SENIOR FOUR
SELF STUDY MATERIALS
SCIENCE PACKAGE

THE REPUBLIC OF UGANDA
Ministry of Education and Sports

NCDC
NATIONAL CURRICULUM DEVELOPMENT CENTRE

CHEMISTRY

Topic: Reaction Rates and Reversible Reactions

By the end of this topic, you should be able to observe and explain the effects of different factors on reaction rates.

Introduction

Why are some reactions much faster than others? Is it possible to change how fast a reaction occurs? In this ***lesson***, you will learn what the rate of a chemical reaction is. You will also discover how factors such as temperature, concentration, surface area, and catalysts impact reaction rates.

Reaction Rate

When you hear the word rate, what do you think of? A loan interest rate? A rate of speed? A growth rate? Or maybe a rate of pay? Most rates have something happening in a specific amount of time, like the percentage of interest you pay on a bank loan every month, how far you drive in an hour, how fast you grow in a year, or how much you are paid every hour.

In Chemistry, the rate of a reaction describes how fast a reaction proceeds over time. In other words, a rate of reaction measures how quickly **reactants are changed into products**.

Reaction rate is the change in concentration of reactants over time or the change in concentration of products over time. Units for reaction rates are in terms of Mass/time. For faster reactions, seconds are used for units of time; for longer reactions, minutes are used.

Reaction rates may be expressed in terms of any chemical substances involved in the reaction. Reaction rate can be written for the disappearance of a reactant or the appearance of a product.

As an example of a reaction, take the reaction between hydrochloric acid and zinc metal. When combined, the acid "eats away" the metal to produce hydrogen gas and some dissolved metal salts. The rate of this reaction could be measured in terms of the disappearance of the zinc or the rate of appearance of hydrogen gas.

If we were expressing reaction rate in terms of disappearance of zinc metal, we would write:

$$\text{Reaction rate} = \frac{-\,change\,[zinc]}{time}$$

(If you were to draw a graph for this reaction, the slope of the line would be negative, because the concentration of our reactant is constantly decreasing).

If we were expressing reaction rate in terms of appearance of hydrogen gas, we would write:

$$\text{Reaction rate} = \frac{change\,[hydrogen\ gas]}{time}$$

(If you were to draw a graph for this reaction, the slope of the line would be positive, because the concentration of our reactant is constantly increasing.)

This reaction happens quickly, but think ... What are some ways that we could increase the rate of reaction? What are some ways that we could decrease the rate of reaction?

Before we talk about factors that influence reaction rate, let us look at a chemical reaction on the molecular level.

Chemical Reactions: A Molecule's View

Remember, molecules are made up of atoms bonded together by the sharing of electrons. These bonds are relatively strong and require a certain amount of energy to break. The random bumping and colliding of molecules with each other generally does not contain enough energy to break these bonds and cause a **chemical reaction**. Additionally, molecules must collide with proper orientation.

According to the collision theory, in order for a chemical reaction to happen, there needs to be an effective collision between the reactants. To be effective, a collision must meet the following two requirements:

i) Molecules collide with enough energy to break bonds

ii) Molecules collide with a favourable orientation

Any factor that affects the likelihood of an effective collision also affects the rate of reaction. Chemical reaction rates can differ when different factors are present. In this lesson, you will focus on the main rate changing contributors: temperature, concentration, surface area, and catalysts.

Temperature

Activity 1: You will investigate the effect of temperature on the rate of the reaction.

Things you will need: An anti-acid tablet (e.g. magnesium/activated charcoal tablets) two plastic cups labelled A and B, cold/iced water, hot water

Procedure

1. In cup A, put the iced/cold water and add ½ a tablet of anti-acid tablet.
2. In cup B, put the hot water add ½ a tablet of anti-acid tablet.
3. Observe which reaction is the quickest.

Questions

1. Which reaction had the fastest rate? How were you able to tell this?
2. Explain what could be occurring at the molecular level. (How are the molecules moving or acting?)

Concentration

Activity 2: You will investigate the effect of concentration on the rate of a reaction.

You will use the different concentrations of vinegar and baking soda for these reactions.

Things you will need: Vinegar/lemon juice, baking soda, water, cup, tea spoon

Procedure:

1. In one cup, use pure vinegar/lemon juice (3mL) and place one tea spoonful of baking soda.
2. In another cup, add pure vinegar/lemon juice (1.5mL) and water (1.5 mL) before you add the tea spoonful of baking soda.
3. Observe what is happening in the cups.

Questions

1. Which reaction had the fastest rate? How were you able to tell this?

2. Explain what could be occurring at the molecular level in each example. (How are the molecules moving or acting?)
3. Why are high concentration reactions faster than low concentrations?

Surface area

What is surface area? Surface area is the exposed matter of a solid substance. Imagine that you are holding a perfect cube of magnesium. The surface area is the sum of the area of all six sides of the cube. The surface area of the cube can be increased by dividing the cube into smaller cubes. Surface area is maximized when a single large cube is crushed to fine powder.

Activity 3: You will investigate the effect of surface area on the rate of a reaction.

You will use **steel wool** and the lighter/source of heat for the reactions.

Things you will need: Steel wool, box of matches

Procedure

1. Ball up pea size amount of steel wool. Burn the piece for 10 seconds.
2. Spread out the same amount of steel wool. Burn the spread-out piece for another ten seconds.
3. Make observations of what happens in both cases.

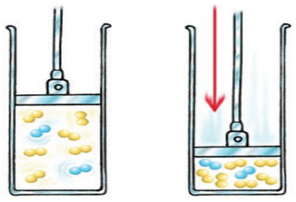
Questions

1. Which reaction had the fastest rate? How were you able to tell this?
2. Explain what could be occurring at the molecular level for the balled piece versus the spread-out piece. (How are the molecules moving or acting?)
3. If left to burn for more than 10 seconds, which would take longer, the balled piece or the spread-out piece? Explain your answer.

Pressure

How does pressure affect the reaction rate?

The concentration of a gas is a function of the pressure on the gas. Increasing the pressure of a gas is exactly the same as increasing its concentration. If you have a certain number of gas molecules, you can increase the pressure by forcing them into a smaller volume.



Under higher pressure or at a higher concentration, gas molecules collide more frequently and react at a faster rate. Conversely, increasing the volume of a gas decreases pressure which in turn decreases the collision frequency and thus reduces the reaction rate.

It is important to note, however, that there are reactions involving gases in which a pressure change does not affect the reaction rate. For this reason, the rates of reactions involving gases have to be determined by experiment. Also note that solids and liquids are not affected by pressure changes.

Catalyst

Activity 4: You will investigate the effect of catalysts on the rate of a reaction.

You will use the catalyst provided with the vinegar and baking soda for these reactions.

Things you will need: Vinegar, baking soda, yeast, balloon, plastic bottle

Procedure

1. In a small plastic bottle, use pure vinegar and place one tea spoonful of baking soda and cover with a balloon.
2. In another small plastic bottle, add pure vinegar and add catalysts (yeast) before you add the tea spoonful of baking soda covered with a balloon.
3. Make observations of what happens in both cases.

Questions

1. Which reaction had the fastest rate? How were you able to tell this?
2. Explain what could be occurring at the molecular in each example. (How are the molecules moving or acting?)
3. How does the catalyst cause this effect? (**Hint**: Think of the structure of the catalyst)

Follow-up Activity

1. Utilise your knowledge of reaction rates to explain why we keep most foods in the refrigerator.
2. Utilise your knowledge of reaction rates to explain why highly concentrated medications can be deadly.
3. If the temperature, concentration or surface area were increased in the following scenario, hypothesize how it would change the reaction.
   Reactant A + Reactant B -> Product

PHYSICS

INTRODUCTION TO CURRENT ELECTRICITY

Lesson 1

Competence:
By the end of this lesson, you should be able to:
1. Explain what is meant by electromotive force (emf).
2. Construct a simple electric cell using local materials.
3. Describe how dry cells convert chemical energy into electrical energy.

Introduction:
Have you ever used a torch that uses a dry cell (battery)? Have you ever noticed that such a torch does not work without the dry cell(s)? What is it that these dry cells have that make the torch to light?

Materials you need:
- A lemon/orange fruit
- A dry cell (e.g. Tiger head)
- Two copper nails
- Two zinc nails
- Four crocodile clips
- A torch bulb or LED
- Two connecting wires

Procedures:
1. Look around your home/community and get the following:Two copper nails
   i. Two zinc nails
   ii. Four crocodile clips
   iii. A torch bulb or a LED
   iv. Connecting wires.
2. Pick a lemon or an orange fruit (You can buy one from the market).
3. Connect the circuit shown in Figure 1.1. (In absence of the crocodile clips you may connect the connecting wires directly to the nails and the terminals of the LED or bulb).

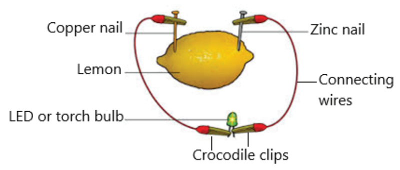


Figure 1.1: The lemon cell

4. Explain what you observe.
5. Remove the crocodile clip from the zinc nail. Explain what you observe.
6. Replace the copper nail with another zinc nail. What happens to the LED?
7. Replace the zinc nails in procedure 5 with two copper nails. What happens to the LED?
8. Reconnect **Figure 1.1**, this time replacing the connecting wires with pieces of cotton thread. What do you observe?
9. Replace the lemon fruit with a dry cell e.g. a Tiger head cell and repeat procedures **3** to **8**.

Activity:

1. Explain your observations in procedures **6**, **7** and **8**.
2. Describe the energy transformations that take place in Figure 1.1.

For your knowledge:

1. An electrochemical cell is a device which can convert chemical energy into electrical energy. The lemon acts like an electrochemical cell.
2. A closed path connected to an electric cell is called an electric circuit.
3. The energy which the lemon cell produces to drive the electrons round the electric circuit connected to it is called electromotive force (emf).
4. The rate of flow of electrons in an electric circuit is known as electric current or simply electricity.
5. Electric current cannot flow through an open circuit or an insulator like the cotton thread.

Activity:

Connect **Figure 1.1** using an apple, a pineapple, a mango, an Irish potato and a tomato. Explain your observations in relation to the brightness of the bulb.

Lesson 2

By the end of this lesson, you should be able to:

1. Identify the different types of electric cells.
2. State the uses of electric cells and their limitations.
3. Describe different sources of emf.

Introduction:

In lesson 1, you learnt that electricity is the rate of flow of electrons in an electric circuit. Can you name some of the equipment in your home or community which needs electricity to operate? You will now need to understand the different sources of electricity used in different equipment.

For your knowledge

1. When two or more electrochemical cells are connected together, they form a battery.
2. There are two types of electrochemical cells/batteries, namely:
   i. Primary cells/batteries which are not rechargeable.
   ii. Secondary cells/batteries which are rechargeable.

Materials you need:

- Primary cells/batteries.
- Secondary cells/batteries.

Procedures:

1. Name some of the commonly used primary cells/batteries in your home or community.
2. Repeat procedure 1 for the commonly used secondary cells/batteries.
3. Study Figure 1.2 and identify the primary and secondary cells/batteries.

Figure 1.2: Primary and secondary cells/batteries

4. Name the equipment in which each type of cell/battery shown in Figure 1.2 is applied in your home/community.
5. What are the advantages and disadvantages of using primary cells over secondary cells?

Project:

Visit a place where batteries are charged (e.g. where car or phone batteries are charged). Ask the mechanic or the person charging the phone batteries to explain to you what happens during discharging and recharging of a battery and take notes.

Other sources of electricity

Figure 1.3: Some sources of electricity

Procedures:

1. Study images shown in Figure 1.3. Identify the sources of electricity in (a), (b), (c), (d) and (e).
2. Which of these sources of electricity are commonly used in your home/community?
3. Describe how the device shown in (e) produces electricity. (You may ask some technical person in your community to assist you).
4. Do you have some people in your community who use the source of electricity shown in (d)?
5. Inquire on the advantages and disadvantages of using the source of electricity in (d) over the source of electricity in (e), and take notes in your notebook.
6. Compare and contrast the electrochemical cells as a source of electricity to the source of energy shown in Figure 1.1 (b).

For your knowledge

1. Direct current is the type of electricity in which the electrons (charges) flow in only one direction. All electrochemical cells and solar cells produce direct current.

Hydro electricity and all electricity produced from generators are alternating currents. Alternating currents vary continuously in magnitude and direction with time.

Project

Figure 1.4

1. State the economic activities taking place in Figure 1.4.
2. Discuss the suitability of the choice of the source of electricity used in Figure 1.4.
3. Design an economic activity which requires use of electricity. Suggest with reasons, the source of electricity you would employ for your project.

Lesson 3

By the end of this lesson, you should be able to:

1. Identify instruments used for measuring current and voltage.
2. Draw the circuit symbols in circuit diagrams.

Introduction:

An electric circuit has got many components like the source of emf, the connecting wires, the gadget used for measuring the amount of current flowing in the circuit, the bulbs and many others. Scientists have developed standard symbols to identify these components in the electric circuit. In this lesson you will appreciate the use of symbols in circuit diagrams.

Circuit symbol for sources of emf

The emf sources that generate direct currents have one of their terminals (ends or connecting points) labelled positive (+) and the other terminal is labelled negative (-). The circuit symbols are shown below:

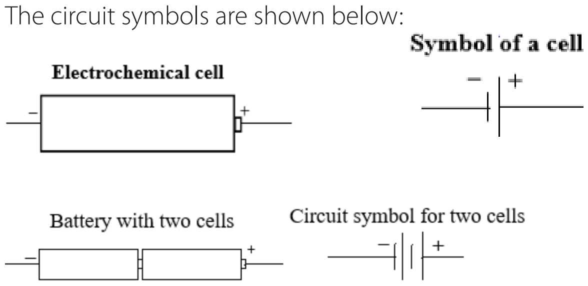
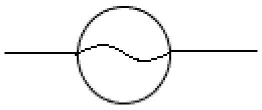


Figure 1.5: Circuit Symbols

Activity:

- Draw a circuit symbol for a battery with six (6) cells.

As you learnt earlier, the emf produced by electric generators yield alternating currents. The circuit symbol for emf sources that generate alternating currents is as below:



Circuit symbol for source of alternating emf

Note that the terminals of the source of an alternating emf do not have + or – signs.

Switch

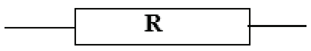
A switch in a circuit component is used to open or close the circuit. The circuit symbol is shown below:

Switch

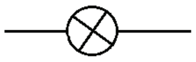
Electrical Appliances

When any electrical appliance like a bulb, flat iron, radio, heater, etc is connected in an electric circuit, it opposes the flow of current through itself. Therefore, work must be done to force electric current through the appliance. Such an appliance which opposes the flow of electric current through itself is called a **resistor** in the circuit.

The circuit symbol for any resistor in a circuit is as below:



Symbol of a Resistor

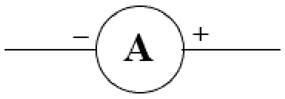


Special symbol for a bulb

A measure of the amount of opposition to the flow of current through any electrical appliance is called the Electrical Resistance (R) of the appliance. The unit for measuring resistance is **Ohm** (Ω).

Measurement of Current

The instrument used to measure the amount of current flowing in a circuit is called an **Ammeter**. The unit for measuring electric current is the **Ampere** (symbol **A**). The circuit symbol for an Ammeter is shown below:

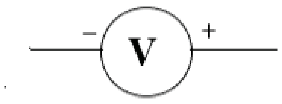


Circuit symbol of an Ammeter

The Ammeter has a positive and a negative terminal. In a circuit, the positive terminal of the Ammeter must be connected to the positive terminal of a direct current source of electricity. Traditionally, the positive terminal of the Ammeter was always coloured red while the negative terminal had a black clolour. To measure the amount of current flowing through an appliance, the appliance and the Ammeter must be connected in line (series).

Potential difference

This is the amount of energy required to move current through an electrical appliance against its opposition to the flow of current through itself. Potential difference (pd) is measured in volts (V) using an instrument called the voltmeter. The circuit symbol for a voltmeter is shown below:



Circuit symbol for a Voltmeter

When measuring the potential difference across an appliance, the voltmeter should be connected opposite (parallel) to the appliance with the positive terminal of the voltmeter connected to the positive terminal of the source of emf.

All these components can be drawn in a single circuit diagram as shown in Figure 1.6:

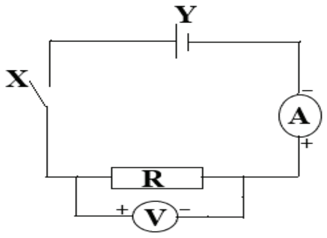


Figure 1.6: Components of an electric circuit

Procedures

1. Identify the components A, R, V, X and Y in Figure 1.6.
2. Draw a circuit diagram for Figure 1.1.

For your knowledge

1. Not all circuit components are very necessary in a circuit e.g. if you do not want to measure the current in the circuit, you can remove the Ammeter from the circuit and hence you do not include it in the circuit diagram.
2. Some circuits have a combination of the same components e.g. different brands of bulbs. These must be drawn as resistors with their different resistance values indicated.

Lesson 4

Competence:

By the end of this lesson, you should be able to explain the series connection of electrical appliances (Resistors).

Introduction:

At times you may have many components to connect in a circuit. One of the ways to connect these components is to arrange them in a series.

Series arrangement of resistors:

In this case, the electrical appliances (resistors) are connected in line, one following the other as shown in Figure 1.7.

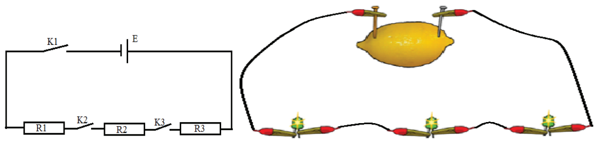


Figure 1.7: Series connection of resistors

Materials you need:

- One dry cell (1.5V size 3D)
- Three torch bulbs
- Three switches
- Seven connecting wires

Procedures:

1. Connect the circuit shown in Figure 1.7 using the materials listed above.
2. Close switch K1. Do the bulbs R1, R2 and R3 light?
3. Open switch K1.
4. Repeat procedures 2 and 3 for switches K2 and K3.
5. Now, close all the three switches K1, K2 and K3. Comment on your observation.
6. Remove bulb R3 from the circuit and close all the switches. Compare the brightness of bulbs R1 and R2 before and after removing bulb R3.
7. Remove bulb R2 so that only bulb R1 remains in the circuit. Close all the switches and compare the brightness of bulb R1 to its brightness in cases 5 and 6 above.
8. What conclusions can you draw from your observations in 5, 6 and 7?

Activity:

1. Replace the dry cell with a lemon fruit and repeat the procedures 1 to 8 above.
2. If you can get Ammeters, replace all the switches with Ammeters as shown in the Figure 1.8:

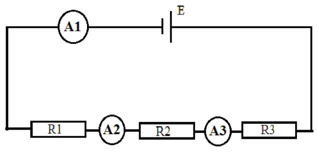


Figure 1.8

3. Compare the readings of Ammeters A1, A2 and A3. What conclusion can you draw?
4. Look for Voltmeters and connect the circuit shown in Figure 1.9.

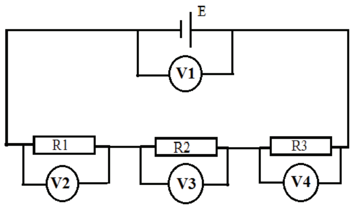


Figure 1.9

5. Compare the readings of Voltmeters V1, V2, V3 and V4. What conclusion can you draw?

For your knowledge

1. The same current flows through all resistors connected in a series.
2. The sum of the potential drops across the individul resistors is equal to the emf of the source of electricity.
3. The potential drop across each resistor is directly proportional to the resistance of the resistor.

Project

Check the electrical appliances in your home or community which are connected in series to an emf source. What happens when one of them blows? Explain your response.

Lesson 5

Competence:

By the end of this lesson, you should be able to explain parallel connection of electrical appliances (Resistors).

Introduction:

In lesson 4, you learnt that one way to connect many components in a circuit is to arrange them in a series. Another alternative of arranging these components is to connect them in parallel.

Parallel arrangement of resistors:

In this case, the electrical appliances (resistors) are connected side by side as shown in Figure 1.10.

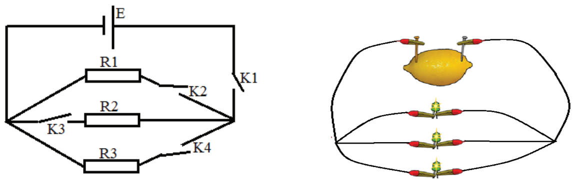


Figure 1.10: Parallel connection of resistors

Materials you need:

- One dry cell (1.5V size 3D)
- Three torch bulbs
- Three switches
- Seven connecting wires

Procedures:

1. Connect the circuit shown in Figure 1.10 using the materials listed above.
2. Close switch K1. Do the bulbs R1, R2 and R3 light?
3. Open switch K1.
4. Repeat procedures 2 and 3 for switches K2, K3

and K4.
5. Close switch K1.
6. Close switch K2 as switches K3 and K4 remain open. Comment on your observation.
7. Open switch K2.
8. Repeat procedure 6 and 7 for K3 and K4.
9. Close switches K2 and K3, leaving switch K4 open. Comment on your observation.
10. Close all the switches and comment on your observation.

Activity:
1. Replace the dry cell with the lemon fruit and repeat procedures 1 to 10 above.
2. If you can get Ammeters, replace all the switches with Ammeters as shown in the Figure 1.11:

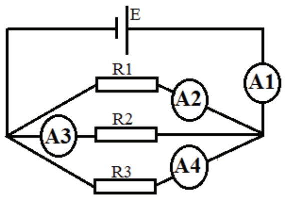


Figure 1.11

3. Compare the readings of Ammeters A1, A2, A3 and A4. What conclusion can you draw?
4. Look for Voltmeters and connect the circuit as shown in Figure 1.12;

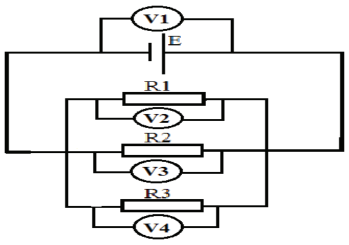


Figure 1.12

5. Compare the readings of Voltmeters V1, V2, V3 and V4. What conclusion can you draw?
6. Discuss the advantages and disadvantages of a series connection over the parallel network of resistors.

For your knowledge
1. The potential drop across each of the resistors in a parallel network is the same.
2. The current flowing through each resistor is inversely proportional to the resistance of the resistor. This means that less current flows through components with higher resistance.
3. The current in the circuit is the algebraic sum of the currents flowing through the individual resistors.

Activity:
Check the electrical appliances in your home or community which are connected in a series to an emf source. What happens when one of them blows? Explain your response.

Project
1. Construct two model houses using ply wood or hard paper with each house having four rooms. Wire the houses such that each room has one bulb. In one house the bulbs should be wired in series while in the other the bulbs should be wired in parallel.
2. Two tenants, A and B, live in different rooms but in the same house. Whenever tenant A switches on his electric stove to start cooking, the bulbs in the room of tenant B go dim. This has brought about conflict between the two tenants. As a Physician, write an explanation to the landlord on the root cause of this problem and suggest a solution.

Lesson 6

Competence:
By the end of this lesson, you should be able to explain a series connection of sources of emf.

Introduction:
Most batteries in the market produce emf of up to 1.5V. This value is often written on the cell or battery. However, some of the electrical appliances you use at home require more emf than this to operate. The only way to obtain these high voltages is by combining the cells/batteries.

Series arrangement of cells:
In case a higher voltage is required to operate an appliance, the cells are connected in line, one following the other as shown in Figure 1.13.

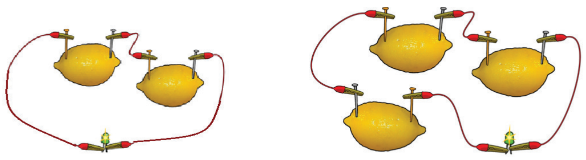


Figure 1.13: Series connection of resistors

Materials you need:
- Three lemon fruits
- One torch bulb or LED
- Four connecting wires
- Eight crocodile clips
- Three copper nails
- Three zinc nails

Procedures:
1. Connect the circuit shown in Figure 1.13 (a). Observe the brightness of the bulb/LED.
2. Connect the circuit shown in Figure 1.13 (b). Compare the brightness of the bulb/LED now and in case 1 above.
3. What conclusion can you draw?

Materials you need:
- Three dry cells
- Two switches
- One torch bulb
- Six connecting wires

Procedures:

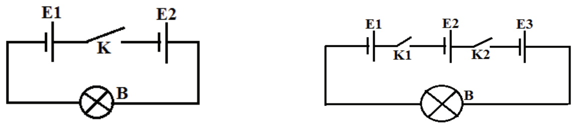


Figure 1.14: Cells in series

1. Connect the circuit shown in Figure 1.14 (a) using the materials listed above.
2. Close switch K and note the brightness of bulb B.
3. Open switch K1.
4. Add a third cell E3 to the circuit so that the circuit is as shown in Figure 1.14 (b).
5. Close switch K1 leaving switch K2 open. Comment on your observation.
6. Repeat procedure 5 with switch K1 open and switch K2 closed.
7. Close both switches K1 and K2. Comment on your observation.
8. Compare your observations in procedure 2 to that in procedure 7.

Materials you need:
- Three dry cells
- An Ammeter
- One torch bulb
- Six connecting wires

Procedures

Figure 1.15: Current generated by cells in series

1. Connect the circuit in Figure 1.15 (a). Read and record the Ammeter reading.
2. Connect the circuit in Figure 1.15 (b). Read and record the Ammeter reading.
3. Explain the variations in the ammeter readings in procedures 1 and 2 above.

Materials you need:
- Three dry cells
- Four Voltmeters
- One torch bulb
- Six connecting wires

Procedures

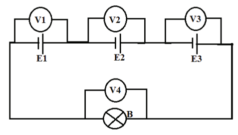


Figure 1.16: Potential different across a bulb connected to cells in series

1. Connect the circuit shown in Figure 1.16.
2. Read and record the readings of the Voltmeters V1, V2, V3 and V4.
3. Remove cell E1 and Voltmeter V1 from the circuit.
4. Close the circuit and take the readings of the remaining Voltmeters V2, V3 and V4.
5. What conclusion can you draw?

For your knowledge
When cells are connected in series:
1. They supply more current to the circuit.
2. They supply more energy to drive the charges round the circuit.

Project
Check the electrical appliances in your home or community which use sources of emf that are connected in series. What happens:
1. When the terminals of one of the emf sources is reversed?
2. To the aging of the individual sources of emf?

Lesson 7

Competence:
By the end of this lesson, you should be able to explain the parallel connection of sources of emf.

Introduction:
In lesson 6, you learnt that one way to connect many sources of emf in a circuit is to arrange them in series. Many cells can also be connected in a circuit in parallel.

Parallel arrangement of cells:
In this case, the cells are connected side by side as shown in Figure 1.17.

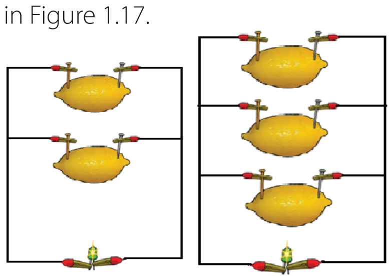


Figure 1.17: Parallel connection of emf sources

Materials you need:
- Three lemon/orange fruits

- One torch bulb/LED
- Seven connecting wires

Procedures:
1. Connect the circuit shown in Figure 1.17 (a) using the materials listed above.
2. What happens to the bulb/LED?
3. Add a third lemon to obtain the circuit shown in Figure 1.17 (b).
4. What happens to the bulb/LED?
5. Comment on the brightness of the bulb/ LED in procedures 1 and 3.

Materials you need:
- Two dry cells
- One torch bulb/LED
- Seven connecting wires
- Three switches

Procedures:

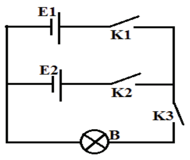


Figure 1.19: The behaviour of cell in parallel connection

1. Connect the circuit shown in Figure 1.19.
2. Close switch K3. What happens to the bulb?
3. With switch K3 closed, close switch K1 and leave switch K2 open. Comment on your observation.
4. Open switch K1 and close switch K2. Comment on your observation.
5. Close all the switches K1, K2 and K3. Comment on your observation.
6. Compare the brightness of the bulb in procedures 2, 4 and 5.

Project

Connect three (3) cells in parallel to a bulb and carryout the investigations as prescribed in the above procedures.

Materials you need:
- Two dry cells
- One torch bulb
- Seven connecting wires
- Three Ammeters

Procedures:

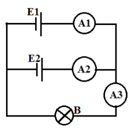


Figure 1.20: Current supplied by cells in parallel

1. Connect the circuit shown in Figure 1.20.
2. Read and record the readings of the Ammeters A1, A2 and A3.
3. Comment on the values of current read from Ammeters A1, A2 and A3.
4. What conclusion can you draw?

Materials you need:
- Two dry cells
- One torch bulb
- Seven connecting wires
- Three Voltmeters

Procedures:

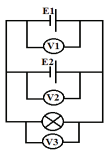


Figure 1.21: Pd across a bulb connected to cells in parallel

1. Connect the circuit shown in Figure 1.21.
2. Read and record the readings of the Voltmeters V1, V2, and V3.
3. What conclusion can you draw?

Activity:

Check the electrical appliances in your home or community in which the cells are connected in a parallel arrangement. Did you locate these appliances easily? Give reasons for for response.

CHAPTER 2

VOLTAGE, RESISTANCE AND OHM'S LAW

Lesson 1

Competence:

By the end of this lesson, you should be able to:
1. Calculate the electric current or charge flowing through a conductor.
2. Determine effective resistances.

Introduction:

In chapter 1, you learnt that electric current is the rate of flow of electric charges. Mathematically this can be expressed as:

$$Electric\ current = \frac{Quantity\ of\ charge}{Time\ taken}$$

$$Electric\ current = \frac{Quantity\ of\ charge}{Time\ taken}$$

The symbol for electric charge is *I*, and that for the quantity of charge is *Q*. Therefore, the above equation can be expressed as:

$$I = \frac{Q}{t} I = \frac{Q}{t}$$

The unit of current is Amperes if the quantity of charge is measured in *Coulombs (C)* and time is measured in *seconds (s)*.

Exercises 2.1:
1. Find the current flowing through a point in a circuit if:
   1. 20C of charge flows through the point in 3min.
   2. It takes 5s for 20C of charge to flow through the point.
   3. 1.2×10^{-6}C of charge flows through the point in 4×10^{-3}s.
2. A current of 2.4A flows through a circuit for 1hour, 30min, 10s respectively. Find the charge that flows through a point in the circuit in the respective times.

Effective resistance of resistors in series arrangement

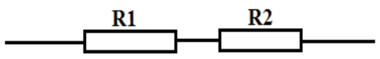


Figure 2.1: Resistors in series

If two resistors of resistances R1 and R2 are connected in series as shown in Figure 2.1, their effective resistance, R, is given by addition:

R = R1 + R2

Recall the unit of resistance is the Ohm (Ω).

Exercise 2.2:
1. Given that the following resistors are in a series arrangement, find their effective resistance:
   a) 5Ω and 7 Ω.
   b) 12 Ω and 28 Ω.
   c) 3Ω, 8 Ω and 9 Ω.
2. The effective resistance of two resistors connected in series is 15 Ω. If the resistance of one of the resistors is 7Ω, find the resistance of the other resistor.
3. The resistance of one resistor is twice the resistance of another resistor. When the two resisitors are connected in series, their effective resistance is 21Ω. Find the resistance of each of the resistors.

Effective resistance of resistors in parellel arrangement

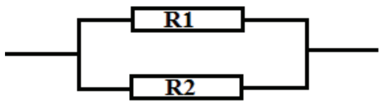


Figure 2.2: Resistors in parallel

If two resistors of resistances R1 and R2 are in a parallel arrangement as shown in Figure 2.2, their effective resistance, R, is given by addition:

$$\frac{1}{R} = \frac{1}{R1} + \frac{1\ 1}{R2\ R} = \frac{1}{R1} + \frac{1}{R2}$$

Special case:

If there are only two resistors in parallel arrangement, the effective resistance, according to equation (3) is given by:

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} = \frac{R1+R2}{R1R2}$$

$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} = \frac{R1+R2}{R1R2}$$

$$\therefore R = \frac{R1R2}{R1+R2} \therefore R = \frac{R1R2}{R1+R2}$$

From equation (4), the effective resistance, R, is given by:

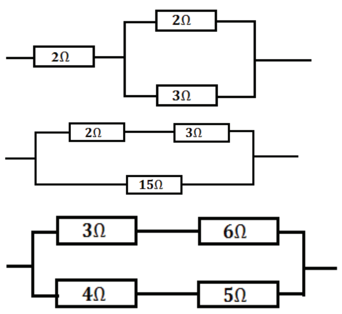
$$R = \frac{Product\ of\ resistances}{Sum\ of\ resistances}$$

$$R = \frac{Product\ of\ resistances}{Sum\ of\ resistances}$$

Exercise 2.3:
1. Find the effective resistances of the following resistors if connected in a parallel arrangement:
   a) 3Ω and 6Ω
   b) 6 Ω and 6 Ω
   c) 8 Ω and 12 Ω
   d) 2 Ω, 5 Ω and 10 Ω
2. The effective resistance of two resistors in a parallel arrangement is 2.4 Ω. If the resistance of one of the resistors is 4 Ω, find the reisitance of the other resistor.

Resistors in both series and parallel arrangement

Now that you can find the effective resistance of resistors in a series arrangement or in a parallel arrangement, try to find the effective resistance of the following resistors:



BIOLOGY

Topic: Growth and Development

Introduction

By the end of this topic, you should be able to conduct an experiment on plant growth over time. You should also be able to plot a growth-time graph on the growth observed.

You can easily determine the growth in plants by using a germinating seedling. The rate at which a seedling grows shows the availability of nutrients in the soil and the overall health of the plant.

Activity: Determining the growth rate of a seedling

In the activity below, you will germinate seeds and take measurements on the shoot of the seedlings to determine the rate of growth.

Things you will need: Maize grains, empty plastic water bottle, water, knife or razor blade, ruler, pen / pencil, graph paper

Procedure

1. Half way the length of the water bottle, make a mark with pencil / pen.
2. Cut the bottle using a knife or razor blade from the marked part.
3. Remove the top part of the bottle.
4. Put soil in the remaining part of the bottle.
5. Put maize grains in the soil but on the side nearer the wall of the bottle where you can see.
6. Sprinkle water onto the soil. Why is this so? Keep checking on the seeds.
7. Note down when the shoot appears. Record this as day 0 in the table.

Time (days)	Length of shoot (cm)
Day shoot appears (day 0)	0
Day 2	
Day 4	
Day 6	
Day 8	
Day 10	

8. Then after two days, measure the height of the shoot in millimeters. Continue with measurement and record the result after every two days for the next 5 days.
9. From the records obtained, plot a graph of growth rate against time (number of days).

Follow-up activity

During germination and growth of maize, the dry weight of the endosperm, the weight of the embryo and the total dry weight were determined at two-day intervals. The results are shown in the table below.

Time after planting (days)	Dry weight of endosperm (mg)	Weight of embryo (mg)	Total dry weight (mg)
0	43	2	45
2	40	2	42
4	33	7	40
6	20	16	37
8	10	25	35
10	6	33	39

1. On the same axes, draw a graph of the dry weight of the endosperm, weight of the embryo and the total dry weight against time.
2. Determine the total dry weight on day 5
3. Explain:
   i) the decrease in dry weight of the endosperm from days O to 10.
   ii) the increase in dry weight of embryo from days O to 10.
   iii) the decrease in total dry weight from day O to 8.
   iv) the increase in total dry weight after 8 days.

MATHEMATICS

Class: SENIOR FOUR

Mathematics

Topic: Algebra

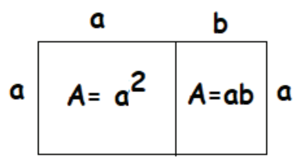
Introduction: By the end of the topic you will be able to expand, factorise and solve quadratic equations with degree polynomial of 3.

In S.2 and S.3 you learnt how to expand algebraic expressions, we will begin by revising what we did.

Lesson 1

Let us review how to expand a(a+b)

We shall use a rectangle with length (a+b) and width a



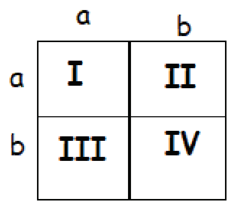
Learning Tip: To find the area of the rectangle, you need to divide it into a square of length a and rectangle of width b and length of a+b.

Total area of Rectangle= Area of square + Area of Rectangle

$a(a+b) = a^2+ab$

Learning Tip: Finding the area of the rectangle has enabled us to expand a(a+b) to obtain a^2+ab. The process introduces us to expansion by opening the brackets

Using the same approach let us expand (a+b) (a+b)



Learning tips: The dimensions of the four-sided figure are (a+b) and (a+b)

The area of the four-sided figure= Area of (I+II+III+IV)

$= (a^2+ab+ab+b^2)$

Area of the four-sided figure $= a^2+2ab+b^2$

Hence Expanding (a+b) (a+b) $=a^2+2ab+b^2$

IDENTITY 1: (a+b) (a+b) $=a^2+2ab+b^2$

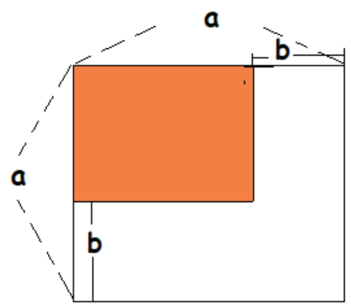
Activity 1

Expand the following

a. **(a+2) (a+3)**
b. **(a+1) (a+2)**
c. **$(a+1)^2$**
d. **$(a+2)^2$**

Lesson 2: Let us now expand (a-b)(a-b)

We use a four- sided square of dimension a, to find the area of the shaded part.

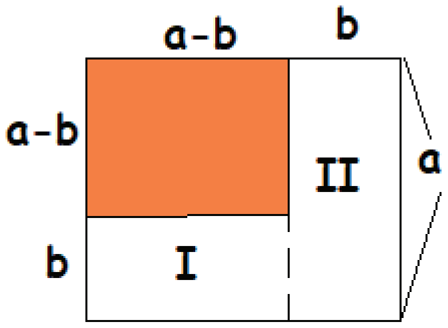


Learning Tip:*dimension of the square is a-b*

Find the Area of shaded Part = (a-b) (a-b)

Area of Shaded part = Area of big square- Area of Un shaded part

Let us find the area of the shaded part



Learning Tips: The unshaded part is further sub divided into two portions to enable us find the area
Area of (I+II)

A=b(a-b)+a×b

A=ab-b^2+ab

The Area of the Unshaded area is 2ab-b^2

A=2ab-b^2

Therefore, the area of the unshaded part =Area of the big square- The area of the Unshaded part

We have been able to expand (a-b) (a-b) to obtain the answer as a^2+2ab-b^2

(a-b) (a-b) =a^2+2ab-b^2

Activity 2

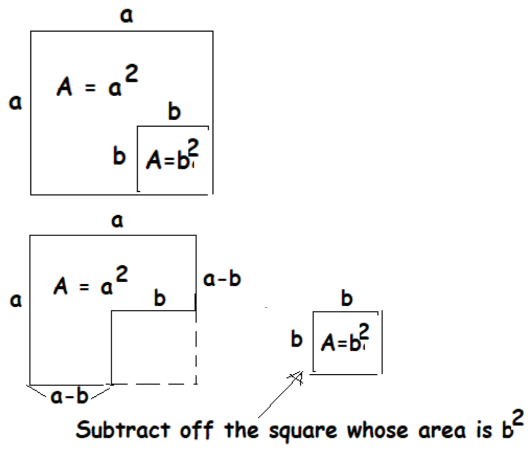
Expand the following

e. **(a-2) (a-3)**
f. **(a-1) (a-2)**
g. **$(a-1)^2$**
h. **$(a-2)^2$**

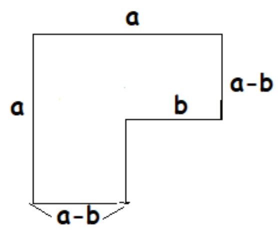
Lesson 3: Let us expand (a+b) (a-b)

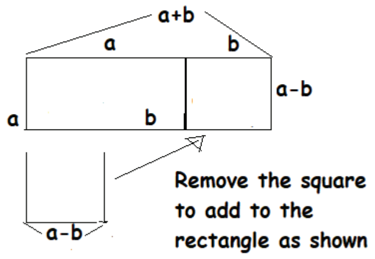
If we consider two squares whose dimensions are a and b respectively.

Then we take cut out the square whose Area is b^2 we shall be left with a^2



The remaining area is a^2-b^2 represented by the shape





Clearly from the figure; (a+b)(a-b)=a^2-b^2

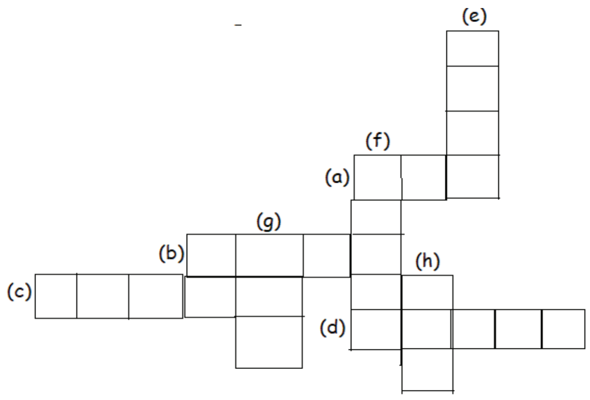
IDENTITY 3: a^2-b^2 =(a+b)(a-b)

ACTIVITY

1. Expand the following
   a) (a+3) (a-3)
   b) (b+4) (b-4)
   c) (d+5) (d-5)

Cross Number Puzzle

You have to solve the given cross number puzzle to qualify for thenext round ofMathematics quiz competition. Evaluate the values of given expression at x = 0, y = 1, z = 2. Fill the cross number along Across and Downward with the help ofgiven clues, (Numbers to be written in words)



Across(a) xy + yz + zx

(b) $x^2y^2 + z^2 - 2xyz$

(c) 8 – (x+y)

(d) $x^2y^3 + y^2z^3 + z^2x^3$

Down

(e) $x^2 - 2xy (y-z)$

(f)

(g) $x^3 + y^3 + z^3 - 2yz^2$

(h) 2x + 2y + 2

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