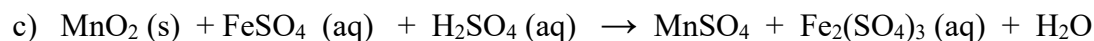
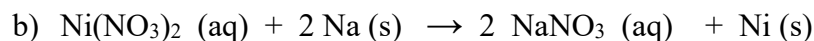
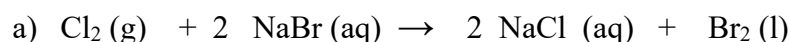


Topics:

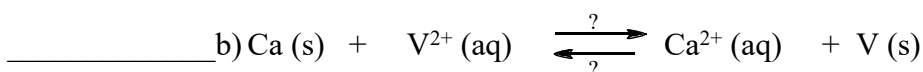
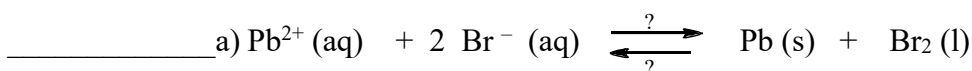
- Concept of oxidation and reduction (putting in oxidation numbers (charges) on all elements in a reaction.)
- Writing half reactions with # of electrons balanced. Writing full balanced redox equations
- Determining what element is most easily oxidized based on whether a reaction occurs or not.
- Determining E°_{net} values using reference charts and half reactions. (positive E°_{net} is spontaneous)
- Fully labeling a diagram of an electrochemical cell (voltaic and electrolytic)-- anode, cathode, flow of electrons, flow of ions in salt bridge.
- Purpose of salt bridge, mass changes of electrodes, necessity of using a battery (if non-spontaneous).
- Understanding how one can increase the voltage by connecting multiple cells together.
- Batteries-- familiar with basic types-- being able to answer questions given the half reactions

Practice Problems:

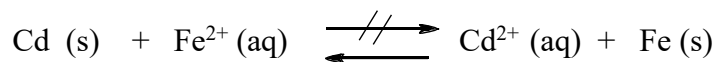
1) For the following reactions put in all charges and use tie lines to indicate the oxidation and reduction.



2) Determine if these reactions are spontaneous in the **forward** direction or in the **reverse** direction. (You do NOT need to calculate E°_{net} , but use reference chart to explain.)



3) This reaction is non-spontaneous in the forward direction. (Thus, it is spontaneous in the reverse direction) Which metal is more easily oxidized? **Cd or Fe** (Do not use reference chart to answer.)



4) Sometimes a Mg rod is placed inside a hot water heater which is made of mostly iron. What is the purpose of the Mg rod? Explain how it works. (Hint -- which is more easily oxidized-- Mg or Fe?)

5) Given enough time, what will happen if tomato sauce (acidic-- contains H^+) is covered with aluminum foil? To answer, complete these half reactions: (HINT: use reference chart to determine this Rxn.)

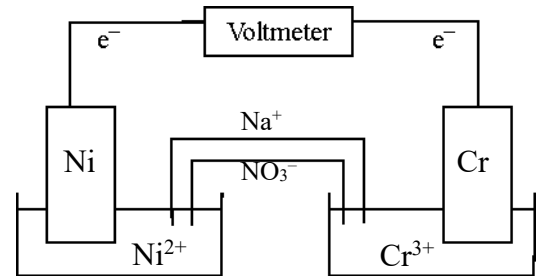


- 6) Given this reaction, $F_2(g) + Cu(s) \rightarrow CuF_2(s)$
Write the two half reactions (balanced), determine the E°_{net} , and determine if the reaction is spontaneous.

Ox: $E^\circ_{ox} =$
 Red: _____ $E^\circ_{red} =$
 $E^\circ_{net} =$

- 7) Look at the diagram of the voltaic cell (spontaneous reaction). Determine which metal is more easily oxidized, write balanced half reactions, determine the overall reaction (balanced), determine the E°_{net} . Label the **anode and cathode**, show the **flow of electrons** and **flow of ions** in the salt bridge.

Ox: $E^\circ_{ox} =$
 Red: _____ $E^\circ_{red} =$
 Overall: $E^\circ_{net} =$



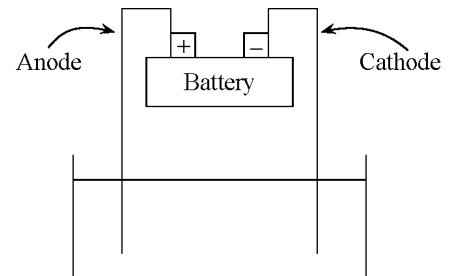
- a) Which electrode will gain mass? _____ Why?
 b) Which electrode will lose mass? _____ Why?

- 8) The electrolysis of $NiI_2(aq)$

- a) Two graphite electrodes are attached to a power source (9V) and are placed into $NiI_2(aq)$.
 What species are in the sol'n?

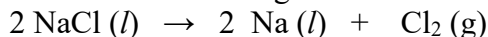
Possible oxidation half reactions	E°_{ox}	Possible reduction half reactions	E°_{red}
$2 H_2O \rightarrow O_2 + 4 H^+ + 4 e^-$	-1.23	$2 H_2O + 2 e^- \rightarrow 2 OH^- + H_2$	-0.83
$2 I^- \rightarrow I_2 + 2 e^-$	-0.54	$Ni^{2+} + 2 e^- \rightarrow Ni$	-0.25

- b) After writing the half reactions below, go back and label the diagram with the substances observed at the anode and cathode.
 c) In the diagram, label what would be observed at the anode and cathode (*remember, I_2 reacts w/ I^- to form brown I_3^-*). Label the direction of flow of electrons.
 d) Determine the overall reaction below and calculate E°_{net} .



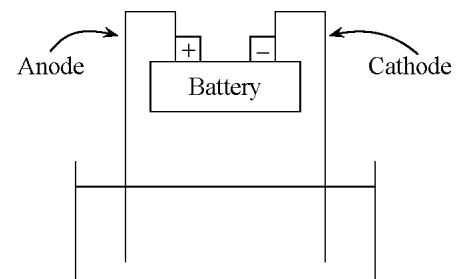
Ox: $E^\circ_{ox} =$
 Red: _____ $E^\circ_{red} =$
 Overall: $E^\circ_{net} =$

- 9) Liquid sodium metal (Na) and Cl_2 gas can be produced by electrolysis (a battery is used). To do this, one sends an electrical current through molten NaCl. The overall reaction is as follows:



- a) Write the two half reactions, and determine the E_{net} .

Ox: $E^\circ_{ox} =$
 Red: _____ $E^\circ_{red} =$
 $E^\circ_{net} =$



- b) In diagram, label where the **liquid** and the **gas** are produced. Show the flow of electrons.
 c) What does the sign of E°_{net} tell you about the reaction?

10) For the following situations below, complete the chemical equations assuming each reaction takes place. Then, determine if the reaction is spontaneous. Based on this decision, predict what would be observed in each case. (HINT: Both reactions are just simple single replacement reactions.)

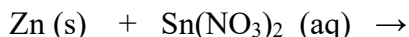
a) A strip of silver metal (Ag) is placed into an aqueous solution of MgSO_4 .



Spontaneous reaction? _____ Explanation? _____

Observations: _____

b) A Zn of magnesium metal is placed into an aqueous solution of $\text{Sn}(\text{NO}_3)_2$.



Spontaneous reaction? _____ Explanation? _____

Observations: _____

c) Neither one of these situations as described above produces electricity. Why not?

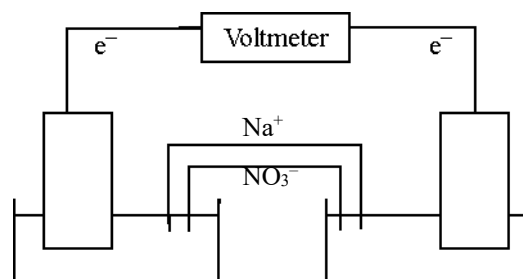
11) Three fictional elements G, L, & Q are to be ranked in order of *decreasing* reduction potential (i.e. hardest to easiest to oxidize). The following reactions are attempted and observations made:

<u>Reaction</u>	<u>Observation</u>	<u>Easier to Oxidize</u>	<u>Harder to Oxidize</u>
i. $\text{G} + \text{L}^{2+} \rightarrow \text{G}^+ + \text{L}$	No Reaction	_____	_____
ii. $\text{G} + \text{Q}^{3+} \rightarrow \text{G}^+ + \text{Q}$	Reaction Occurs	_____	_____
iii. $\text{L}^{2+} + \text{Q} \rightarrow \text{L} + \text{Q}^{3+}$	No Reaction	_____	_____

a) Rank the elements from *hardest to easiest* to oxidize (most to least positive reduction potential for its ion) and explain your ranking.

b) Suppose you wanted to make a voltaic cell using two of the systems. Which element and ion would you use to obtain the maximum E°_{net} ? Explain. Write the overall reaction that would occur.

c) Label the voltaic cell at right with the elements & ions of your selected systems (assume the elements are metals), label the anode & cathode, and show the flow of electrons in the wire and ions in the salt bridge.



d) Explain the role of the salt bridge.

e) Explain the direction of movement of the ions in the salt bridge.

12) A 12 V battery consists of several 1.5V cells connected in series. How many 1.5 V cells must be in a 12 V battery? _____

13) What is a primary battery? What is a secondary battery?

14) How is a fuel cell similar to a battery (storage cell)? How is it different?

15) Elements towards the bottom of the chart (i.e., Mg, Na, Ca, Ba, Cs and K) do not exist naturally as the pure metals. Instead these elements are only naturally found in compounds.

a) Explain why these elements are only found in compounds (i.e. oxidized).

b) By what process must these metals be obtained from their compounds? _____

16) Determine the overall reaction which takes place when tarnished silver (*Tarnish is Ag₂S*) is placed in an aluminum pan containing an aqueous solution of NaCl and baking soda. (*Note: The aqueous NaCl solution does not react.*)



(Note: S²⁻ is not oxidized or reduced and is not in the half reactions)

Answers: 5) E°_{net} = +1.66 V; 6) E°_{net} = 2.53 V; 7) E°_{net} = 0.49 V; 8) -0.79 V; 9) E°_{net} = -4.07 V