ELECTROLYSING SOLUTIONS

1. a) potassium sulphate solution:

product at cathode: hydrogen

cathode equation: either $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

or $2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

product at anode: oxygen

anode equation: either $4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$

or $2H_2O_{(l)} \longrightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

b) dilute hydrochloric acid (of ordinary lab concentration):

product at cathode: hydrogen

cathode equation: either $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

or $2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

product at anode: chlorine

anode equation: $2Cl^-_{(aq)} \longrightarrow Cl_{2(g)} + 2e^-$

c) very, very dilute hydrochloric acid:

product at cathode: hydrogen

cathode equation: either $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

or $2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

product at anode: oxygen

anode equation: either $4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$

or $2H_2O_{(l)} \longrightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

d) lead(II) nitrate solution:

product at cathode: lead

cathode equation: $Pb^{2+}_{(aq)} + 2e^- \longrightarrow Pb_{(s)}$

product at anode: oxygen

anode equation: either $4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$

or $2H_2O_{(l)} \longrightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

e) magnesium bromide solution:

product at cathode: hydrogen

cathode equation: either $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

or $2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

product at anode: bromine

anode equation: $2Br^-_{(aq)} \longrightarrow Br_{2(aq)} + 2e^-$

f) silver nitrate solution:

product at cathode: silver

cathode equation: $Ag^+_{(aq)} + e^- \longrightarrow Ag_{(s)}$

product at anode: oxygen

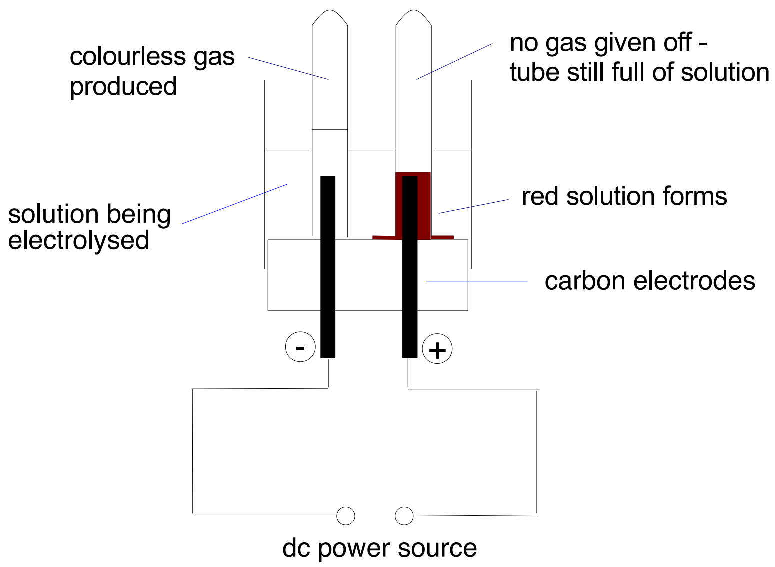
anode equation: either $4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$

or $2H_2O_{(l)} \longrightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

2. a) The colourless gas is hydrogen, and the red solution was probably iodine coming from a solution containing iodide ions. So the positive ion in the solution was either hydrogen or a metal probably from about aluminium upwards in the electrochemical series.

(The metal isn't likely to be from zinc downwards because otherwise you would probably get some metal deposited unless the solution was very dilute. But if it was very dilute, the amount of iodine being released would also be very small, and unlikely to give as dark a colour as red.)

b) You need to be able to collect the gas to be able to test it. The simplest way is:



Both of the small test tubes would have started full of the solution being tested.

3. a) The cathode (metal ions are always positively charged, and so can only be discharged at the negative cathode.)

b) (i) the anode: $Ni_{(s)} \longrightarrow Ni^{2+}_{(aq)} + 2e^-$

(ii) the cathode. $Ni^{2+}_{(aq)} + 2e^- \longrightarrow Ni_{(s)}$

4. a) cathode equation: either $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

or $2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$

anode equation: either $4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$

or $2H_2O_{(l)} \longrightarrow O_{2(g)} + 4H^+_{(aq)} + 4e^-$

b) Imagine 4 electrons flow around the circuit. Those 4 electrons will be involved in the formation of one molecule of oxygen, but 2 molecules of hydrogen.

Therefore you get twice as many molecules of hydrogen formed as oxygen.

According to Avogadro's Law, you will therefore get twice the volume of hydrogen as oxygen.