Edexcel GCSE Chemistry

Topic 3: Chemical changes

Electrolytic processes

Notes

3.22 Recall that electrolytes are ionic compounds in the molten state or dissolved in water

- When an ionic substance is melted or dissolved, the ions are free to move about within the liquid or solution. This is called an electrolyte

3.23 Describe electrolysis as a process in which electrical energy, from a direct current supply decomposes electrolytes

- Electrolysis = process in which electrical energy, from a direct current supply decomposes electrolytes
- Passing a current through substances that are molten or solution means that the solution can be broken down into elements. This is electrolysis, and the substance being broken down is the electrolyte.

3.24 Explain the movement of ions during electrolysis, in which: positively charged cations migrate to the negatively charged cathode, and negatively charged anions migrate to the positively charged anode

- During electrolysis, positively charged ions (cations) move to the negative electrode (cathode), and negatively charged ions (anions) move to the positive electrode (anode).
- Ions are discharged at the electrodes producing elements.

3.25 Explain the formation of the products in the electrolysis, using inert electrodes, of some electrolytes, including: copper chloride solution, sodium chloride solution, sodium sulfate solution, water acidified with sulfuric acid and molten lead bromide (demonstration)

- When you have a ionic solution (NOT a molten ionic compound), your solution will contain: the ions that make up the ionic compound, and the ions in water (OH^- and H^+)
- at the cathode (-):
    - hydrogen (from H^+ in water) is produced UNLESS the + ions in the ionic compound are from a metal less reactive than hydrogen
    - if the metal is less reactive, it will be produced instead
- at the anode (+):
    - oxygen (from OH^- in water) will be produced UNLESS the ionic compound contains halide ions (Cl^-, Br^-, I^-)
    - if there are halide ions, the halogen will be produced instead (e.g. Cl_2)

- Electrolysis of:
  - Copper chloride solution
    - Cu^+ ions go to cathode, Cu (s) is produced (Cu is less reactive than hydrogen)
    - Cl^- ions go to anode, Cl_2 (g) is produced (Cl^- are halide ions)
  - Sodium chloride solution
    - H^+ ions go to cathode, H_2 (g) is produced (Na is more reactive than hydrogen)
    - Cl^- ions go to anode, Cl_2 (g) is produced (Cl^- are halide ions)
  - Sodium sulfate solution
    - H^+ ions go to cathode, H_2 (g) is produced (Na is more reactive than hydrogen)
    - OH^- ions go to anode, O_2 (g) is produced (SO_4^{2-} ions are not halide ions)
  - Water acidified with sulfuric acid
    - H^+ to cathode, H_2 (g) is produced (these are the other ions present in sulfuric acid H_2SO_4)
    - OH^- to anode, O_2 (g) is produced (SO_4^{2-} ions are not halide ions)
  - Molten lead bromide
    - Pb^{2+} to cathode, Pb (s) is produced (not in solution so these are the only + ions present)
    - Br^- to anode, Br_2 (l) is produced (not in solution so these are the only - ions present)

3.26 Predict the products of electrolysis of other binary, ionic compounds in the molten state

if ionic compounds are molten it is much more simple to predict the products of electrolysis as there are no ions present except those in the ionic compound:

- identify which ions there are within the ionic compound
- the + ions will go to the cathode
- the - ions will go to the anode

3.27 (HT only) Write half equations for reactions occurring at the anode and cathode in electrolysis

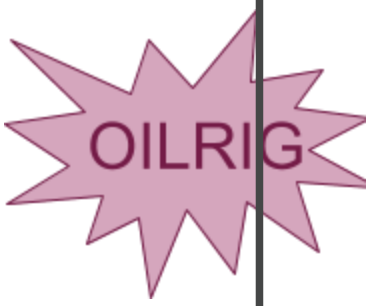
- This is an example of a half equation; the small number is always the same as the 2 larger numbers within the equation. & electrons are represented by the symbol 'e-'

$$2Cl^- \longrightarrow Cl_2 + 2e^-$$

or

$$2Cl^- - 2e^- \longrightarrow Cl_2$$

- writing half equations for the reactions at each electrode:
    - negative electrode: X^+ -> X, so ionic equation must be: $X^+ + e^-$ -> X, electrons gained, so positive ions are reduced
    - positive electrode: X^- -> X, so ionic equation must be: X^- -> e^- + X, electrons are lost, so negative ions are oxidised



3.28 (HT only) Explain oxidation and reduction in terms of loss or gain of electrons

- Oxidation Is Loss (of electrons)
- Reduction Is Gain (of electrons)
- see above picture to help you remember OIL RIG

3.29 (HT only) Recall that reduction occurs at the cathode and that oxidation occurs at the anode in electrolysis reactions

- ANODE – loss of electrons, oxidation of anions (-) (they would have to lose electrons to have a neutral charge)
- CATHODE – gain of electrons, reduction of cations (+) (they would have to gain electrons to get a neutral charge)

3.30 Explain the formation of the products in the electrolysis of copper sulfate solution, using copper electrodes, and how this electrolysis can be used to purify copper

- set up:
    - anode is made of impure copper (that you are purifying)
    - cathode is made of pure copper
    - the solution is copper sulfate
- what happens:
    - Cu^{2+} ions from the anode move to the cathode, where they gain electrons and are discharged as pure copper
    - impurities form as sludge below the anode
- the cathode will increase in mass as it gains pure copper, whilst the anode will lose mass as copper ions are lost (they replace the ones from the $CuSO_4$ solution that go to the cathode) and so are impurities

3.31 Core practical: Investigate the electrolysis of copper sulfate solution with inert electrodes and copper electrodes

with inert electrodes:

- at the cathode Cu (s) is produced (Cu is less reactive than hydrogen)
- at the anode O_2 is produced (SO_4^{2-} ions are not halide ions)
- this leaves H^+ and SO_4^{2-} ions in the solution, which will react to form H_2SO_4- sulfuric acid

with copper electrodes:

- same as experiment in 3.30, where the Cu^{2+} ions deposited as Cu at the cathode from the solution are replaced by Cu^{2+} ions from the anode, meaning the concentration of Cu^{2+} ions in the solution remains constant