Studying Electrochemical Half-Cells and Half-Reactions

Tuesday, February 27, 2007
2:11 PM

Purpose: None… this is a demo, not an experiment.

Hazards: $Pb(NO_3)_2$ is toxic and $CuSO_4$ is an irritant.

Data:

1. Oxidation-Reduction Reactions

System	Observation
Zn-Cu system	Zinc turned black
Pb-Cu system	No change
Zn-Pb system	Zinc turned black

2. Electrochemical cells

System	Cell voltage
Zn-Cu	1.065
Fe-Cu	.681

$Zn \rightarrow Zn^{2+} + 2e^-$
$Cu^{2+} + 2e^- \rightarrow Cu$
$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

Calculations:

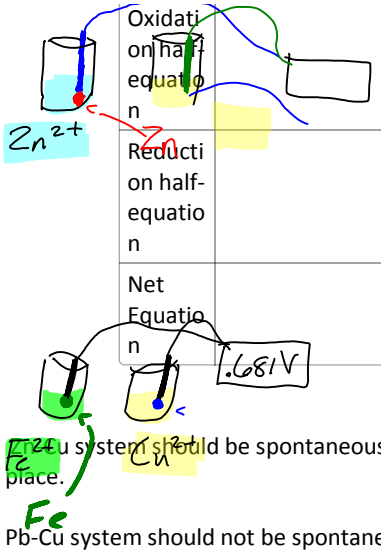
1. Oxidation-Reduction Reactions
   a. Zn-Cu System

Oxidation half-equation	$Pb \rightarrow Pb^{2+} + 2e^-$	E^0_{oxid}=	0.76 V
Reduction half-equation	$Cu^{2+} + 2e^- \rightarrow Cu$	E^0_{red}=	0.34 V
Net Equation	$Pb + Cu^{2+} \rightarrow Pb^{2+} + Cu$	E^0_{net}=	1.1 V

   b. Pb-Cu System

Oxidation half-equation	$Zn \rightarrow Zn^{2+} + 2e^-$	E^0_{oxid}=	0.13 V
Reduction half-equation	$Pb^{2+} + 2e^- \rightarrow Pb$	E^0_{red}=	-0.34 V
Net Equation	$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$	E^0_{net}=	-0.21 V

   c. Zn-Pb System



Oxidation half-equation		E^0_{oxid}=	0.76 V
Reduction half-equation		E^0_{red}=	-0.13
Net Equation		E^0_{net}=	0.63

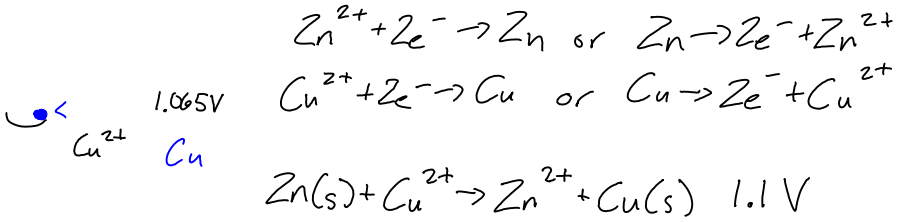
Zn-Cu system should be spontaneous because E^0_{net} >0. We also experimentally observed this reaction spontaneously taking place.

Pb-Cu system should not be spontaneous because E^0_{net} <0. Our observations confirmed this because we saw no reaction.

Zn-Pb system should be spontaneous because E^0_{net} >0. We observed a reaction confirming this prediction.

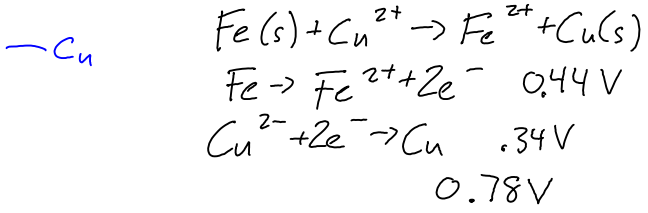
d. Strength of Reducing Agent Lowest to Highest: Cu, Pb, Zn
e. It is consistent because Cu^{2+}=34V, Pb^{2+}=-0.13V, and Zn^{2+}=-0.76V
f. Oxidation would be reverse order with Zn, Pb, Cu
g. This is consistent with table one. The reverse reactions are oxidation and the reduction voltage can be changed from positive to negative.

2. Electrochemical Cells
   a. Zn-Cu Electrochemical Cells



Our observed voltage was 1.065V while the calculated value was 1.1V

   b. Fe-Cu Electrochemical Cells



Our observed voltage was .681V while the calculated voltage was .78V