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Chemistry 12

Electrochemistry Sections 7,8 and 9 - Worksheet #3

Directions: Answer in the space provided. Make sure you fully answer the questions.

1. An impure sample of iron was dissolved in acid. The Fe^{2+} in this solution was titrated with 0.0210 M $KMnO_4$. Use the following data table and redox equation to determine the moles of Fe^{2+} in the sample. **(3 marks)**

$$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

TRIAL	VOLUME $KMnO_4$
1	37.26 mL
2	35.18 mL
3	35.22 mL

2. In a titration, a 10.00 mL sample of an antiseptic solution containing hydrogen peroxide required 17.6 mL of a 0.0200 M solution of KMnO 4 to reach the endpoint. The equation for the reaction is

$$5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 5O_2 + 2Mn^{2+} + 8H_2O$$

a) Identify the reducing agent. (1 mark)

b) Calculate the concentration of H_2O_2 in the antiseptic solution. (3 marks)

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3.

Consider the following:

$$MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

A 20.00 mL sample of a solution containing $\left[Fe^{2+}\right]$ was titrated using 0.0184 M $KMnO_4$ and the following data were collected.

	TRIAL 1	TRIAL 2	TRIAL 3
Volume of $KMnO_{4(aq)}$ used	29.07 mL	26.55 mL	26.45 mL

Calculate the concentration of Fe^{2+} in the solution. **(3 marks)**

4. A 35.00 ml of nitrous acid $(HNO_2)_{(aq)}$, is reacted with an excess of KI solution according to the equation

$$2\ HNO_2 + 2\ I^- + 2\ H^+ \longrightarrow 2\ NO + I_2 + 2\ H_2O$$

If the I2 produced requires 19.6 ml of 0.225 M Na2S2O3 solution to reach a stoichiometry point according to the equation

$$2\ S_2O_3^{-2} + I_2 \longrightarrow S_4O_6^{-2} + 2\ I^-$$

What is the concentration of the nitrous acid solution?

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5. A cell is made up as follows. A piece of Ni foil is immersed in a beaker of $NiCl_2$ solution, and a strip of Cu foil is immersed in a beaker of $CuSO_4$ solution. The metal electrodes are connected by a wire and the beakers connected by a salt bridge. The net ionic equation for the reaction is:

$$Ni_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Ni^{2+}_{(aq)} + Cu_{(s)}$$

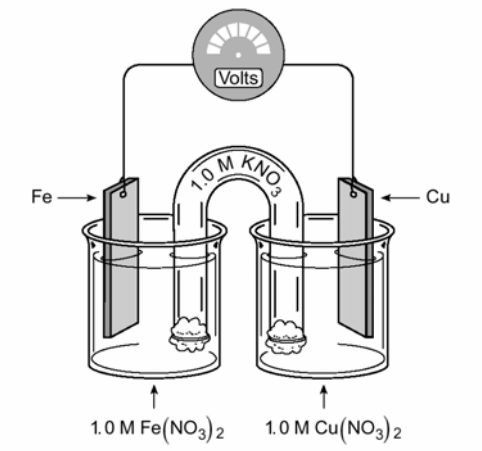
(a) Which electrode is the anode? _____

(b) Toward which electrode do the SO_4^{2-} ions migrate? _____

(c) Which way do the electrons flow in the wire? _____

(d) Toward which electrode do the Ni^{2+} ions migrate after being formed? _____

6. Consider the following electrochemical cell:



a) Clearly indicate on the diagram above, the direction of electron flow through the wire. **(1mark)**

b) Write the equation for the half-reaction taking place at the Fe electrode. **(1mark)**

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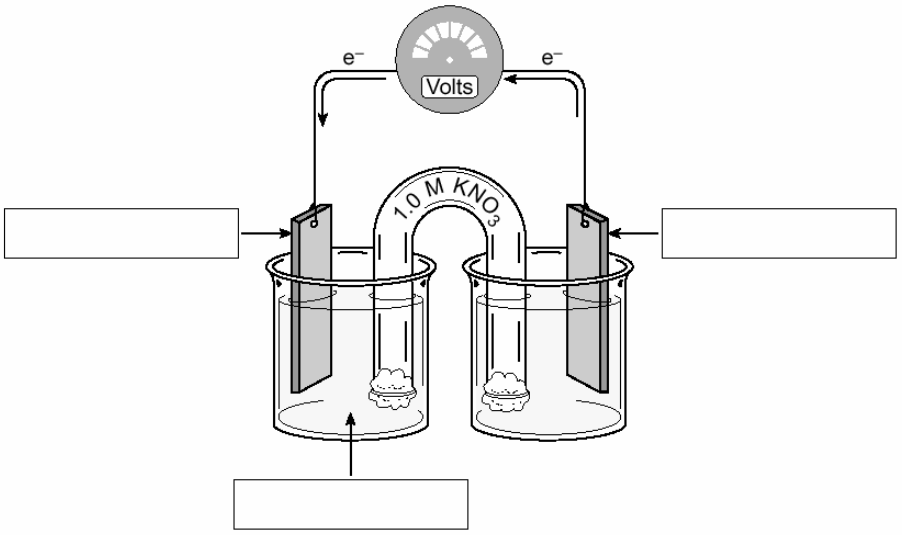
7.

1. Consider the following materials and cell diagram:
   - silver, aluminum and nickel electrodes
   - 1.0 M solutions of $AgNO_3$, $Al(NO_3)_3$ and $Ni(NO_3)_2$

a) From the above list, select the materials that are capable of producing the greatest voltage, then label the diagram below. **(3 marks)**



b) Which two metals from the above list would produce an electrochemical cell with the smallest initial voltage? **(1 mark)**

8. Assume two half-cells consisting of $Ni_{(s)}$ in a $Ni(NO_3)_2$ solution and $Mn_{(s)}$ in a $MnCl_2$ solution are connected to make an electrochemical cell. During the reaction, more $Ni_{(s)}$ is formed. Draw and label the parts of the cell, write the equation for the individual half-reactions and overall reaction, and indicate the directions in which electrons and ions flow.

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9. Calculate E^{o}_{CELL} for each reaction and state whether the reaction is expected to be spontaneous.

(a) $Cr + 3\,Ag^{+} \longrightarrow Cr^{3+} + 3\,Ag$

(b) $Cu^{+} + Fe^{3+} \longrightarrow Cu^{2+} + Fe^{2+}$

(c) $Mn^{2+} + 2\,H_2O + I_2 \longrightarrow MnO_2 + 4\,H^{+} + 2\,I^{-}$

(d) $3\,Cu + 2\,NO_3^{-} + 8\,H^{+} \longrightarrow 3\,Cu^{2+} + 4\,H_2O + 2\,NO$

(e) $2\,Cr^{3+} + 7\,H_2O + 3\,Pb^{2+} \longrightarrow Cr_2O_7^{2-} + 14H^{+} + 3\,Pb$

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10. You have four metals A, B, C, and D in 1.00 M solutions of A^{2+}, B^{2+}, C^{2+} and D^{2+} respectively. The following results were found when some of the half-cells are connected together.

Cathode	Anode	Cell Voltage
C	A	0.75 V
D	A	0.49 V
D	B	0.61 V

Arrange the metal ions in order of DECREASING strength as oxidizing agents.

11. The voltage of the cell $Pb^{2+} + Zn_{(s)} \longrightarrow Pb_{(s)} + Zn^{2+}$ changes depending on the conditions used. Arrange the following three sets of conditions in order of the voltages that they produce, from highest to lowest. Each pair of half-cells is connected to form an electrochemical cell using a salt bridge.

(a) A thin Zinc wire is immersed in 0.5 M Zn^{2+} and a thick Lead strip is immersed in 1 M Pb^{2+}.

(b) A thick Zinc strip is immersed in 1 M Zn^{2+} and a thin Lead wire is immersed in 0.5 M Pb^{2+}.

(c) A thick Zinc strip is immersed in 1 M Zn^{2+} and a thick Lead wire is immersed in 1 M Pb^{2+}.

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12. Given the half-cell $Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$, which of the following cases has the highest reduction potential?

CASE 1: $[Sn^{4+}] = 1$ M and $[Sn^{2+}] = 2$ M
CASE 2: $[Sn^{4+}] = 1$ M and $[Sn^{2+}] = 1$ M
CASE 3: $[Sn^{4+}] = 2$ M and $[Sn^{2+}] = 1$ M