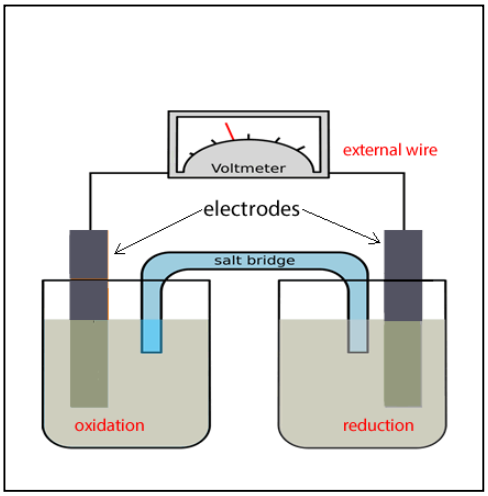
Friday worksheet 4 – constructing a galvanic cell from an overall equation.

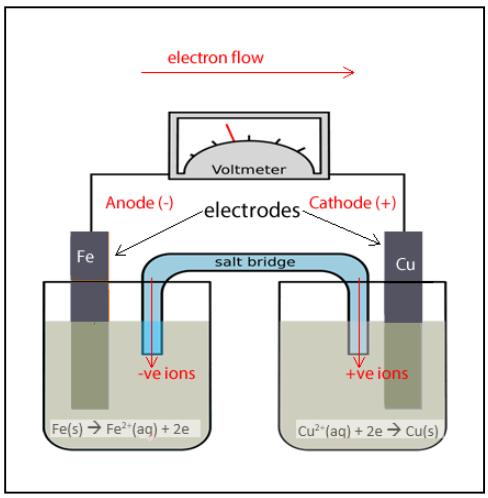
A galvanic cell is really a redox reaction that is separated into two half-reactions, the oxidation and reduction, that are separated and connected only by an external wire and a salt bridge. A general image of a galvanic cell is shown on the right.



The function of the external wire is to conduct electrons away from the half-cell that oxidation is occurring in to the half-cell where reduction is taking place. The salt bridge on the other hand contains positive and negative ions that move into each half cell to prevent a build-up of charge. Negative ions always flow into the oxidation half-cell while positive ions flow into the reduction half-cell.

1. Consider the following overall equations.

i. Separate each into its oxidation and reduction half equations.
ii. Construct a labelled galvanic cell that can be used to generate electricity from this overall equation.



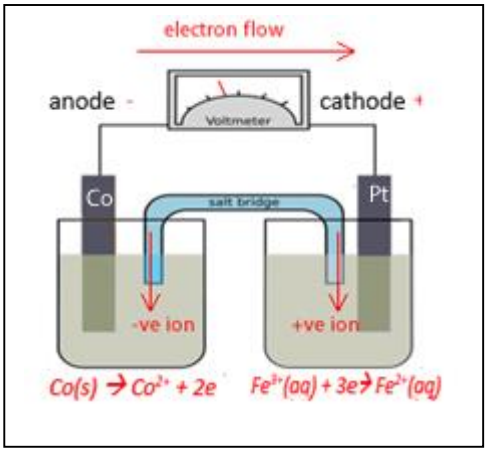
The first one is done for you.

a. $Cu^{2+}(aq) + Fe(s) \rightarrow Cu(s) + Fe^{2+}(aq)$
Identify the:
- *oxidant* ____$Cu^{2+}(aq)$_____
- *reductant* ____Fe(s)_____
write the half reactions
oxidation ---- $Fe(s) \rightarrow Fe^{2+}(aq) + 2e$
Reduction ----- $Cu^{2+}(aq) + 2e \rightarrow Cu(s)$
Draw the galvanic cell clearly labelling the:
- anode
- cathode
- direction of electron flow
- direction of positive and negative ion flow
- polarity and material of each electrode
- half equation of the reaction taking place in each half-cell.

**** Note – if a metal element exists in the oxidation or reduction half equations in the solid state then electrodes can be constructed from this metal.***
eg In the oxidation half equation solid iron is present so solid iron metal can be used as the electrode for the anode. **Fe(s)** → $Fe^{2+}(aq) + 2e$
In the reduction half equation solid copper is present so solid copper metal can be used as the electrode for the cathode. $cu^{2+}(aq) + 2e$ → **Cu(s)**

If a metal is not present use either carbon or platinum electrodes.

b. $2Fe^{3+}(aq) + Co(s) \rightarrow Co^{2+}(aq) + 2Fe^{2+}(aq)$



Identify the:

- *oxidant* __*$Fe^{3+}(aq)$* _
- *reductant* ___ *Co(s)* _____

write the half reactions

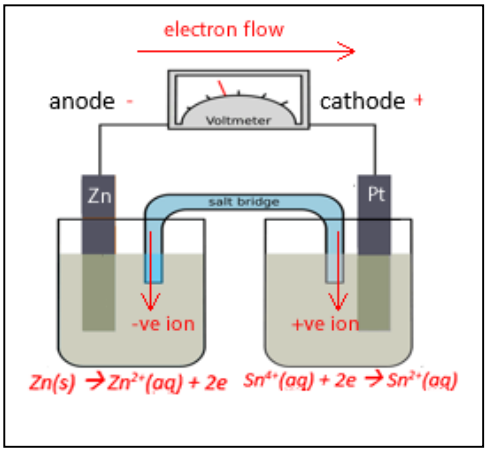
oxidation -- *$Co(s) \rightarrow Co^{2+} + 2e$*

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

Draw the galvanic cell clearly labelling the:

- anode
- cathode
- direction of electron flow
- direction of positive and negative ion flow
- polarity of each electrode
- half equation of the reaction taking place in each half-cell.

c. $Zn(s) + Sn^{4+}(aq) \rightarrow Zn^{2+}(aq) + Sn^{2+}(aq)$



Identify the:

- *oxidant* ___ *$Sn^{4+}(aq)$* __
- *reductant* ___*Zn(s)*____

write the half reactions

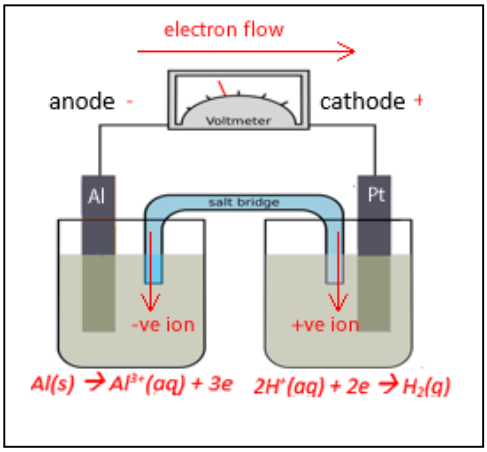
oxidation ---- *$Zn(s) \rightarrow Zn^{2+}(aq) + 2e$*

Reduction ---- *$Sn^{4+}(aq) + 2e \rightarrow Sn^{2+}(aq)$*

Draw the galvanic cell clearly labelling the:

- anode
- cathode
- direction of electron flow
- direction of positive and negative ion flow
- polarity of each electrode
- half equation of the reaction taking place in each half-cell.

d. $2Al(s) + 6H^{+}(aq) \rightarrow 3H_2(g) + 2Al^{3+}(aq)$



Identify the:

- *oxidant* ___*$H^{+}(aq)$* __
- *reductant* ___*Al(s)*____

write the half reactions

oxidation ---*Al(s)* → *$Al^{3+}(aq) + 3e$*

Reduction ---*$2H^{+}(aq) + 2e \rightarrow H_2(g)$*

Draw the galvanic cell clearly labelling the:

- anode
- cathode
- direction of electron flow
- direction of positive and negative ion flow
- polarity of each electrode
- half equation of the reaction taking place in each half-cell.

e. $Au^{+}(aq) + Fe^{2+}(aq) \rightarrow Fe^{3+}(aq) + Au(s)$

Identify the:

- *oxidant* __ *$Au^{+}(aq)$* ___
- *reductant* ___ *$Fe^{2+}(aq)$* ____

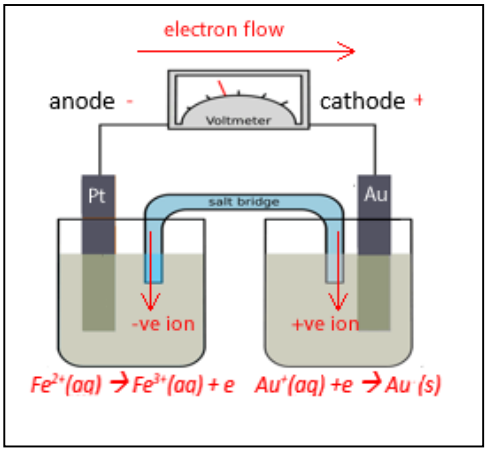
write the half reactions

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

Reduction --- *$Au^{+}(aq) + e \rightarrow Au(s)$*

Draw the galvanic cell clearly labelling the:

- anode
- cathode
- direction of electron flow
- direction of positive and negative ion flow
- polarity of each electrode
- half equation of the reaction taking place in each half-cell.



f. $Cu(s) + 2Ag^{+}(aq) \rightarrow 2Ag(s) + cu^{2+}(aq)$

Identify the:

- *oxidant* __*$Ag^{+}(aq)$*____
- *reductant* _ *Cu(s)* _____

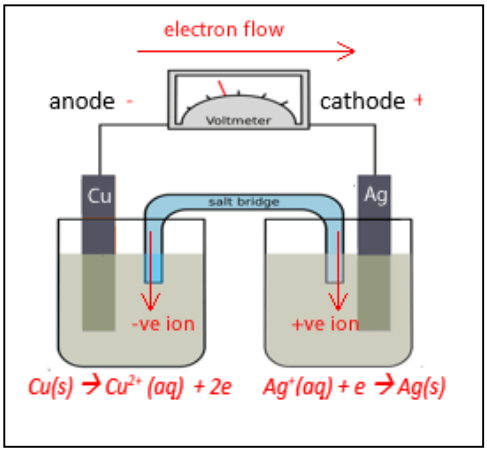
write the half reactions

oxidation ---- *$Cu(s) \rightarrow Cu^{2+}(aq) + 2e$*

Reduction ---- *$Ag^{+}(aq) + e \rightarrow Ag(s)$*

Draw the galvanic cell clearly labelling the:

- anode
- cathode
- direction of electron flow
- direction of positive and negative ion flow
- polarity of each electrode
- half equation of the reaction taking place in each half-cell.



g. $2Ag^{+}(aq) + Pb(s) \rightarrow 2Ag(s) + Pb^{2+}(aq)$

Identify the:

- *oxidant* __*$Ag^{+}(aq)$* ____
- *reductant* __*Pb(s)*___

write the half reactions

oxidation ---- *$Pb(s) \rightarrow Pb^{2+}(aq) + 2e$*

Reduction --- *$Ag^{+}(aq) + e \rightarrow Ag(s)$*

Draw the galvanic cell clearly labelling the:

- anode
- cathode
- direction of electron flow
- direction of positive and negative ion flow
- polarity of each electrode
- half equation of the reaction taking place in each half-cell.