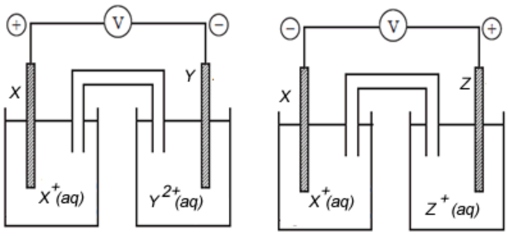
Friday Worksheet **Name: ………………**

Galvanic cells worksheet 2

1) Two galvanic cells were constructed under standard conditions in an experiment to determine the relative position in the electrochemical series of the standard electrode potential, E°, for the following reactions. Both cells generate a potential difference.



$X^+(aq) + e \rightleftharpoons X(s)$ — E^o_1

$Y^{2+}(aq) + 2e \rightleftharpoons Y(s)$ — E^o_2

$Z^+(aq) + e \rightleftharpoons Z(s)$ — E^o_3

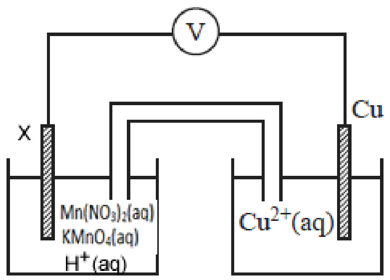
Place the electrode potentials in order from highest to lowest.

In galvanic cells, electrons flow from the (-) electrode to the (+) electrode. Since electrons always move from the site of oxidation to the site of reduction, the stronger oxidant is the species that is reduced and must be in the half-cell containing the (+) electrode.

$E^o_3 > E^o_1 > E^o_2$

Students should be aware that each half-cell contains an oxidant and a reductant, and that electrons move from the half-cell containing the weaker oxidant to the half-cell containing the stronger oxidant. Also in a half-cell, the species with the element at the higher oxidation number is the oxidant.

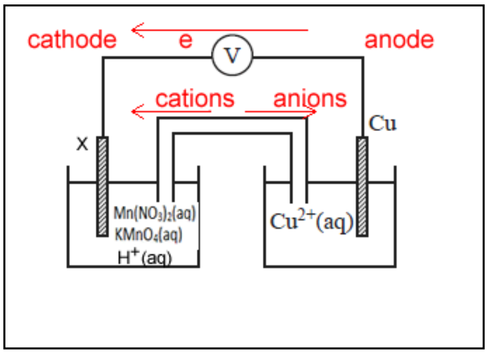
a) The following galvanic cell was set up under standard conditions. MnO_4 is a stronger oxidant than Cu^{2+}.



a) What are the properties of material X?

Must not take part in a reaction with the reactants in the half cell and must conduct electricity.

b) On the diagram above label
   - the direction of electron flow
   - the direction of anion flow
   - the direction of cation flow
   - the anode and cathode

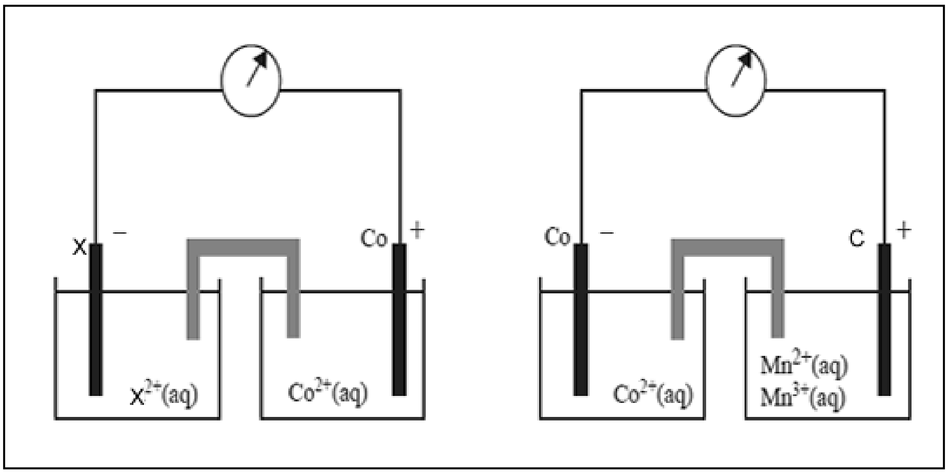


c) Write the equation for the reaction that occurs at the anode
   $Cu(s) \Rightarrow Cu^{2+}(aq) + 2e$

d) Write the equation for the reaction that occurs at the cathode
   $MnO_4^-(aq) + 8H^+(aq) + 5e \Rightarrow Mn^{2+}(aq) + 4H_2O(l)$

e) Write the overall equation for the cell.
   $2MnO_4^-(aq) + 16H^+(aq) + 5Cu(s) \Rightarrow 2Mn^{2+}(aq) + 8H_2O(l) + 5Cu^{2+}(aq)$

2) Two standard galvanic cells are shown below.



Two standard galvanic cells are shown below.

On the basis of the polarity of the electrodes shown above, which of the following reactions would not be expected to occur spontaneously? Give a reason for each

A. $Co^{2+}(aq) + X(s) \rightleftharpoons Co(s) + X^{2+}(aq)$

B. $2Mn^{2+}(aq) + Co^{2+}$ ($\rightleftharpoons$ $2Mn^{3<}+(aq) + Co(s)$

C. $2Mn^{3+}(aq) + X(s) \rightleftharpoons 2Mn^{2+}(aq) + X^{2+}(aq)$

D. $X^{2+}(aq) + Co^{2+}(aq) \rightleftharpoons X(s) + Co(s)$

Since electrons move spontaneously from the strongest reductant to the strongest oxidant we see that Co^{2+} (aq) is a stronger oxidant than X^{2+}(aq) and in turn Mn^{3+} (aq) is a stronger oxidant than Co^{2+}(aq). On the electrochemical series the species appear as shown below.

Mn^{3+} (aq) + e $\rightleftharpoons$ Mn^{2+}(aq)

Co^{2+} (aq) + 2e $\rightleftharpoons$ Co(s)

X^{2+} (aq) + 2e $\rightleftharpoons$ X(s)

A spontaneous reaction will occur between a reductant and an oxidant that is located higher than the reductant.

Mn^{3+} (aq) + e $\rightleftharpoons$ Mn^{2+}(aq)

Co^{2+} (aq) + 2e $\rightleftharpoons$ Co(s)

X^{2+} (aq) + 2e $\rightleftharpoons$ X(s)

So option a) will occur spontaneously

Option b) will not occur spontaneously as the reductant (Mn^{2+}) is above the oxidant (Co^{2+})

Option C will occur spontaneously

Option D will not occur spontaneously as the reaction involves two oxidants. The equation is also not balanced for charge.