.

c. 2 H_2O on the left and 4 OH^- on the right.

d. 4 OH^- on the left and 2 H_2O on the right.

e. 2 OH^- on the left and 1 H_2O on the right.

37. Consider the reaction of sulfur dioxide and water, which is represented by the equation

$$SO_2(g) + H_2O(g) \Rightarrow H_2S(g) + (3/2)O_2(g)$$

How many moles of electrons are transferred according to the equation that is written?

(<u>Solution Rational:</u> This reaction is very rare in the scheme of redox reactions… It has 2 reductions of oxygen on reactant side of the equation. That is, the two oxygen from SO_2 each lose $2e^{-s}$ (= $4e^{-s}$) and the one oxygen of water loses $2e^{-s}$ for a total of total of $6e^{-s}$ for the oxidation process forming 3 neutral oxygen atoms. This charge transfer balances with the gain of $6e^{-s}$ by sulfur as it changes from +4 in the SO_2 to -2 in the H_2S. The above equation is typically written as $2SO_2(g) + 2H_2O(g) \Rightarrow 2H_2S(g) + 3O_2(g)$ which totals to 12 e^{-s} in redox process.)

a. 2
b. 4
c. 6 ⟸ ($6e^{-s}$ oxidation process = $6e^{-s}$ reduction process <u>as written</u>)
d. 8
e. 12

Remaining questions will be from Exams I and II… Have a great summer!

1. d
2. e
3. a
4. e
5. b
6. d
7. a
8. a
9. e
10. e
11. d
12. b
13. d
14. a
15. a
16. d
17. e
18. e
19. c
20. d
21. a
22. d
23. d
24. e
25. b
26. b
27. a
28. d
29. e
30. b
31. b
32. c
33. c
34. a
35. b
36. a
37. c (special problem)