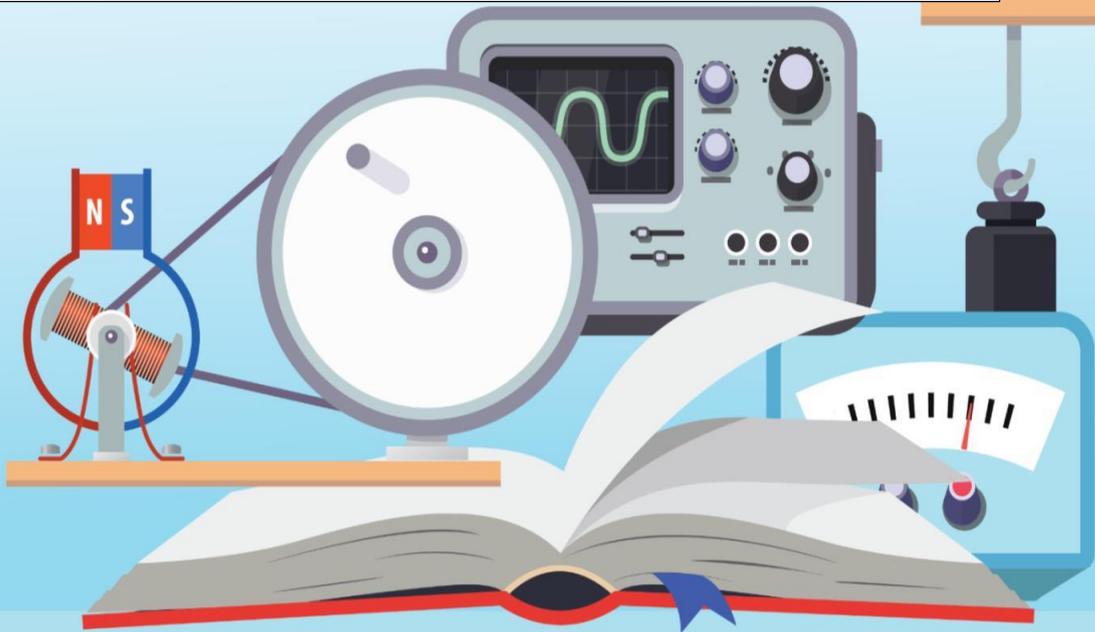


Science – Grade 11

Competency 2.0 Investigate matter, properties of matter and their interaction to enhance the quality of life.

Competency level - 2.6, 2.7, 2.8

Lesson - Electrochemistry



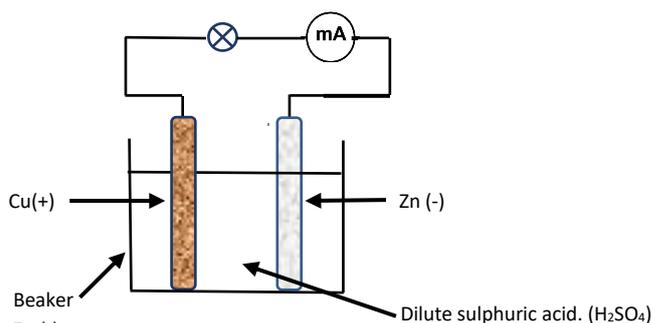
Content: Electrochemical cells, Electrolysis and Electroplating, Corrosion

Prepared by: Provincial Department of Education, North Western Province

Competency level - 2.6 Investigate the components of an electro chemical cell and their relevant reactions.

Exercises:

1. The following diagram shows a rough sketch of a simple cell. Answer the questions relevant to it by writing them in the given space.



1. There are three types of ions and one type of molecules in the solution before using it.

Write them.

.....

2.(a) What is the observation of the milliammeter?

.....

(b) What is the observation of the bulb?

.....

(c) What is the conclusion you would arrive at, due to the above observations?

.....

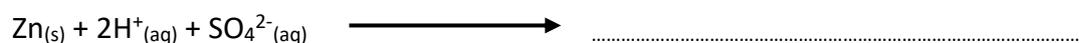
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| | Positive terminal (+) Cu | Negative terminal (-) Zn |
|---|---------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| 3 | Observation associated with the copper plate | Observation associated with the Zinc plate |
| 4 | Half reaction relevant to the above observation. | Half reaction relevant to the above observation. |
| 5 | Due to the nature of the reaction, It gains electrons It acts as the cathode | Due to the nature of the reaction, It is a reduction |

6. Construct the overall reaction by adding the above anodic reaction and the cathodic reaction.



7. Activity series can be used to identify the positive terminal and the negative terminal of an electrochemical cell. Explain how.

.....

.....

.....

8. Write the direction of the flow of electrons and the direction of the standard current of the above simple cell.

.....

9. Two instances in which different materials are used to construct a simple cell are given below.

Write the half reactions and the overall reaction that occur in each cell.

a. Fe and Cu

1. Anode (-) (Fe) \longrightarrow + 2e

2. Cathode (+) (.....) $2H^+_{(aq)} + 2e \longrightarrow H_{2(g)}$

3. Overall reaction.

.....

b. Zn and Fe

Anode (-) (.....) \longrightarrow

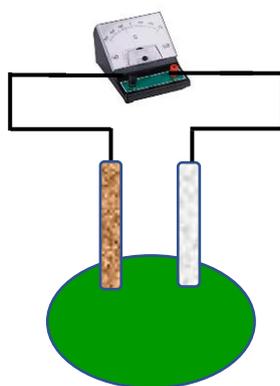
Cathode (+) (.....) \longrightarrow

Overall reaction

.....

Past Papers:

Two plates of Zn and Cu were pushed into a lime closer but not touching each other and connected to a galvanometer as shown in the diagram.



I. State the observation which confirms that electricity is produced by the interaction of metals with the contents of the lime.e.....

II. The above set up demonstrates a simple cell. In this cell, name the substances that act as the following components.

a. cathode..... b. anode.....

c. electrolyte.....

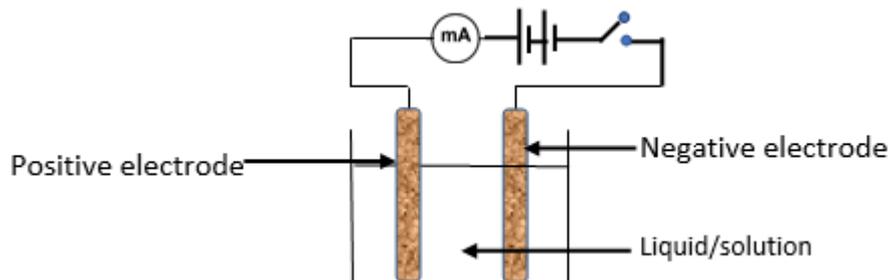
III. From which to which metal plate the electron current flows in the above simple cell . Give reasons for your answer.

.....

Competency level - 2.7 Investigates different electrolysis processes

Exercises

1. The following experimental set up is used to test whether current flows through solutions and liquids.



a. What is the above set up called?

.....

b. Electrodes are made up of graphite (C) or Platinum (Pt). Write two reasons for using the above elements to make electrodes.

1.....

2.....

c. Write the method used to test whether current passes or not through the liquid/solution in the setup?

d. Classify the following solutions and liquids as electrolytes and non-electrolytes.

Distilled water

Acidulated water

Kerosene

Copper sulphate solution

Sodium chloride crystals

Molten/fused sodium chloride

Sodium chloride solution

Ethanol

Electrolytes

Non electrolytes

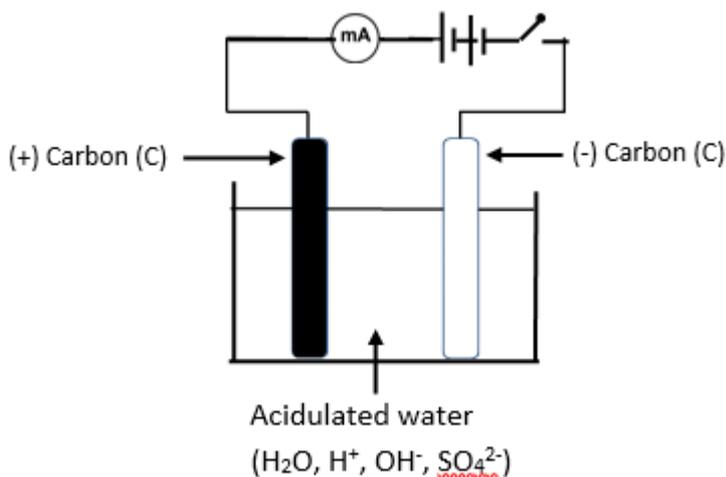
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e. What is the essential factor possessed by an electrolyte in order to pass current through it?

.....

2. The following diagram shows an electrolytic cell designed to electrolyse acidulated water.



a. What is the method used to prepare a sample of acidified water?

.....

b. Write three observations that can be obtained when the switch of the setup is closed (turned on).

I.

II.

III.

c. Fill in the blanks relevant to the half reactions that occur in the positive terminal and the negative terminal.

Positive terminal

- I. Half reaction
- II. gaining electrons or losing electrons.
- III. oxidation or reduction?
- IV. cathode or anode?

Negative terminal

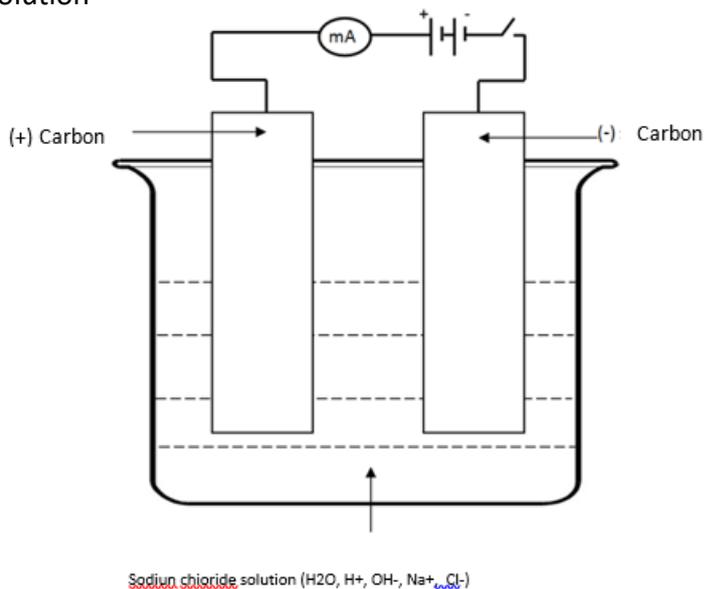
- I. Half reaction
- II. gaining electrons or losing electrons.
- III. oxidation or reduction?
- IV. cathode or anode?

d. Construct the overall reaction relevant to the above set up.

.....
.....
.....

e. What is the ratio of the volumes of the gases Oxygen and Hydrogen formed in the above set up when the overall reaction is considered?

2. The following diagram shows a cell designed to electrolysis an aqueous sodium chloride solution



a. Write three observations you would get when the switch is turned on(closed)

- I.....
- II.....
- III.....

b. Complete the following facts relevant to the reactions that occur at the positive terminal and the negative terminal of the cell.

Positive terminal

- I. Half reaction
- II. gaining or losing electrons.....
- III. oxidation or reduction
- IV. cathode or anode.

Negative terminal

- I. Half reaction
- II. gaining or losing electrons.....
- III. oxidation or reduction
- IV. cathode or anode.

c. Construct the overall reaction using the half reactions relevant to the above set up.

.....

.....

.....

d. The colour of red litmus and blue litmus put into the electrolyte did not show any colour change before electrolysis.

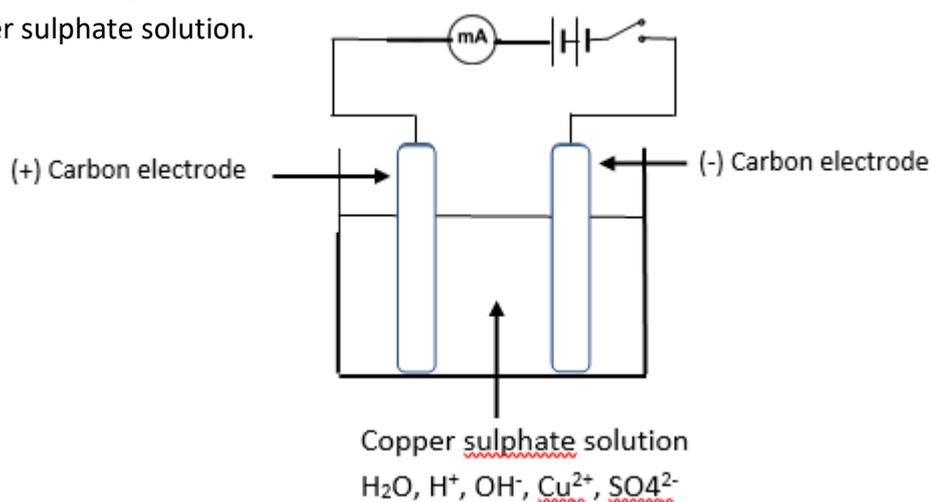
After carrying out electrolysis, red litmus put into the electrolyte turned into blue. Explain the reason for the above observation.

.....

.....

.....

4. The following diagram shows an electrolytic cell used for the electrolysis of an aqueous copper sulphate solution.



a. Write the observations you would get at the following parts of the cell when the switch of the circuit is turned on(closed).

I. Milli ammeter

.....

II. Carbon rod connected to the negative terminal (-)

.....

III. Carbon rod connected to the positive terminal (+)

.....

IV. Intensity of blue colour of the solution.

.....
b. Provide the following information relevant to the chemical reactions that occur at the positive terminal and the negative terminal of the cell.

Positive terminal

I. Half reaction

II. Gaining or losing electrons.....

III. Oxidation or reduction

IV. Cathode or anode.

Negative terminal

I. Half reaction

II. Gaining or losing electrons.....

III. Oxidation or reduction

IV. Cathode or the anode.

c. Construct the overall reaction using the above half reactions.

.....
.....
.....

d. The colour of red litmus and blue litmus put into the electrolyte did not show any changes before the electrolysis.

After carrying out electrolysis, blue litmus put into the electrolyte turned into red. Explain the reason for the above observation.

.....
.....
.....

5. Extraction of highly reactive metals such as sodium metal is one of the uses of electrolysis. Sodium metal is extracted by the electrolysis of molten/fused sodium chloride.

a. Name the cell used for the electrolysis of molten /fused sodium chloride.

.....

b. The melting point of pure sodium chloride is about 840. What is the strategy used to reduce that value in the above cell?

.....

c. Name the materials used as the cathode and the anode of the above cell and write the relevant half reactions too.

I. Cathode

II. Half reaction

III. Anode-

IV. Half reaction

d. What is the method used to prevent the reaction between liquid sodium and chlorine gas produced during the process?

.....

e. Write three uses of sodium metal.

I.....

II.

III.

f. Write four uses of chlorine gas.

I.....

II.....

III.....

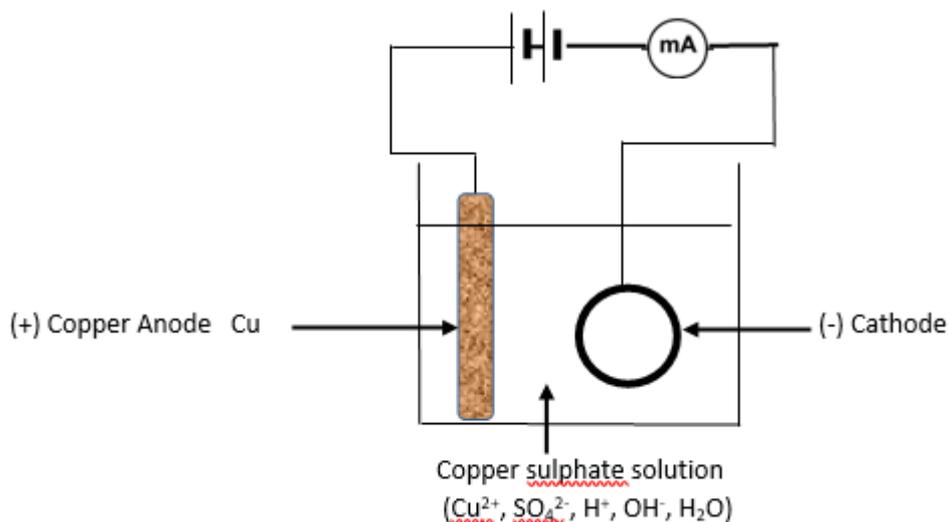
IV.....

6. Electroplating is another important use of electrolysis.

a. What is meant by electroplating?

.....

b. The following diagram shows a set up used to plate copper metal on an iron ring.



I. Write three observations you would get when the switch of the setup is turned on (closed)

1.
2.
3.

II. Write the half reactions at the cathode and the anode.

Cathodic half reaction (.....)

Anodic half reaction (.....)

III. Write within brackets in the above (II) whether each of the half reactions is an oxidation or a reduction.

IV. When a copper sulphate solution is electrolysed using carbon electrodes, the intensity of blue colour gradually decreases. But in the above set up, the blue colour of the solution does not change. Write the reason in brief.

.....

c. Complete the given table based on materials used in electroplating.

| | Instance relevant to electroplating | Cathode (The object which is to be plated) | Anode (The metal that supplies positive ions of the metal plated.) | Electrolyte (Solution containing positive ions of the plating metal) |
|----|---------------------------------------|--------------------------------------------|--------------------------------------------------------------------|----------------------------------------------------------------------|
| 1. | Plating copper metal on an iron ring. | | | |
| 2. | Plating gold on a bangle. | | | Gold cyanide solution |
| 3. | Plating silver on a necklace | | | silver cyanide solution. |

d. Write four instances in which electroplating is carried out.

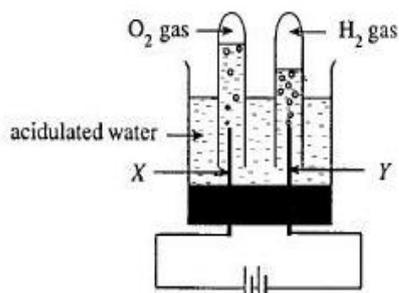
- I.....
- II.
- III.
- IV.

f. Write four industrial uses of electroplating.

- I.....
- II.
- III.
- IV.....

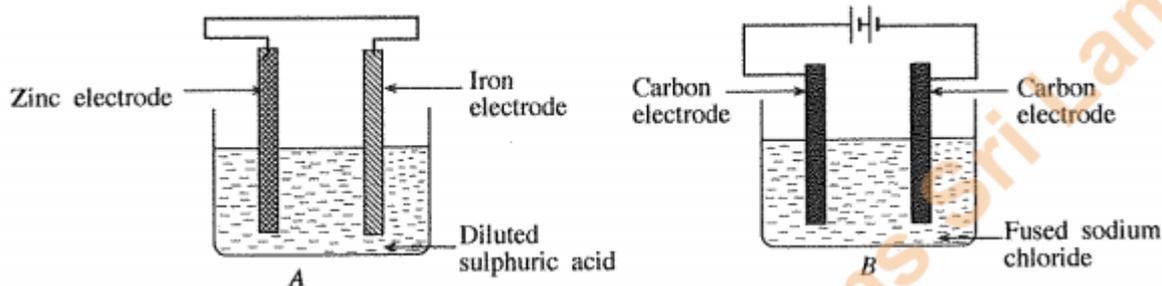
Past papers:

- The diagram given shows electrolysis of water, acidulated by a few drops of Sulphuric acid. The gases that evolve at electrodes are collected separately as shown below.



- Same substance is used as both electrodes in this electrolysis process. Name a suitable substance to be used for these electrodes.
- Consider the way the electrodes are connected to the terminals of the battery and name the anode and the cathode separately from X and Y.
- Write the cathodic reaction as a balanced equation.
- State an observation which helps to identify that a chemical reaction is taking place here.
- What is the reason for using dilute Sulphuric acid in the electrolysis of water?
- After a certain period of time, the volumes of gases collected in the electrodes differ from each other. Explain the reason for this difference based on the molecular formula of water.
- Calculate the number of moles of H_2 and O_2 produced when 9g of water is subjected to electrolysis completely. (H=1.O=16)

- In the following figures, Two cells are given as A and B.



- From the above two cells A and B, which is the electrolytic cell?
- Write one observation that could be obtained when the cell A operates.
- Write the cathodic reaction that takes place in cell B.
 - What is the name commonly given to the electrodes where oxidation reaction takes place in both cells?
- What is the reason for not using cell B in the production of sodium metal, industrially? (2017)

Competency level - 2.8 Investigates the process of corrosion

Exercises.

1. a. Define corrosion of metals.

.....

b. Name the two factors essential for rusting of iron by studying the activities 12.3.1, 12.3.2 and 12.3.3 of the text book.

I..... II.....

2. Rusting of iron is a series of electrochemical reactions. Write the relevant half reactions for the changes occur in the following instances.

a. Forming of Fe ions by losing electrons from iron atoms by oxidation.

.....

b. Formation of hydroxyl ions by combining the removed electrons in the above with water and oxygen. (Reduction)

.....

c. Multiplication of the half reaction in (a) in order to make the number of electrons equal in both half reactions.

.....

d. Writing of the overall reaction by combining both half reactions mentioned above.

.....

.....

e. Conversion of Fe (OH)₂ to hydrated ferric oxide by reacting with oxygen.

.....

f. The most suitable chemical formula for iron rust.

3. Identify the factors that affect the rate of rusting of iron by studying the activities 12.3.4 and 12.3.5 of the text book. Using that,

a. write two factors that increase the rate of rusting.....

b. write a factor that decreases the rate of rusting.

4. When controlling rusting of iron, the contact of iron with oxygen and water is prevented. For these, protective layers (coatings) are applied on iron. Give examples for such things and the relevant instances in our day to day life.

| Substance coated | Example for the instance |
|------------------|--------------------------|
| I . Paints | gates and Grills |
| II..... | |
| III..... | |
| IV. | |
| V..... | |

5. Pay attention for the activity 12.3.7 of the text book, which is carried out to find out the effect of other metals on rusting of iron.

a. Which components of the medium are used for the following? The iron nails are immersed in this medium.

- I. To identify Fe^{2+} ions formed at the anode
- II. To identify OH^- formed at the cathode
- III. To prevent the diffusion of irons formed.

b. Mention three metals that can be used to give cathodic protection for iron using the knowledge of the activity series.

- I.....
- II.
- III.

c. Write two instances in which cathodic protection is used.

- I.....
- II.....

Past papers:

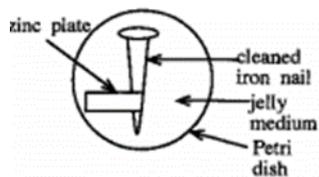
1.(A) (i) L and M are two metals which form only dipositive cations. When metal L is added to an aqueous solution of the sulphate of metal M (MSO_4), metal L gradually diminishes while metal M precipitates. (L and M are not standard symbols. When writing answers, use symbols L and M)

(a) Write the balanced chemical equation relevant to the chemical change stated above.

(b) Name the type of chemical change to which the reaction written in (a) above belongs.

(c) Of the two metals L and M, which metal is placed above in the activity series?

(ii) Figure of a set up arranged by a student to examine the effect of other metals on the corrosion of iron is given here. The jelly medium in this contains sodium chloride, phenolphthalein, potassium ferricyanide, water and agar.



- (a) I. When observed after a few hours, what colour can be observed in the jelly medium near the iron nail?
II. What is the ion which causes that colour change?
- (b) Write the balanced ionic equation for the half-reaction that occurs near the zinc plate.
- (c) What is the reason for adding sodium chloride to the jelly medium in this experiment?
- (d) I. Which metal act as the cathode in this experiment?
II. State the practical application related to this experiment.

(2018)

Translation completed