Redox 9.1 homework 3

1. Complete and balance the following half-reactions. In each case indicate whether the half-reaction is an oxidation or a reduction.

(a) $Sn^{2+}(aq) \longrightarrow Sn^{4+}(aq)$ (acidic solution)

(b) $TiO_2(s) \longrightarrow Ti^{2+}(aq)$ (acidic solution)

(c) $ClO_3^-(aq) \longrightarrow Cl^-(aq)$ (acidic solution)

(d) $N_2(g) \longrightarrow NH_4^+(aq)$ (acidic solution)

2. Complete and balance the following equations, and identify the oxidizing and reducing agents:

(a) $Cr_2O_7^{2-}(aq) + I^-(aq) \longrightarrow Cr^{3+}(aq) + IO_3^-(aq)$ (acidic solution)

(b) $MnO_4^-(aq) + CH_3OH(aq) \longrightarrow Mn^{2+}(aq) + HCO_2H(aq)$ (acidic solution)

(c) $I_2(s) + OCl^-(aq) \longrightarrow IO_3^-(aq) + Cl^-(aq)$ (acidic solution)

(d) $As_2O_3(s) + NO_3^-(aq) \longrightarrow H_3AsO_4(aq) + N_2O_3(aq)$ (acidic solution)

3. A disproportionation reaction is an oxidation-reduction reaction in which the same substance is oxidized and reduced. Complete and balance the following disproportionation reactions:

(a) $Ni^+(aq) \longrightarrow Ni^{2+}(aq) + Ni(s)$ (acidic solution)

(b) $MnO_4^{2-}(aq) \longrightarrow MnO_4^-(aq) + MnO_2(s)$ (acidic solution)

(c) $H_2SO_3(aq) \longrightarrow S(s) + HSO_4^-(aq)$ (acidic solution)

4. Use these equations, which refer to aqueous solutions, to answer the questions that follow:

$$Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$$
$$Cu(s) + 2Au^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Au(s)$$
$$Mg(s) + Fe^{2+}(aq) \rightarrow Mg^{2+}(aq) + Fe(s)$$

i. List the metals above in order of **decreasing** reactivity. (1)
ii. Define oxidation, in electronic terms, using **one** example from above. (2)
iii. Define reduction, in terms of oxidation number, using **one** example from above. (2)
iv. State and explain which is the **strongest reducing agent** in the examples above. (2)
v. State and explain which is the **strongest oxidizing agent** in the examples above. (2)
vi. Deduce whether a gold coin will react with aqueous magnesium nitrate. (2)

5. Arsenic and nitrogen can play significant roles in environmental chemistry. Nitrogen-containing fertilizers can contaminate water, while arsenous acid, H3AsO3, can be found in anaerobic (oxygen-poor) water.
i. Define oxidation and reduction in terms of electron loss or gain. (1)
ii. Deduce the oxidation states of arsenic and nitrogen in each of the following species. (4)

As_2O_3 NO_3^- H_3AsO_3 N_2O_3

iii. Distinguish between the terms **oxidising agent** and **reducing agent**. (1)
iv. In the removal of arsenic from contaminated groundwater, H_3AsO_3 is often first oxidized to arsenic acid, H_3AsO_4. The following **unbalanced** redox reaction shows another method of forming H_3AsO_4.

$$As_2O_3(s) + NO_3^-(aq) \rightarrow H_3AsO_4(aq) + N_2O_3(aq)$$

Deduce the balanced redox equation, and identify both the oxidizing and reducing agents in the reaction. (3)

6. For the following cell: indicate which is the negative electrode. Give the direction of electron flow in the external circuit and write an overall equation for the reaction that occurs.

a $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

b $Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$

$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$

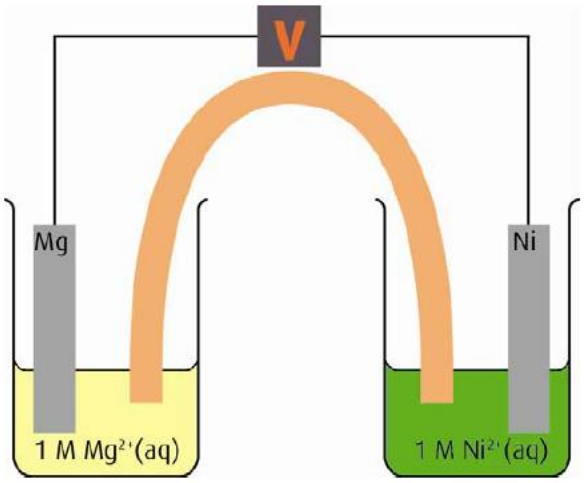
c $Ag^+(aq) + e^- \rightarrow Ag(s)$

$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$

d $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightarrow 2Cr^{3+}(aq) + 7H_2O(l)$

$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$

7. The diagram shows a voltaic cell:



a On the diagram label the following:

anode **cathode** **positive electrode** **negative electrode**

b Explain the function of the salt bridge.

c Indicate on the diagram the direction of electron flow in the external circuit.

d Indicate on the diagram the direction of flow of positive ions in the salt bridge.

e Explain whether the voltage will increase or decrease when the nickel half cell is replaced by a $Cu/CuSO_4$ half cell.