Name: _____   Date: _____

Chemistry 30
Redox Reactions and Electrochemistry   **60**

I.   Multiple Choice   *20*

1. The sum of the oxidation number in $K_2Cr_2O_7$ is:

    A. -2   C. +2
    B. 0   D. +11

2. Which answer correctly indicates the change in oxidation number for Fe in the reaction

    $$2 Fe_2O_3 \rightarrow 4 Fe + 3 O_2$$

    A. 0 to + 3   C. +3 to 0
    B. +2 to +4   D. +3 to –2

3. The sum of the oxidation numbers in CO_3^{2-} is:

    A. 0   C. -1
    B. +2   D. -2

4. Oxidation is best defined as

    A. gaining electrons   C. gaining protons
    B. losing electrons   D. losing protons

5. Which of the following is **NOT** a redox reaction?

    A. $Sn^{4+} + Fe^{2+} \rightarrow Sn^{2+} + Fe^{3+}$
    B. $SO_3 + H_2O \rightarrow H_2SO_4$
    C. $Ba + S \rightarrow BaS$
    D. $Cl_2 + 2 Br^- \rightarrow Cl^- + Br_2$

6. An element that changes in oxidation number in a chemical reaction from –2 to 0 is said to be:
    A. oxidized
    B. reduced
    C. both oxidized and reduced
    D. neither oxidized or reduced.

7. Monatomic ions (ions consisting of a single atom) are all assigned oxidation numbers equal to:
    A. +1   C. their charge
    B. zero   D. -1

8. The oxidation number of hydrogen in most compounds is:
    A. -1   C. -2
    B. zero   D. +1

9. The oxidation number of Mn in MnO_2 is:
    A. 0   C. +2
    B. +4   D. +8

10. The substance that is oxidized in a chemical reaction is also the:
    A. oxidizing agent   C. reducing agent
    B. dissolving agent   D. buffering agent

11. In the reaction

    $$Cu_{(s)} + 2 Ag^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2 Ag_{(s)}$$

    the oxidizing agent is
    A. $Cu_{(s)}$ C. $Ag^+_{(aq)}$
    B. $Cu^{2+}_{(aq)}$ D. $Ag_{(s)}$

12. In the reaction

    $$4NH_3 + 5O_2 \rightarrow 6H_2O + 4NO$$

    the oxidation number of nitrogen changes from
    A. +3 to +1
    B. +3 to +2
    C. -3 to +2
    D. -3 to -2

13. The half-reaction

$$ClO_3^- + 6H^+ + 5e^- \rightarrow \frac{1}{2}Cl_2 + 3H_2O$$
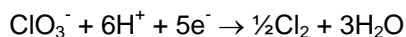
is best described as the:

A. oxidation of chlorine

B. oxidation of H^+

C. reduction of chlorine

D. reduction of H^+

14. An electrochemical cell involves:

A. the conversion of chemical energy into electrical energy

B. the conversion of electrical energy into chemical energy

C. either A or B

D. neither A or B

15. In the electroplating of silver, Ag, on an iron metal spoon, the reaction taking place at the spoon is:

A. $Ag \rightarrow Ag^+ + e^-$ C. $Ag^+ + e^- \rightarrow Ag$

B. $Fe \rightarrow Fe^{2+} + 2e^-$ D. $Fe^{2+} + 2e^- \rightarrow Fe$

16. In an electrochemical cell, electrons travel through the external circuit:

A. from the diode to the cathode

B. from the cathode to the diode

C. from the cathode to the anode

D. from the anode to the cathode

17. The primary difference between electrolysis and an electrochemical cell is that in the electrochemical cell the reaction is:

A. reduction only   C. non-spontaneous

B. oxidation only   D. spontaneous

18. A metal can be protected from corrosion by making it:

A. either electrode in an electrochemical cell.

B. the electrolyte in an electrochemical cell.

C. the anode in an electrochemical cell.

D. the cathode in an electrochemical cell.
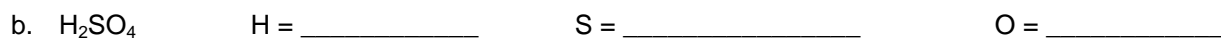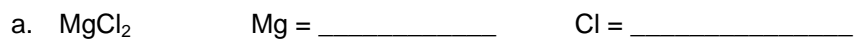
19. The electrode at which reduction occurs is the:

A. neutrode.   C. diode.

B. cathode.   D. anode.

20. Consider the following half-reactions; electrode potentials are given:

$$Zn \rightleftharpoons Zn^{2+} + 2e^-   E° = -0.76 \text{ V}$$
$$Cu \rightleftharpoons Cu^{2+} + 2e^-   E° = +0.34 \text{ V}$$
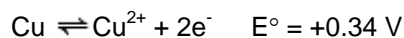
If an electrochemical cell were constructed using $Zn|Zn^{2+}$ and $Cu|Cu^{2+}$, what would be the voltage of the cell?

A. +0.42V   C. +1.10 V

B. -0.42 V   D. +0.55 V

II. Short Answer   *40 marks*

1. Determine the oxidation number of each element in the following: *4 marks*

   a. $MgCl_2$ Mg = _____   Cl = _____

   b. H_2SO_4 H = _____   S = _____   O = _____

   c. PO_4^{3-} P = _____   O = _____

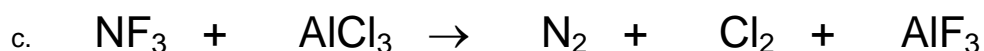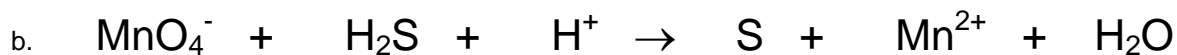   d. NH_4^+ N = _____   H = _____

2. a. Show, by the change in oxidation numbers, that the following equation represents a redox reaction.
   b. Identify the elements that undergo oxidation and reduction.
   c. Also identify the oxidizing agent and the reducing agent.   *3 marks*

$$I_2 + SO_3^{2-} + 2\,OH^- \rightarrow H_2O + SO_4^{2-} + 2I^-$$
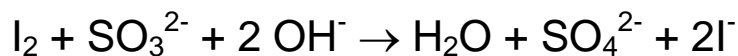
   Element oxidized: _____   Element reduced: _____

   Oxidizing agent: _____   Reducing agent: _____

3. Balance the following redox reactions, using either the oxidation number method or the half-reaction method.

   *6 marks*

   a. HBr + H_2SO_4 → SO_2 + Br_2 + H_2O

   b. MnO_4^- + H_2S + H^+ → S + Mn^{2+} + H_2O

   c. NF_3 + $AlCl_3$ → N_2 + Cl_2 + AlF_3

4. Will a reaction occur if a copper(II) sulfate solution is stored in an aluminum container? Explain and support your answer (a "yes" or "no" alone is not worth any marks) and provide a balanced equation.   *3 marks*

5. Write the two balanced half-reaction equations for the following reaction, and identify each half-reaction as oxidation or reduction.   *4 marks*

    $Ca_{(s)} + F_{2(g)} \rightarrow CaF_{2(s)}$
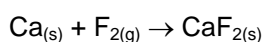
6. Use a table of standard reduction potentials to determine the voltage of the following electrode pairs.

    4 marks

    a. $Co|Co^{2+}$ and $Mg|Mg^{2+}$

    b. $Cl^-|Cl_2$ and $Ni|Ni^{2+}$
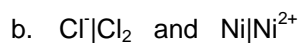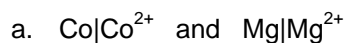
7. Use a table of standard reduction potentials or activity series to determine whether or not the following reactions will occur spontaneously. If it does, write a balanced equation for the reaction. Write N.R. if a reaction does not occur.   *4 marks*

    a $Cr^{3+} + K_{(s)} \rightarrow$

   b. $Mn^{2+} + Zn_{(s)} \rightarrow$
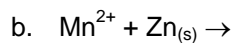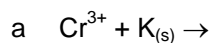
8. Refer to a table of standard reduction potentials to complete the following diagram and questions concerning the **electrochemical cell** created using copper and silver half-cells: 8 *marks*

1.0M Cu(NO$_3$)$_2$ 1.0M AgNO$_3$
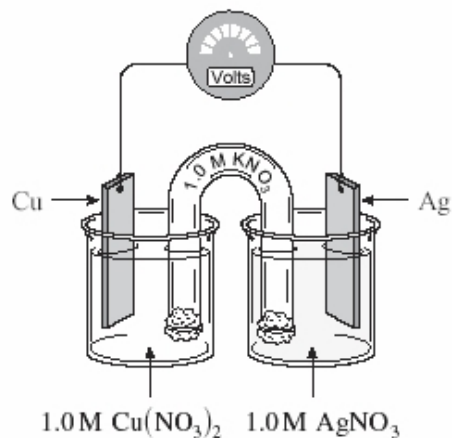
a. Write the equation for the oxidation half-reaction: (1 mark)

b. Write the equation for the reduction half-reaction: (1 mark)

c. What is the voltage produced by this cell: (2 marks)

d. Label the following items on the diagram: (4 marks)
   - anode
   - cathode
   - positive post
   - negative post
   - direction of flow of electrons
   - direction of flow of cations and anions from the salt bridge (show on the diagram or describe below)

9. In the **electrolytic cell** shown here, an iron nail is being plated with copper.   *4 marks*

CuSO$_4$ (aq)
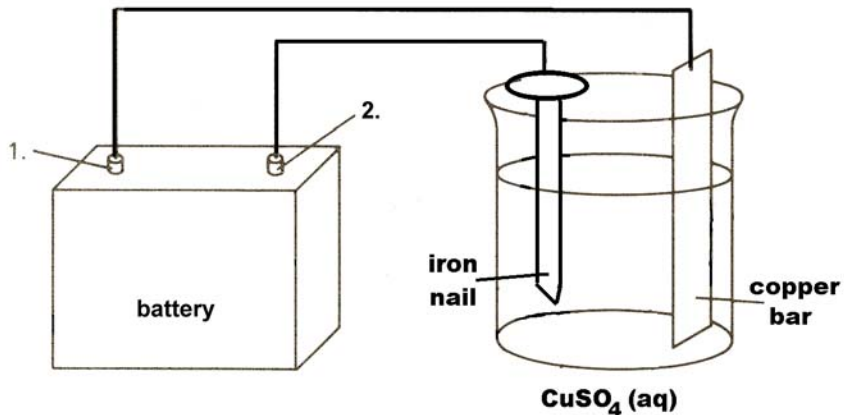
a. Which object, the iron nail or the copper bar, should be connected to the **negative** post of the battery?

b. Write the equation for the half-reaction that occurs at the **cathode** of the **electrolytic cell**.

c. Write the equation for the half-reaction that occurs at the **anode** of the **electrolytic cell**.

d. Show on the diagram the flow of electrons both entering and leaving the battery.