Part A: Definitions

1) Fill in the blank with words from the word bank.

Wordbank:	
Voltaic *Electrochemical Cell* *Electrical Current*	*Cathode* *Anode*

_____ is the flow of electric charge. The generation of electricity through redox reactions is normally carried out in a device called_____.

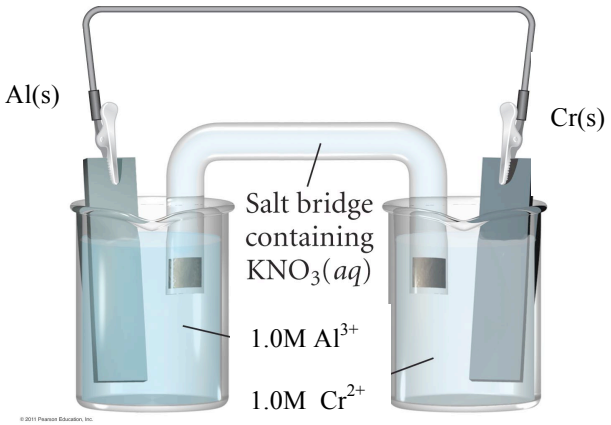
A_____cell is an electrochemical cell that produced electrical current from a *spontaneous* chemical reaction. In all electrochemical cells, we call the electrode where oxidation occurs the _____ and the electrode where reduction occurs the _____.

Part B: Voltaic Cells and Standard Electrode Potentials

2. A voltaic cell is set up with a Cr electrode in 1.0M $Cr(NO_3)_2$ (aq) solution and an Al electrode in a 1.0 M $Al(NO_3)_3$ (aq) solution (T =25°C) as shown below. When set up, the cell produces electrical current.

$Cr^{2+}(aq) + 2\ e^- \rightarrow Cr(s)$ $E°$ = -0.91 V

$Al^{3+}(aq) + 3\ e^- \rightarrow Al(s)$ $E°$ = -1.66 V



a) Write a reaction for the spontaneous redox reaction described above.

b) Label the cathode and the anode on the voltaic cell above.

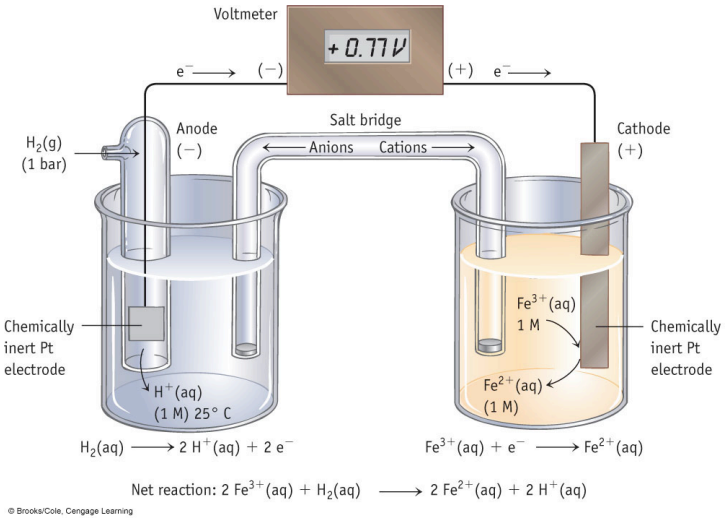
c) Which direction do electrons flow? Which electrode gains mass?

d) What is the purpose of the salt bridge? Label the direction the K^+ and NO_3^- ions will flow.

e) In the problem above, determine the E^o_{cell}.

Part C: Standard Hydrogen Electrode

3. Consider the voltaic cell to the right (T = 298K).



a) What is the standard hydrogen electrode (SHE)? What is its purpose for calculating standard reduction potentials?

b) Notice in this case the SHE is acting as the anode. Discuss with your PAL team why it acts as the Anode and not the Cathode.

c) Consider the electrochemical cell notation for the cell above and identify the parts. Why is Pt used in both cells?

Pt (s) | H_2 (g, 1 bar) | H^+(aq, 1.0M) || Fe^{3+} (aq, 1.0M), Fe^{2+}(aq, 1.0M) | Pt(s)

Part D: Using Tables of Standard Reduction Potentials

4. You are the TA for an Chem 1A lab, and your students attempt to dissolve different metals (solid iron, silver, and gold) in different strong acids (nitric acid and hydrochloric acid).
   a) Your students find that one metal dissolves in HCl. Which one dissolves?

   b) And one of your students is amazed that one metal solid (that did not dissolve in HCl) dissolved in nitric acid. Which metal was it and how do you know?

5. Which metal in the following list is easiest to oxidize? Circle your answer.

   Fe Ag Zn Mg Au

6. Rank the halogens in order of their strength as oxidizing agents.

7. Decide whether hydrogen peroxide in acid solution is a strong oxidizing agent than chlorine.

8. Which of the halogens will oxidize elemental mercury to mercury(II)?

9. Decide which of the halogens is capable of oxidizing gold metal to Au^{3+} (aq). Write a balanced equation.

Standard Reduction Potentials at 298K, 1M, 1atm

HALF-REACTION	E° (V)
$F_{2(g)} + 2\ e^- \rightarrow 2\ F^-_{(aq)}$	+2.87
$O_{3(g)} + 2\ H^+_{(aq)} + 2\ e^- \rightarrow O_{2(g)} + H_2O_{(l)}$	+2.07
$Co^{3+}_{(aq)} + e^- \rightarrow Co^{2+}_{(aq)}$	+1.82
$H_2O_{2(aq)} + 2\ H^+_{(aq)} + 2\ e^- \rightarrow 2\ H_2O_{(l)}$	+1.77
$PbO_{2(s)} + 4\ H^+_{(aq)} + SO_4^{2-}{}_{(aq)} + 2\ e^- \rightarrow PbSO_{4(s)} + 2\ H_2O_{(l)}$	+1.70
$Ce^{4+}_{(aq)} + e^- \rightarrow Ce^{3+}_{(aq)}$	+1.61
$MnO_4^-{}_{(aq)} + 8\ H^+_{(aq)} + 5\ e^- \rightarrow Mn^{2+}_{(aq)} + 4\ H_2O_{(l)}$	+1.51
$Au^{3+}_{(aq)} + 3\ e^- \rightarrow Au_{(s)}$	+1.50
$Cl_{2(g)} + 2\ e^- \rightarrow 2\ Cl^-_{(aq)}$	+1.36
$Cr_2O_7^{2-}{}_{(aq)} + 14\ H^+_{(aq)} + 6\ e^- \rightarrow 2\ Cr^{3+}_{(aq)} + 7\ H_2O_{(l)}$	+1.33
$MnO_{2(s)} + 4\ H^+_{(aq)} + 2\ e^- \rightarrow Mn^{2+}_{(aq)} + 2\ H_2O_{(l)}$	+1.23
$O_{2(g)} + 4\ H^+_{(aq)} + 4\ e^- \rightarrow 2\ H_2O_{(l)}$	+1.23
$Br_{2(l)} + 2\ e^- \rightarrow 2\ Br^-_{(aq)}$	+1.07
$NO_3^-{}_{(aq)} + 4\ H^+_{(aq)} + 3\ e^- \rightarrow NO_{(g)} + 2\ H_2O_{(l)}$	+0.96
$2\ Hg^{2+}_{(aq)} + 2\ e^- \rightarrow Hg_2^{2+}{}_{(aq)}$	+0.92
$Hg_2^{2+} + 2\ e^- \rightarrow 2\ Hg_{(l)}$	+0.85
$Ag^+_{(aq)} + e^- \rightarrow Ag_{(s)}$	+0.80
$Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$	+0.77
$O_{2(g)} + 2\ H^+_{(aq)}\ 2\ e^- \rightarrow H_2O_{2(aq)}$	+0.68
$MnO_4^-{}_{(aq)} + 2\ H_2O_{(l)} + 3\ e^- \rightarrow MnO_{2(s)} + 4\ OH^-_{(aq)}$	+0.59
$I_{2(s)} + 2\ e^- \rightarrow 2\ I^-_{(aq)}$	+0.53
$O_{2(g)} + 2\ H_2O + 4\ e^- \rightarrow 4\ OH^-_{(aq)}$	+0.40
$Cu^{2+}_{(aq)} + 2\ e^- \rightarrow Cu_{(s)}$	+0.34
$AgCl_{(s)} + e^- \rightarrow Ag_{(s)} + Cl^-_{(aq)}$	+0.22
$SO_4^{2-}{}_{(aq)} + 4\ H^+_{(aq)} + 2\ e^- \rightarrow SO_{2(g)} + 2\ H_2O_{(l)}$	+0.20
$Cu^{2+}_{(aq)} + e^- \rightarrow Cu^+_{(aq)}$	+0.15
$Sn^{4+}_{(aq)} + 2\ e^- \rightarrow Sn^{2+}_{(aq)}$	+0.13
$2\ H^+_{(aq)} + 2\ e^- \rightarrow H_{2(g)}$	0.00
$Pb^{2+}_{(aq)} + 2\ e^- \rightarrow Pb_{(s)}$	-0.13
$Sn^{2+}_{(aq)} + 2\ e^- \rightarrow Sn_{(s)}$	-0.14
$Ni^{2+}_{(aq)} + 2\ e^- \rightarrow Ni_{(s)}$	-0.25
$Co^{2+}_{(aq)} + 2\ e^- \rightarrow Co_{(s)}$	-0.28
$PbSO_{4(s)} + 2\ e^- \rightarrow Pb_{(s)} + SO_4^{2-}{}_{(aq)}$	-0.31
$Cd^{2+}_{(aq)} + 2\ e^- \rightarrow Cd_{(s)}$	-0.40
$Fe^{2+}_{(aq)} + 2\ e^- \rightarrow Fe_{(s)}$	-0.44
$Cr^{3+}_{(aq)} + 3\ e^- \rightarrow Cr_{(s)}$	-0.74
$Zn^{2+}_{(aq)} + 2\ e^- \rightarrow Zn_{(s)}$	-0.76
$2\ H_2O_{(l)} + 2\ e^- \rightarrow H_{2(g)} + 2\ OH^-_{(aq)}$	-0.83
$Mn^{2+}_{(aq)} + 2\ e^- \rightarrow Mn_{(s)}$	-1.18
$Al^{3+}_{(aq)} + 3\ e^- \rightarrow Al_{(s)}$	-1.66
$Be^{2+}_{(aq)} + 2\ e^- \rightarrow Be_{(s)}$	-1.85
$Mg^{2+}_{(aq)} + 2\ e^- \rightarrow Mg_{(s)}$	-2.37
$Na^+_{(aq)} + e^- \rightarrow Na_{(s)}$	-2.71
$Ca^{2+}_{(aq)} + 2\ e^- \rightarrow Ca_{(s)}$	-2.87
$Sr^{2+}_{(aq)} + 2\ e^- \rightarrow Sr_{(s)}$	-2.89
$Ba^{2+}_{(aq)} + 2\ e^- \rightarrow Ba_{(s)}$	-2.90
$K^+_{(aq)} + e^- \rightarrow K_{(s)}$	-2.93
$Li^+_{(aq)} + e^- \rightarrow Li_{(s)}$	-3.05