Chemistry 30

# Redox Reactions & Electrochemistry 60

## I. Multiple Choice 20

| | | | |
|---|---|---|---|
| 1. B | 6. A | 11. C | 16. D |
| 2. C | 7. C | 12. C | 17. D |
| 3. D | 8. D | 13. C | 18. D |
| 4. B | 9. B | 14. A | 19. B |
| 5. B | 10. C | 15. C | 20. C |

## II. Short Answer 35

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

a. $MgCl_2$ Mg = ____+2____ Cl = _____-1_____

b. $H_2SO_4$ H = ____+1_____ S = _____+6_____ O = ____-2_____

c. $PO_4^{3-}$ P = ____+5_____ O = _____-2_____

d. $NH_4^+$ N = ____-3_____ H = _____+1_____

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: _____S_____ Element reduced: _____I_____

Oxidizing agent: _____$I_2$_____ Reducing agent: ____$SO_3^{2-}$_____

3. Balance the following redox reactions, using either the oxidation number method or the half-reaction method. *6 marks*

a. **2** HBr + **1** $H_2SO_4$ → **1** $SO_2$ + **1** $Br_2$ + **2** $H_2O$

b. **2** $MnO_4^-$ + **5** $H_2S$ + **6** $H^+$ → **5** S + **2** $Mn^{2+}$ + **8** $H_2O$

c. **2** $NF_3$ + **2** $AlCl_3$ → **1** $N_2$ + **3** $Cl_2$ + **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*

**$2\ Al + 3\ Cu^{2+} \rightarrow 2\ Al^{3+} + 3\ Cu$**

There are different ways to solve this question. One method is to calculate $E^o$. This is found to be +2.00 (students should show work to support this). Because $E^o$ is positive, the reaction will be spontaneous. An activity series may be used instead.

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

$Ca_{(s)} + F_{2(g)} \rightarrow CaF_{2(s)}$

oxidation: $Ca \rightarrow Ca^{2+} + 2e^-$

reduction: $F_2 + 2e^- \rightarrow 2\ F^-$

6. Use a table of standard reduction potentials to determine the voltage of the following electrode pairs. *4 marks*

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

| | |
|---|---|
| $Co^{2+} + 2\ e^- \rightarrow Co$ | $E^o = -0.28$ |
| $Mg \rightarrow Mg^{2+} + 2\ e^-$ | $\underline{E^o = +2.37}$ |
| net voltage: | $E^o = +2.09$ |

b. $Cl^-|Cl_2$ and $Ni|Ni^{2+}$

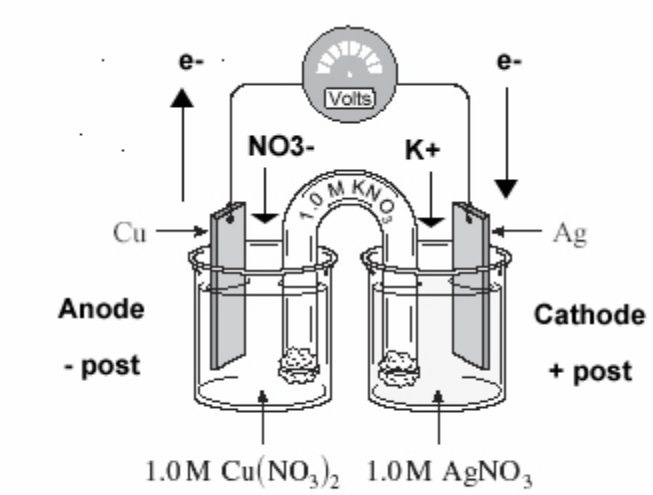
| | |
|---|---|
| $Cl_2 + 2\ e^- \rightarrow 2\ Cl^-$ | $E^o = +1.36$ |
| $Ni \rightarrow Ni^{2+} + 2\ e^-$ | $\underline{E^o = +0.26}$ |
| net voltage: | $E^o = 1.62$ |

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

   b. $Mn^{2+} + Zn_{(s)} \rightarrow NR$ $E^{o} = -0.43$. Not a spontaneous reaction

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*




   a. Write the equation for the oxidation half-reaction: (1 mark)

      $Cu \rightarrow Cu^{2+} + 2\ e^{-}$

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

      $Ag^{+} + e^{-} \rightarrow Ag$

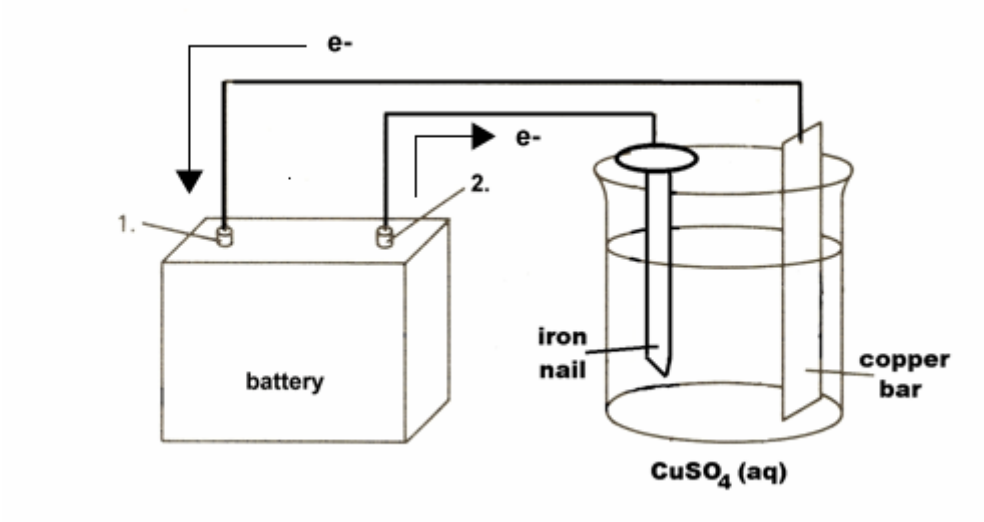
   c. What is the voltage produced by this cell: (2 marks)

      0.46 V

   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*




a. Which object, the iron nail or the copper bar, should be connected to the **negative** post of the battery?

the iron nail

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

$Cu^{2+} + 2\ e^- \rightarrow Cu$

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

$Cu \rightarrow Cu^{2+} + 2\ e^-$

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

see diagram above