Redox reactions – galvanic cells
Lesson 4

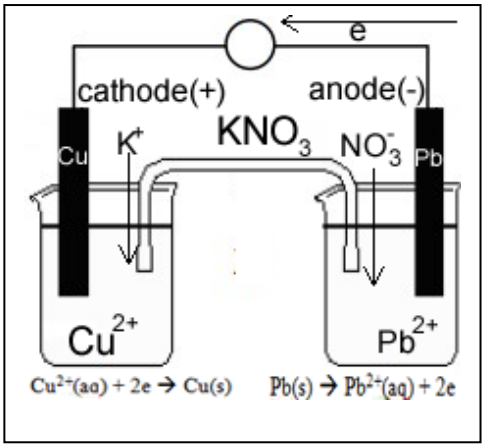
Oxidation = anode(-), reduction = cathode(+), electrons flow from anode to cathode.

Two half cells were set up. One half cell contained the reductant Cu metal and its conjugate oxidant Cu^{2+} ions in solution while the other contained the reductant Pb metal and its conjugate oxidant Pb^{2+} ions in solution.
Will a reaction occur?

Reaction	Standard electrode potential ($E^{\ominus}$) in volts at 25 °C
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	+1.77
$Au^+(aq) + e^- \rightleftharpoons Au(s)$	+1.68
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(1)$	+1.23
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.09
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$O_2(g) + 2H^+(aq) + 2e^- \rightleftharpoons H_2O_2(aq)$	+0.68
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	−0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	−0.14
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	−0.23

What is the voltage of the cell

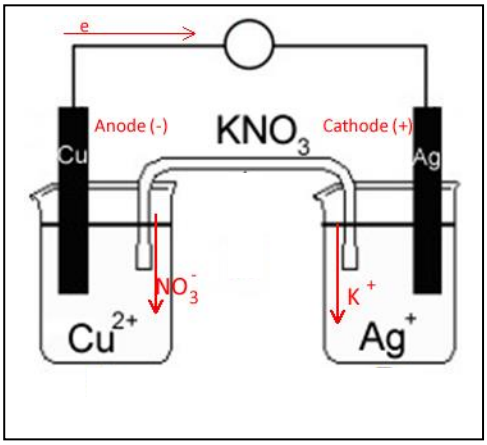
Indicate on the diagram the
Anode and its polarity
Cathode and its polarity
Direction of electron flow
Direction of negative ion flow
Direction of positive ion flow
Write the
Oxidation half equation_____
Reduction half equation_____



Overall equation $Cu^{2+}(aq) + Pb(s) \rightarrow Pb^{2+}(aq) + Cu(s)$

Steps to follow when analysing a galvanic cell

Consider the following galvanic cells
Will a reaction occur? *Yes between Ag^+ ions and Cu metal.*
What is the theoretical cell voltage (EMF) if all half cells are at standard conditions? *0.80 - 0.34 =* 0.46V
Indicate on the diagram the
Anode and its polarity
Cathode and its polarity
Direction of electron flow
Direction of negative ion flow
Direction of positive ion flow

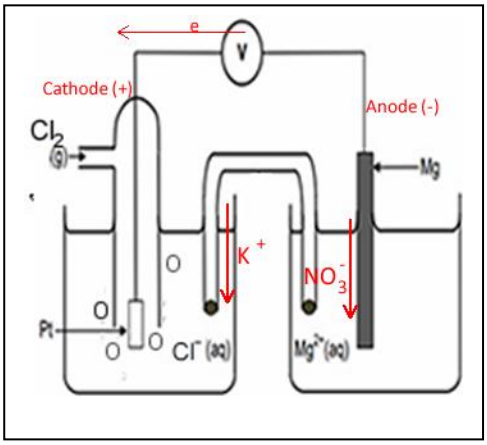


Write the
Oxidation half equation *$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$*

Reduction half equation *$Ag^+ + e^- \rightarrow Ag(s)$*

Overall equation *$Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$*

Consider the following galvanic cells



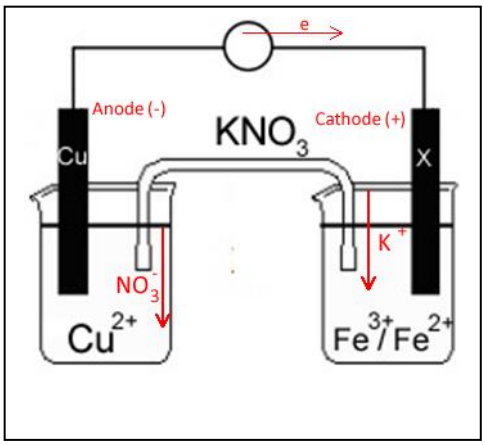
Will a reaction occur? *Yes between Cl_2 and Mg metal*
What is the theoretical cell voltage (EMF)? *3.73V*
Indicate on the diagram the
Anode and its polarity
Cathode and its polarity
Direction of electron flow
Direction of negative ion flow
Direction of positive ion flow
Write the
Oxidation half equation *$Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$*

Reduction half equation *$Cl_2(g) + 2e \rightarrow 2Cl^-(aq)$*

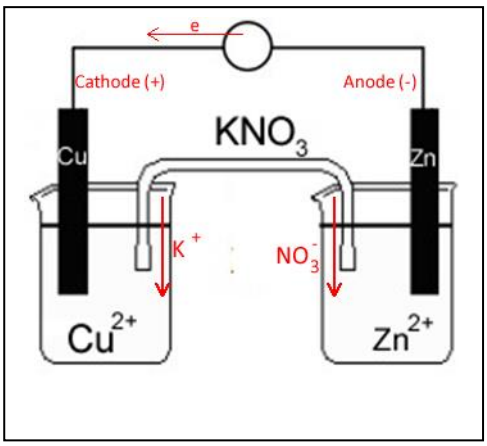
Overall equation *$Mg(s) + Cl_2(g) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$*

Indicate on the diagram the
Anode and its polarity
Cathode and its polarity
Direction of electron flow
Direction of negative ion flow
Direction of positive ion flow
Write the
Oxidation half equation *$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$*

Reduction half equation *$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$*



Overall equation *$2Fe^{3+}(aq) + Cu(s) \rightarrow 2Fe^{2+} + Cu^{2+}(aq)$*
What is electrode "X" made of. *Pt or graphite (C)*
What properties should the material that electrode "X" is made of have? *Conduct electricity and be inert.*



Will a reaction occur? *Yes- between the Cu^{2+} ions and the Zn metal*

What is the theoretical cell voltage (EMF)? *1.10V*

Indicate on the diagram the

Anode and its polarity

Cathode and its polarity

Direction of electron flow

Direction of negative ion flow

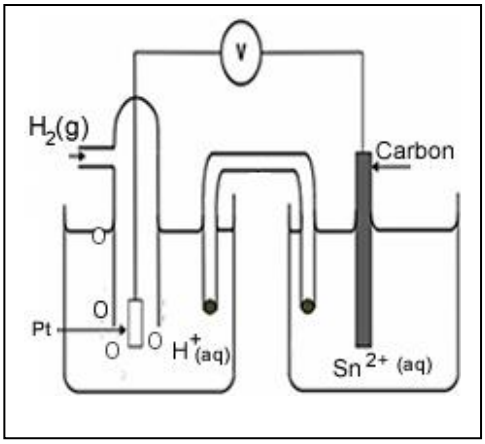
Direction of positive ion flow

Write the

Oxidation half equation *$Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$*

Reduction half equation *$Cu^{2+}(aq) + 2e \rightarrow Cu(s)$*

Overall equation *$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$*



Will a reaction occur? *No*

What is the theoretical cell voltage (EMF)?

Indicate on the diagram the

Anode and its polarity

Cathode and its polarity

Direction of electron flow

Direction of negative ion flow

Direction of positive ion flow

Write the

Oxidation half equation_____

Reduction half equation _____

Overall equation _____

$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	−0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	−0.14

No spontaneous reaction will occur