<table>
<tr><td>SUBJECT and GRADE</td><td>PHYSICAL SCIENCES Grade 12</td></tr>
<tr><td>TERM 4</td><td>Week 3</td></tr>
<tr><td>TOPIC</td><td>Electrochemical cells - Electrolytic Cells</td></tr>
<tr><td>RESOURCES</td><td>Paper based resources</td></tr>
<tr><td></td><td>Mind the Gap: Pg 159 -168</td></tr>
<tr><td>AIMS OF LESSON</td><td>At the end of this lesson you must be able to :
Define the electrolytic cell .
Define an electrolyte.
Describe the movement of ions in the solution.
State the direction of electron flow in the external circuit.
Write equations for the half-reactions taking place at the anode and cathode.
Describe, using half-reactions and the equation for the overall cell reaction as well as the layout of the particular cell using a schematic diagram, the following electrolytic process:
The decomposition of copper(II) chloride</td></tr>
<tr><td>INTRODUCTION</td><td><u>Period 1 and 2</u>
<u>Gr 11 Revision</u>
<table>
<tr><th>OXIDATION</th><th>REDUCTION</th></tr>
<tr><td>Oxidation is the loss of electrons by a substance (i.e. by an atom, a molecule or an ion).</td><td>Reduction is the gain of electrons by a substance (i.e. by an atom, a molecule or an ion).</td></tr>
<tr><td>Learn: LEO for
Loss of Electrons is Oxidation.
or
OIL for
Oxidation Is Loss (of electrons)</td><td>Learn: GER for
Gain of Electrons is Reduction.
(because gaining electrons is gaining minuses, so reducing)
or
RIG for
Reduction Is Gain (of electrons)</td></tr>
<tr><td>A substance that is oxidised (i.e. loses electrons) is called a reducing agent.</td><td>A substance that is reduced (i.e. gains electrons) is called an oxidising agent.</td></tr>
<tr><td>The oxidation number of a compound that is oxidised, increases (becomes less negative, or becomes more positive)</td><td>The oxidation number of a compound that is reduced, decreases (becomes more negative or less positive</td></tr>
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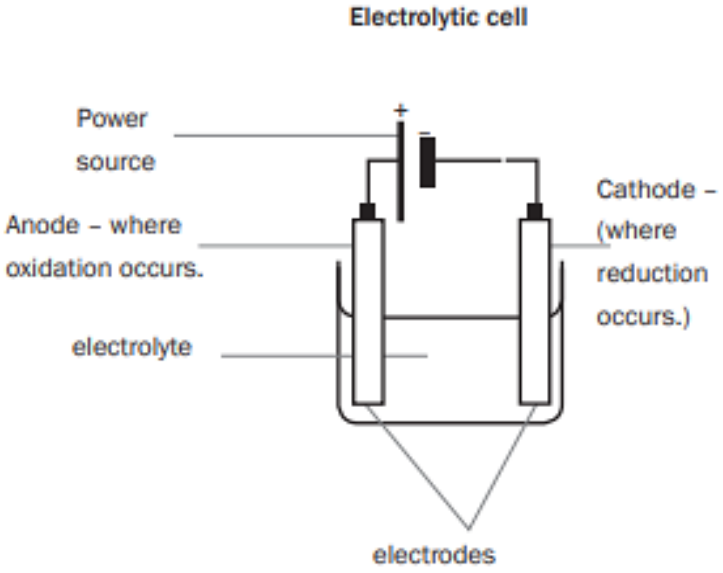
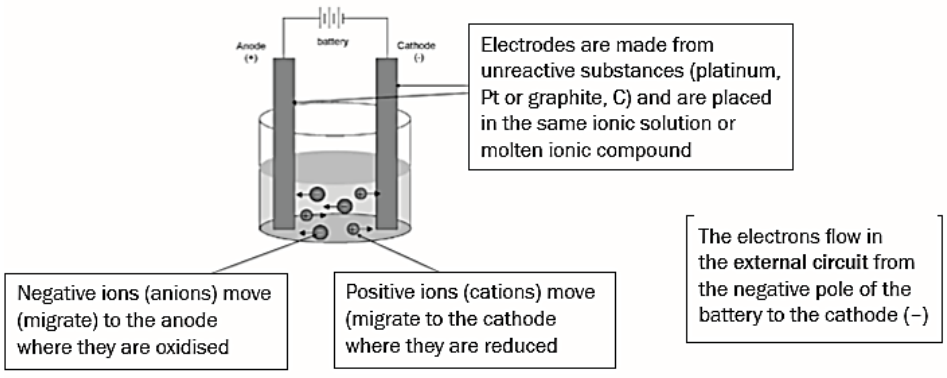
CONCEPTS AND SKILLS	**Electrolytic cell** is an electrochemical cell that converts electrical energy to chemical energy. (Non-spontaneous cell)



<u>Summary of Electrolytic cell:</u>

Electric energy → chemical energy.
No salt bridge.
Non-spontaneous redox reactions.
Endothermic reaction.
Positive electrode → anode → oxidation.
Negative electrode → cathode → reduction.
Emf is always negative

<u>Operation of an Electrolytic cell</u>



1. View the following youtube videos:

   Electrolytic cells – Type 2
   https://youtu.be/o8auXrCo_BM

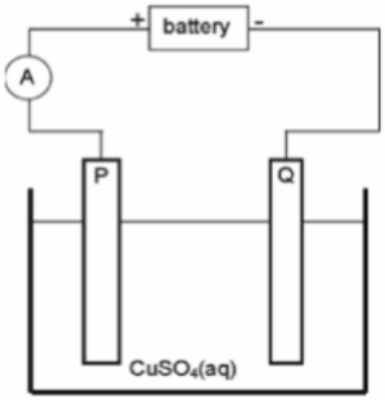
   Electrolysis of NaCℓ and elctrolysis of H_2O
   https://youtu.be/dRtSjJCKkIo

Electroplating
https://youtu.be/NClagKbLUMM

Electrorefining/ Extraction of metal
https://youtu.be/wwN8lwpQVLk

Period 3

2. Example 1: The decomposition of copper(II) chloride



Question:
Explain how the electrolysis of a copper (II) chloride solution $CuC\ell_2$ (aq) takes place.

Solution :
The **anions** $C\ell^-$ and OH^- migrate to the positive anode.
The $C\ell^-$ ions are **oxidised**.

Oxidation half-reaction: $2C\ell^-(aq) \rightarrow C\ell_2(g) + 2e^-$

The **cations** (Cu^{2+} and H^+) migrate to the cathode.
The Cu^{2+} ions are reduced.

Reduction half-reaction: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

The overall net reaction: $Cu^{2+}(aq) + 2C\ell^-(aq) \rightarrow Cu(s) + C\ell_2(g)$

The solution or electrolyte is initially blue due to the presence of the Cu^{2+} ions, but as they are reduced to Cu(s), the solution turns colourless and red-brown Cu(s) is deposited on the cathode.

	3. Example 2: Now using the Standard Reduction potential table (4A or 4B) obtain the oxidation and reduction half reaction of an electrolytic cell if NaCℓ is used as electrolyte and carbon as electrodes. The electrolysis process can be applied in **Electroplating** and **Extraction of Metals.** Now read Mind the Gap pages 161 – 168. Go over the Worked Examples 4 and 5.
ACTIVITIES/ ASSESSMENT	**Period 4** 1. In Mind the Gap, answer Activity 3, 4, 5, 6 and 18 (page191) 2. Read through the Notes attached to the previous lesson plan (pages 11 – 16). Link: https://drive.google.com/file/d/14C1MDaCpiwExQYmE-RSpANLMR3PmL3sh/view?usp=sharing
CONSOLIDATION	**Period 5**: You should now be able to : 4. Distinguish between electrolytic and galvanic cells. 5. Explain the operation of an electrolytic cell. 6. Work through practice questions on pages 15 - 17. Link: https://drive.google.com/file/d/14C1MDaCpiwExQYmE-RSpANLMR3PmL3sh/view?usp=sharing
VALUES	Electrolytic cells have important uses in everyday life such as electroplating of jewellery, extraction of metals in the mining industry, production of $C\ell_2$, H_2 and NaOH (in the chlor-alkali industry) These processes require a power supply and as such the power utility needs to either burn more coal or uranium used in Nuclear power plants. It is therefore important not to waste power as the more coal is burnt, the more green house gases are produced etc.