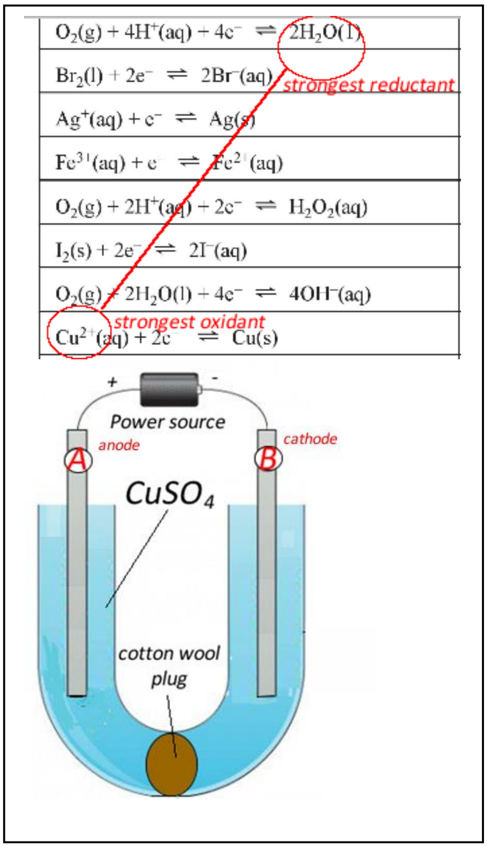
Revision 1

- Electrolysis with solutions and equilibrium.

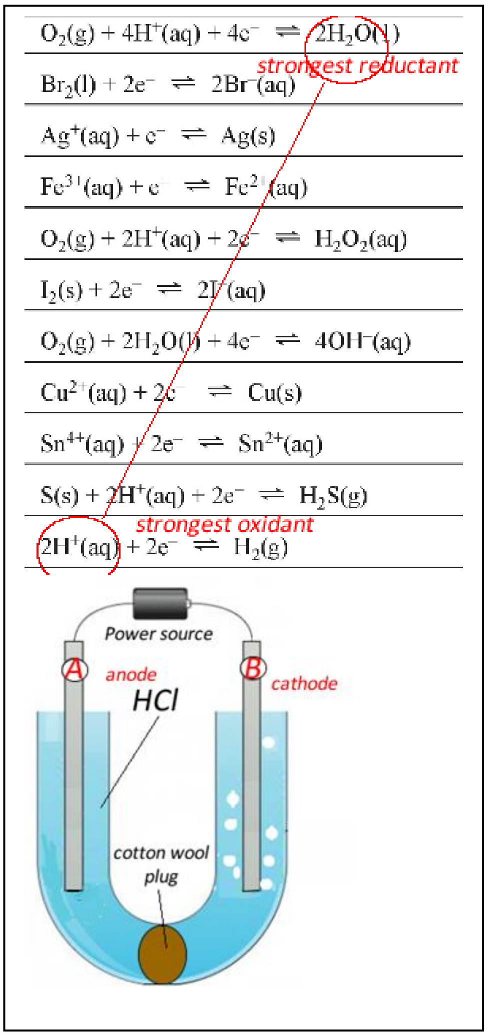
1) Electrolysis is performed by running direct current through a 1.00 M $CuSO_4$ solution, as pictured on the right.



a) Identify the anode and cathode.
b) What is the strongest oxidant present?
c) What is the strongest reductant present?
d) What products are formed at the cathode?
$Cu(s)$
e) What products are formed at the anode?
$H^+(aq) + O_2(g)$
f) How does the pH change at the:
- Anode *pH decreases*
- Cathode *pH does not change*.

Write the half reaction that takes place at the:
- Anode *$2H_2O(l) \rightarrow 4e + 4H^+(aq) + O_2(g)$*
- Cathode *$Cu^{2+}(aq) + 2e \rightarrow Cu(s)$*

2) Electrolysis is performed by running direct current through a 1.00 M HCl solution, as pictured on the right. Hydrogen gas is seen to come from electrode B.

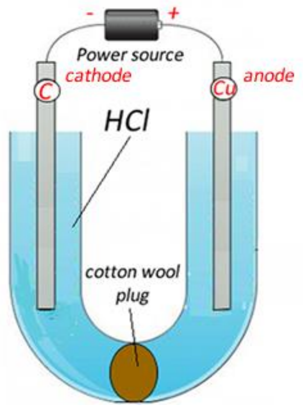


a) Identify the anode and cathode.
b) What is the strongest oxidant present?
c) What is the strongest reductant present?
d) What products are formed at the cathode?
$H_2(g)$
e) What products are formed at the anode?
$O_2(g)$ and H^+ (aq)
f) How does the pH change at the:
- Anode *decreases as H^+ is formed*
- Cathode *increases as H^+ ions are used up*

g) Write the half reaction that takes place at the:
- Anode *$2H_2O(l) \rightarrow 4e + 4H^+(aq)\ O_2(g)$*
- Cathode *$2H^+(aq) + 2e \rightarrow H_2(g)$*

3) Electrolysis is performed by running direct current through a 1.00 M HCl solution, as pictured on the right. Copper and carbon electrodes are used.

$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	
$O_2(g) + 2H^+(aq) + 2e^- \rightleftharpoons H_2O_2(aq)$	
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	*strongest reductant*
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$	
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	*strongest oxidant*
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	



Identify the anode and cathode.

a) What is the strongest oxidant present?

b) What is the strongest reductant present?

c) What products are formed at the cathode?

$H_2(g)$

d) What products are formed at the anode?

$Cu^{2+}(aq)$

e) How does the pH change at the:

- Anode - *no change*
- Cathode – *increase as H^+ ions are used up*

f) Write the half reaction that takes place at the:

- Anode - *$Cu(s) \rightarrow Cu^{2+}(aq) + 2e$*
- Cathode – *$2H^+(aq) + 2e \rightarrow H_2(g)$*

g) What will the half equations at the anode and cathode be if the electrodes are reversed and the carbon electrode is connected to the positive terminal and copper electrode connected to the negative terminal.

The strongest oxidant available at the cathode is H^+ and hence the reaction below will occur.

$2H^+(aq) + 2e \rightarrow H_2(g)$

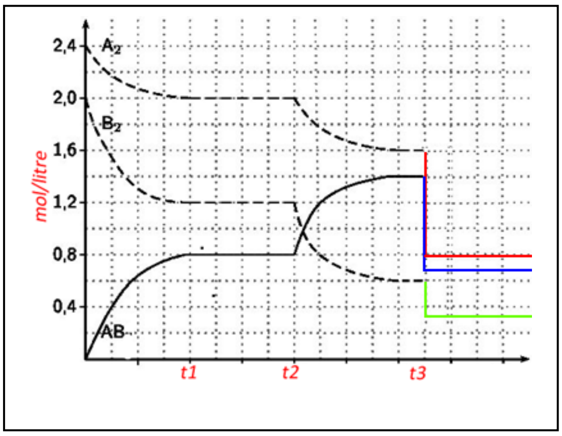
At the anode, however, the strongest reductant is now H_2O and hence the reaction below will take place instead.

$2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e$

4) Two unknown gases A_2 and B_2 were placed in a sealed 2.00 litre container and the temperature kept constant. The gases were allowed to react according to the equation below.

$A_2(g) + B_2(g) \rightleftarrows 2AB(g)$

The concentration of each gas was measured over time and the results shown on the graph on the right.



a) Calculate the equilibrium constant:

- between t_1 and t_2

  $[0.8]^2 / ([2.0][1.2])$

  => 0.267

- just before t_3

  $[1.4 / 2.00]^2 / ([1.60 / 2.00][0.6/2.00])$

  => 2.04

b) At t_2 the temperature is suddenly increased. Is this an exothermic or endothermic reaction? Explain.

Since an increase in temperature increased the K_c the reaction must have moved in a net forward direction. This indicates an endothermic reaction.

c) At t_3 the volume of the reaction is doubled. On the graph above, indicate how the system changes and how it responds to the change.

d) What is the value of the equilibrium constant once the system has reached equilibrium after the change made at t_3? *2.04. Volume change does not alter the value of the equilibrium constant.*