Adam Suttle Year 12 Chemistry 05.02.17

ES 3.1 Electrolysis of aqueous solutions

	Observations
1 Electrolysis of potassium iodide solution (carbon electrodes) Details: 3 sheets of filter paper on one piece of aluminium foil paper. Sheets soaked in potassium iodide solution with starch and phenolphthalein solution mixed in.	**Foil connected to the negative terminal (cathode) and drawing a trace with the anode (positive terminal). Original solution clear.** **After,** • Top piece of paper had a brown trace • Middle piece had no traces and was unchanged • Bottom piece had a pink trace **Foil connected to the anode (positive terminal) and drawing a trace with the negative terminal (cathode) Original solution clear.** **After,** • Top piece of paper had a pink trace • Middle piece had no traces and was unchanged • Bottom piece had a brown trace
Explanation	The iodide ions (I^- anions) are attracted to the anode where they are oxidised to form iodine (brown colour in solution). The iodine subsequently reacts with the starch in solution to form a blue/black precipitate. Potassium is more reactive than hydrogen and so water is attracted to the cathode where it is reduced. The hydrogen ions are reduced releasing hydrogen gas. This increases the concentration of hydroxide (OH^-) ions in solution and so around the cathode, a pink colour was seen. This is because the phenolphthalein turns pink in an alkaline solution.
2 Electrolysis of sodium sulphate solution Details: Sodium sulphate solution was placed in Petri dish with a few drops of universal indicator two carbon electrodes attached to a power pack, dc current.	**Before the solution was colourless and once the UI was added it turned a pale yellow and clear.** **After electrolysis, there was a colour change of:** • Purple at the cathode • Red/Pink at the anode • Fizzing was present at both electrodes
Explanation	Sodium is more reactive than hydrogen and so water is attracted to the cathode where it is reduced. The hydrogen ions are reduced releasing hydrogen gas. This increases the concentration of hydroxide (OH^-) ions in solution and so around the cathode, a purple colour was seen. This is due to the universal indicator identifying the alkaline solution. Bubbles would be seen as hydrogen gas evolves Sulphate ions (SO_4^{2-}) anions have a lower tendency to become oxidised than oxygen anions in the water. Therefore water is oxidised and oxygen gas is formed at the anode. The oxygen gas would react with the graphite electrode and so form carbon dioxide gas. This results in bubbling. As water is oxidised at the anode, this leaves a high proportion of hydrogen (H^+ cations) in solution around the anode. The universal indicator shows a red colour due to the acidic properties.

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3 Electrolysis of copper(II) chloride using carbon electrodes Details: Copper(II) chloride drop links two graphite electrodes 1 isolated drop of potassium bromides solution in Petri dish 1 isolated drop of potassium iodide solution A damps piece of blue litmus paper. Lid placed on top of petri dish 6-8V current DC	**Initially,** • Blue litmus is blue • Copper(II) chloride is blue and clear • Potassium bromide/ iodide are clear **After electrolysis, there was a colour change of:** • Litmus went from blue to red and then bleached to white • Negative electrode was plated with red brown copper deposit • Positive electrode gas evolved, smelt like chlorine • Potassium bromide gradually turned clear red/brown • Potassium iodide darkened overtime to form a black precipitate in solution.
Explanation	Since copper is less reactive than hydrogen (from water solution), the copper(II) (Cu^{2+}) cations are attracted to the cathode where they are reduced and so a deposit of red brown copper forms on the cathode. As a halogen is present and the solution is relatively concentrated, the halide anions (Cl^-) have a greater tendency to become oxidised than water so opposed to oxygen gas forming, chloride ions are oxidise to form chlorine gas. The volatile chlorine would have reacted with the drop of potassium bromide; chlorine is a more reactive halogen than bromine so it displaced the bromide halide from its compound. This resulted in bromine being produced which is red/brown in solution. Likewise the chlorine reacted with potassium iodide solution; chlorine being more reactive than iodine can displace the halide form its compound. This produced iodine in solution which showed a black colour. The chlorine gas reacted with hydrogen in the air to form hydrochloric gas. This dissolves into the damp blue litmus paper and the H+ ion turned it red. Eventually the chamber becomes so filled with chlorine gas that it bleaches the litmus paper white.
4 Electrolysis of copper sulphate using copper electrodes.	**Before,** -Copper sulphate solution is a clear blue -Electrodes are dirty copper colour **After,** • The anode a dark brown deposit of copper was plated. • The cathode, the surface layer near the edges of the electrode was removed to make it shiny. • Pieces of floating copper were seen in the electrolyte solution.
Explanation	At the anode, the copper electrode is oxidised so copper(II) (Cu^{2+}) cations are formed in solution. Sulphate anions (SO_4^{2+}) have a lower tendency to become oxidised. Since copper is less reactive than hydrogen (from water solution), the copper(II) (Cu^{2+}) cations are attracted to the cathode where they are reduced and so a deposit of red brown copper forms on the cathode. With Cu^{2+} ions being added and removed from the solution the concentration remains consistent. Flakes of copper are seen migrating from the anode to the cathode.