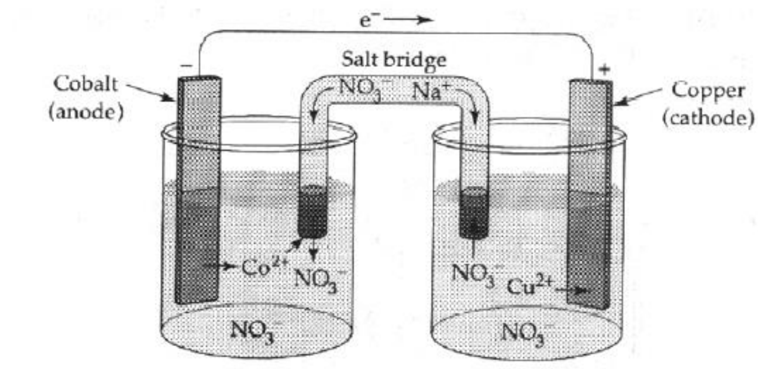
South Pasadena • AP Chemistry Name ______________________________ Period___

21 • Electron Transfer Reactions

STATION 1 – CELL NOTATION

anode reaction	$Co(s) \rightarrow Co^{2+}(aq) + 2\,e^-$
cathode reaction	$Cu^{2+}(aq) + 2\,e^- \rightarrow Cu(s)$
overall reaction	$Co(s) + Cu^{2+}(aq) \rightarrow Co^{2+}(aq) + Cu(s)$



The "cell notation" for this electrochemical cell is $Co(s)\,|\,Co^{2+}\,||\,Cu^{2+}\,|\,Cu(s)$

Use the above information to answer the following questions:

1. The left portion of the cell notation represents the _________ (anode / cathode).
2. The "||" represents the _______________ (anode / cathode / salt bridge)
3. Write the cell notation for $Cl_2(g) + Zn(s) \rightarrow 2\,Cl^- + Zn^{2+}$ _____ | _____ || _____ | _____
4. Write the cell notation for $2Ag(s) + Pt^{2+} \rightarrow Pt(s) + 2Ag^+$ _____ | _____ || _____ | _____

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STATION 2 – E° VALUES

Standard Reduction Potentials (volts)

$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	+0.535
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.337
$Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$	+0.15
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	-0.14
$Cd^{2+}(aq) + 2e^- \rightarrow Cd(s)$	-0.40
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	-0.763
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	-0.828
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66

1. A cell is made from Sn in 1.0 M $Sn(NO_3)_2$ and Al in 1.0 M $Al(NO_3)_3$. The E° of the cell is ______ volts.

2. A cell is made from Sn in 1.0 M $Sn(NO_3)_2$ and Cd in 1.0 M $Cd(NO_3)_2$. The E° of the cell is ______ volts.

3. A cell is made from Ag in 1.0 M $AgNO_3$ and Cu in 1.0 M $Cu(NO_3)_2$. The E° of the cell is ______ volts.

4. A cell is made from Zn in 1.0 M $Zn(NO_3)_2$ and Ag in 1.0 M $AgNO_3$. The E° of the cell is ______ volts.

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STATION 3 – NERNST EQUATION

Standard Reduction Potentials (volts)

$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	-0.14
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	-1.66

$$E_{cell} = E° - \frac{RT}{nF} \ln Q$$

look at your equation sheet for R and F.
"n" is the moles of electrons gained or lost in a redox reaction.

1. $Fe(s) + Cu^{2+}(aq) \rightarrow Fe^{2+}(aq) + Cu(s)$ E° = +0.78 V
   a) What is n? ______ moles
   b) If $[Cu^{2+}]$ = 0.10 M and $[Fe^{2+}]$ = 1.5 M,
      $Q = \frac{[\quad]}{[\quad]} =$
   c) Calculate the E_{cell}.

2. A cell is made from Sn in .25 M $Sn(NO_3)_2$ and Al in 0.25 M $Al(NO_3)_3$ at 25°C.
   a) The E° of the cell is ______ volts.
   b) The reaction at the anode is: ________________________
   c) The reaction at the cathode is: ________________________
   d) The overall reaction is: ______________________________________
   e) The value of n is ______ moles.
   f) $Q = \frac{[\quad]}{[\quad]} =$
   g) Calculate the E_{cell}.

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STATION 4 – BALANCING REDOX EQ'S (ACIDIC)

Balance the following equations in acidic solution:

$$Cr_2O_7^{-2}(aq) + C_2O_4^{-2}(aq) \rightarrow Cr^{+3}(aq) + CO_2(g)$$

$$MnO_4^{-}(aq) + SO_2(g) \rightarrow SO_4^{-2}(aq) + Mn^{+2}(aq)$$

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STATION 5 – BALANCING REDOX EQ'S (BASIC)

Balance the following equations in basic solution:

$$Mn^{+2}(aq) + ClO_3^-(aq) \rightarrow MnO_2(s) + ClO_2(g)$$

$$Cl_2(g) \rightarrow Cl^-(aq) + ClO_3^-(aq)$$

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STATION 6 – ELECTROLYSIS

How long will it take to electroplate each of the following with a current of 100.0 A?

1.0 g of Al(s) from aqueous Al^{+3}.

1.0 g of Ni(s) from aqueous Ni^{+2}.

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STATION 7 – REACTIVITY

Consider the following half-reactions and E° values:

$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$ E° = 0.80 V

$Cu^{+2}(aq) + 2e^{-} \rightarrow Cu(s)$ E° = 0.34 V

$Pb^{+2}(aq) + 2e^{-} \rightarrow Pb(s)$ E° = -0.13 V

1. Which of these metals or ions is the strongest **oxidizing agent**? ____
2. Which is the strongest **reducing agent**? _____

Predict whether each of the following reactions will occur as written:

3. $Cu^{2+} + Pb^{\circ} \rightarrow Pb^{2+} + Cu^{\circ}$ ______
4. $Pb^{2+} + 2Ag^{\circ} \rightarrow 2Ag^{+} + Pb^{\circ}$ ______
5. $2Ag^{+} + Pb^{2+} \rightarrow 2Ag^{\circ} + Pb^{\circ}$ ______

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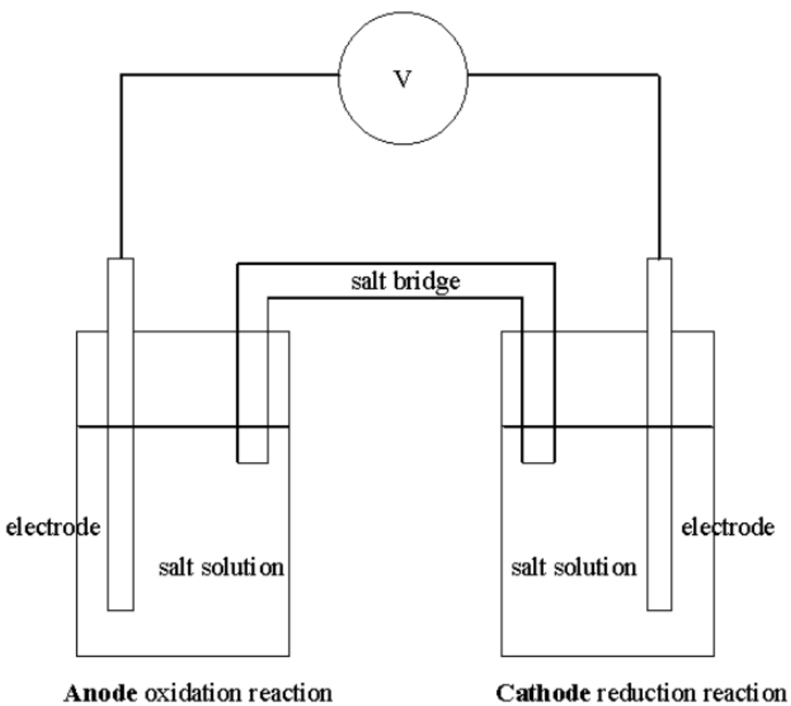
STATION 8 – SKETCH A CELL



Consider these half-reactions & E° values:

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$Cu^{+2}(aq) + 2e^{-} \rightarrow Cu(s)$ E° = 0.34 V

$Pb^{+2}(aq) + 2e^{-} \rightarrow Pb(s)$ E° = -0.13 V

Which two metals and 1.0 M solutions would give the greatest voltage? ___ ___

Label:

- the anode reaction
- the cathode reaction
- the overall reaction
- the metals used for each electrode
- the ions in solution
- the expected voltage
- the direction of flow of electrons
- the flow of ions in the salt bridge
- the charge on each electrode (+ or –)
- ions you might use in the salt bridge
- the observed changes in the electrodes