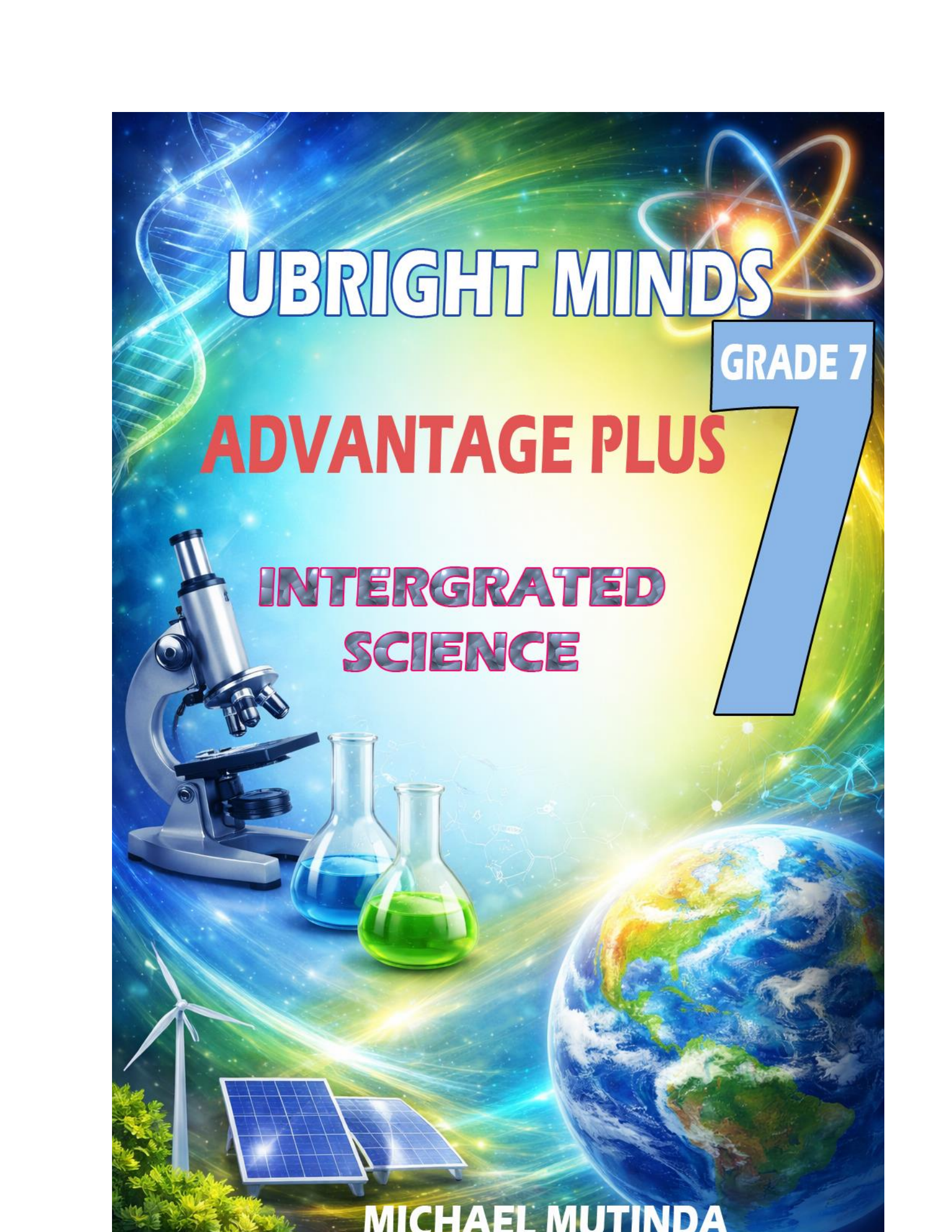




UBRIGHT MINDS

GRADE 7

ADVANTAGE PLUS

**INTERGRATED
SCIENCE**

MICHAEL MUTINDA

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Table of Contents

1.0 Introduction to Integrated Science	3
Meaning of Integrated Science	3
1.1.1 Components of Integrated Science	3
1.1.2 Importance of Science in Daily Life	4
1.1.4 Pathways Related to Integrated Science	7
1.2 laboratory safety.....	11
1.2.1 Common Laboratory Hazards	12
1.2.2 Common Laboratory Accidents, Their Causes, and First Aid Measures.....	14
1.2.3. Prevention of Laboratory Accidents	16
1.3 laboratory apparatus and instruments	19
1.3.1 Basic Skills in Science	19
1.3.2 Uses and Care for Apparatus in the Library	19
1.3.3 International System of Units (SI Units).....	25
1.3.4 Practical activities	26
2.0 mixtures, elements and compounds	49
2.1 Mixtures	49
2.2 Separation of Mixtures.....	51
1. Simple Distillation	51
2. Crystallisation	53
3. Sublimation	54
4. Solvent Extraction.....	56
5. Paper Chromatography	57
6. Evaporation	59
7. Fractional Distillation	60
2.2 ACIDS, BASES AND INDICATORS	61
3.0 LIVING THINGS AND THEIR ENVIRONMENT	69
3.1 HUMAN REPRODUCTIVE SYSTEM	69

3.1.1. The Male Reproductive System	69
3.1.2. The Female Reproductive System	71
3.1.3 adolescence	72
3.2 The human Excretory System	76
3.2.1 The human skin	76
3.2.2 Urinary System	78
4.0 FORCE AND ENERGY	82
4.1 ELECTRICAL ENERGY	82
4.1.1 Sources of Electricity	82
4.1.2 Simple Electrical Circuit	84
4.2 MAGNETISM	88
4.2.1 Types of Magnets	88
4.2.2 Properties of Magnets	88
4.2.3. Magnetic vs Non-Magnetic Materials.....	89
4.2.4 Uses of Magnets in Daily Life	90



1.0 Introduction to Integrated Science

- ❖ Integrated Science shows how different fields of science work together to explain events in everyday life.
- ❖ It gives learners basic **knowledge, skills, values and attitudes** needed for daily life and for future studies in science-related subjects.
- ❖ Integrated Science helps learners understand the **natural world** by observing, asking questions, experimenting and using **facts and evidence**.

Meaning of Integrated Science

- ❖ Integrated means **combining different things to form one whole**. In science, it means bringing together different subjects to learn them as one.
- ❖ Science is the **study of the natural world** such as plants, animals, air, water and matter. Science is based on **facts, experiments and observations**, not guesses.

Integrated Science **combines different fields of science into one learning area**. It helps learners understand how science is used to **solve problems** in daily life. Integrated Science prepares learners for **advanced science subjects** in senior school.

1.1.1 Components of Integrated Science

- ❖ The components of Integrated Science are: **Biology, Chemistry and Physics**
- ❖ These components are studied together because they are **closely related**.

Biology

- ❖ Biology is the **study of living things**.
- ❖ It includes plants, animals and microorganisms.



- ❖ Biology helps us understand **growth, health and life processes**.

Chemistry

- ❖ Chemistry is the **study of the composition, structure, properties and changes that matter undergoes**.
- ❖ It helps us understand **chemicals, materials, medicines and reactions**.
- ❖ Chemistry explains how substances **change or combine**.

Physics

- ❖ Physics is the **study of matter and how it interacts with energy**.
- ❖ It helps us understand **motion, heat, light, sound and electricity**.
- ❖ **Energy** is the **ability to do work**, such as moving objects or producing light.

1.1.2 Importance of Science in Daily Life

- ❖ Science is important because the **knowledge and skills learned in science are used every day**.
- ❖ Science helps people **solve problems**, make work easier and improve the **quality of life**.
- ❖ Through science, people develop **technology, machines and medicines** that help society grow and stay healthy.

Science is Importance of Science in Different Areas

(a) Health

- ❖ Science is used to **make medicines and vaccines** that treat and prevent diseases.
- ❖ Science helps doctors diagnose illnesses using **medical machines**.
- ❖ Medical equipment such as **X-ray machines, scanners and thermometers** are made using science.
- ❖ Science helps improve **human health and life expectancy**.



(b) Agriculture

- ❖ Science helps farmers produce **fertilisers and veterinary medicines** for crops and animals.
- ❖ Science is used to make **farm tools and machines** such as tractors, harvesters and millers.
- ❖ Science helps farmers improve **food production and animal health**.
- ❖ Modern farming methods help reduce **hunger and food shortages**.

(c) Industry

- ❖ Engineers use science to build **roads, bridges, houses and factories**.
- ❖ Science is used to make **building materials** such as cement, tiles and roofing sheets.
- ❖ Science helps in making **plastics, glass and metals** used in daily life.
- ❖ Household chemicals such as **soap, detergents, bleach and disinfectants** are made using science.
- ❖ Science supports **manufacturing and job creation**.

(d) Food

- ❖ Science is used in **food preservation** to prevent food from spoiling.
- ❖ Methods include **fermentation, cooling, drying and canning**.
- ❖ Science is used to make **kitchen equipment** such as electric cookers, ovens, microwaves, fridges and air fryers.
- ❖ Food preservation helps keep food **safe and available for longer periods**.

(e) Textile

- ❖ Science helps in making **natural fabrics** such as cotton and wool.



- ❖ Science is also used to make **man-made fabrics** like nylon and polyester.
- ❖ Machines used for **weaving, dyeing and knitting fabrics** are made using science.
- ❖ Science improves the **quality and durability of clothes**.

(f) Transport

- ❖ Science is used to make **cars, trains, bicycles, motorcycles, ships and aeroplanes**.
- ❖ Transport helps people and goods move by **road, air and water**.
- ❖ Science makes transport **faster, safer and more efficient**.
- ❖ Transport supports **trade, communication and economic growth**.

1.1.3 Career Opportunities Related to Science

- ❖ Science provides many **career opportunities** because scientific knowledge and skills are needed in many areas of life.
- ❖ Learners who study Integrated Science can choose careers that help **improve health, technology, food production and the environment**.

Examples of Science-Related Careers

Engineering – designing and building machines, roads, bridges and buildings.

Medicine – treating and preventing diseases in human beings.

Veterinary science – caring for and treating animals.

Food science – improving food production, preservation and safety.

Computer science – developing computer systems, software and technology.

Environmental science – protecting the environment and managing natural resources.

Pharmacy – preparing and supplying medicines.

Industrial chemistry – producing chemicals used in industries and households



Examples of Science Professionals

Engineers – design and build structures, machines and systems.

Doctors – diagnose and treat diseases.

Veterinary doctors – treat sick animals and improve animal health.

Pharmacists – prepare and give out medicines.

Computer scientists – develop computer programs and systems.

Environmental scientists – study and protect the environment.

Electricians – install and repair electrical systems.

Pilots – operate aircraft and transport people and goods.

Nutritionists – advise people on healthy eating.

Laboratory technicians – carry out scientific tests and experiments.

Importance of Science Careers

Science careers help **solve real-life problems**.

They create **employment opportunities**.

Science professionals help improve **living standards and national development**.

1.1.4 Pathways Related to Integrated Science

- ❖ At **Senior School**, learners choose different **learning pathways** based on their interests, abilities and future career goals.
- ❖ A pathway helps learners decide which **subjects and careers** they can pursue.



Main Pathways

1. Arts and Sports Science

- ❖ This pathway focuses on **talent, creativity and physical ability**.
- ❖ It include:
 - (i) Sports tracks
 - (ii) Performing arts such as music, drama and dance
 - (iii) Visual arts such as drawing, painting and design

2. Social Science

- ❖ This pathway focuses on **human society and communication**.
- ❖ It includes:
 - (i) Languages and literature
 - (ii) Humanities and business studies such as history, geography and economics

3. Science, Technology, Engineering and Mathematics (STEM)

- ❖ This pathway focuses on **science, technology, problem-solving and innovation**.
- (i) Pure sciences
- (ii) Applied sciences
- (iii) Technical studies

Integrated Science belongs to the STEM pathway because it prepares learners for science and technology-related subjects and careers.

STEM Pathway and Its Career Tracks



The **STEM pathway** has **four main career tracks** that guide learners into different science-related fields.

(a) Pure Sciences

- ❖ This track focuses on **theoretical and scientific knowledge**.
- ❖ Learners usually join **universities or middle-level colleges**.

Careers include:

- ❖ Medicine
- ❖ Pharmacy
- ❖ Industrial science
- ❖ Actuarial science

Some learners may start working after training and later get **further education** to improve their qualifications.

(b) Applied Sciences

- ❖ This track focuses on **applying scientific knowledge to solve practical problems**.
- ❖ Learners may join **middle-level colleges or universities**.

Careers include:

Agricultural engineering

Computer engineering

Food science and technology

Hospitality

Home economics



Learners may also work under **specialists** to gain practical experience and skills.

(c) Technical Studies

- ❖ This track is for learners interested in **hands-on and technical skills**.
- ❖ It builds on skills learned in **Pre-Technical Studies at Junior School**.
- ❖ Learners are trained to work in the **industrial and technical sectors**.
- ❖ Graduates may work in workshops, factories or construction sites.

(d) Core and Optional Subjects

- ❖ Each career track has **core subjects** that must be studied by all learners.
- ❖ Learners also choose **one or two optional subjects** depending on their interests and career goals. This allows learners to **specialise** in areas they prefer.

Assess Yourself

1. What does the word *Integrated* mean in Integrated Science?
2. Name the three main components of Integrated Science.
3. Explain how Biology, Chemistry and Physics are connected to each other.
4. Why is science important in our daily life?
5. Give two ways science helps improve health.
6. Explain how science helps farmers in agriculture.
7. Mention two ways science is used in industry.
8. List two methods of food preservation.
9. Name three careers related to science.

1.2 laboratory safety

Meaning of a Laboratory

- ❖ A laboratory is a special room or building that is equipped with apparatus, chemicals and materials for carrying out scientific experiments, investigations and learning.
- ❖ Laboratories are found in:
 - (i) Schools
 - (ii) Hospitals
 - (iii) Research centres
 - (iv) Industries

Laboratory Safety

Laboratory safety refers to rules and precautions taken to prevent accidents and injuries in the laboratory.

Why laboratory safety is important:

- ❖ Prevents accidents and injuries such as burns, cuts and poisoning.
- ❖ Ensures a safe and organised working environment.
- ❖ Promotes proper handling, storage and disposal of chemicals.
- ❖ Protects laboratory users, teachers and visitors.
- ❖ Protects laboratory equipment from damage.
- ❖ Prevents environmental pollution.

General Laboratory Safety Rules

- ❖ Do not run or play in the laboratory.
- ❖ Follow the teacher's instructions carefully.
- ❖ Do not taste or smell chemicals directly.



- ❖ Wear protective clothing (lab coat, gloves, goggles).
- ❖ Tie long hair back.
- ❖ Report accidents immediately.
- ❖ Do not eat or drink in the laboratory.
- ❖ Wash hands after experiments.
- ❖ Dispose of chemicals properly.
- ❖ Handle glassware carefully

1.2.1 Common Laboratory Hazards

Meaning of a Laboratory Hazard

- ❖ A laboratory hazard is anything in the laboratory that can cause injury, illness, or damage to people and property.
- ❖ Hazards may come from:
 - (i) Chemicals
 - (ii) Equipment
 - (iii) Electricity
 - (iv) Fire
 - (v) Radiation

Types of laboratory hazards

Hazard	Description	Examples
Corrosive	Substances that destroy skin, eyes or materials on contact.	Concentrated acids, sodium hydroxide
Radioactive	Substances that produce harmful radiation.	Uranium, radioactive isotopes
Flammable	Substances that easily catch fire.	Ethanol, methylated spirit
Carcinogenic	Substances that can cause cancer.	Certain industrial chemicals

Hazard	Description	Examples
Corrosive	Substances that destroy skin, eyes or materials on contact.	Concentrated acids, sodium hydroxide
Toxic (Poisonous)	Substances that can cause illness or death if inhaled or swallowed.	Chlorine gas, bromine
Explosive	Substances that may explode when heated or hit.	Some gases, unstable chemicals
Irritant	Substances that cause itching or inflammation.	Some cleaning chemicals

Other common laboratory hazards

⚡ Electrical Hazards

Caused by faulty wires or wet hands.

May cause electric shock.

🔥 Fire Hazards

Open flames, gas leaks.

May cause burns or explosions.

🔪 Glassware Hazards

Broken glass can cause cuts.



Corrosive



Radioactive



Flammable



Carcinogenic



Toxic (Poisonous)



Explosive



Carcinogenic



Explosive



Irritant

1.2.2 Common Laboratory Accidents, Their Causes, and First Aid Measures

Definition: First Aid:

The immediate help given to an injured or ill person before professional medical treatment.

Accident	Causes	First Aid Measures
Cuts	• Breaking glass apparatus (test tubes, beakers). • Careless handling of sharp objects (scalpels, razor blades, knives).	1. Wash hands and wear gloves. 2. Apply pressure to stop bleeding. 3. Clean the wound. 4. Cover with sterile dressing or bandage.
Burns and Scalds	• Touching hot apparatus with bare hands. • Splashing concentrated acids or bases on skin. • Careless handling of steam from boiling liquids. • Contact with open flames.	1. Move the person away from the source of heat. 2. Cool the burn under cold running water for about 20 minutes. 3. Remove tight clothing, watches, or jewellery (if not stuck). 4. Cover the burn loosely with clean plastic wrap.
Ingestion of Harmful Substances	• Swallowing harmful chemicals. • Tasting or eating laboratory materials. • Inhaling toxic gases due to poor ventilation.	If conscious: 1. Ask what was swallowed, how much, and when. 2. Inform the teacher or laboratory technician immediately. If unconscious: 1. Inform the teacher or technician immediately. 2. Monitor and record vital signs while

Accident	Causes	First Aid Measures
		waiting for help.
Falls	• Running in the laboratory. • Wet or slippery floors.	1. Help the person sit or lie down safely. 2. Check for injuries (bleeding, swelling, pain). 3. Inform the teacher or laboratory technician immediately.
Electric Shock	• Inserting metallic objects into electric sockets.	1. Do not touch the person directly if still in contact with electricity. 2. Switch off the power source immediately. 3. Inform the teacher or laboratory technician immediately.
Fire Accidents	• Leaving burning candles unattended. • Playing with flames. • Careless mixing of chemicals.	1. Raise alarm immediately. 2. Use fire extinguisher or fire blanket if trained. 3. Move away from the fire to a safe area. 4. Inform the teacher or laboratory technician immediately.

What To Do In Case of an Accident

- ❖ Inform the teacher immediately.
- ❖ Wash affected area with clean water.



- ❖ Use first aid kit if necessary.
- ❖ Do not panic.

FIRST AID KIT: ITEMS AND THEIR USES

Item	Use
Gloves	Protect the First Aider from contact with body fluids (blood, saliva, urine) to prevent infection.
Scissors	Cut bandages and dressings safely and accurately.
Bandages	Cover wounds to keep germs away.
Antiseptic	Clean wounds to prevent infection.
Cotton wool	Apply antiseptic or ointments on wounds, cuts or bruises.
Painkillers	Reduce pain (taken only as advised by a doctor).
Safety pin	Hold bandages in place (must be cleaned with antiseptic before use).
Plaster	Cover small wounds and cuts to keep germs away.

1.23. Prevention of Laboratory Accidents

Laboratory accidents can be prevented when safety rules are strictly followed and responsible behaviour is maintained at all times.

Follow laboratory safety rules.

Always obey the instructions given by the teacher or laboratory technician. Read and understand all procedures before starting any experiment.



Do not run in the laboratory.

Running can cause slipping, falling, or knocking over chemicals and equipment, which may lead to injuries or fires.

Handle chemicals carefully.

Read labels before use. Avoid direct contact with chemicals, and never mix substances unless instructed to do so.

Wear protective clothing (lab coat, gloves).

Protective clothing helps prevent burns, cuts, and chemical splashes from coming into contact with the skin.

Do not taste chemicals.

Chemicals in the laboratory are not safe for consumption and may cause poisoning or serious health problems.

Use equipment properly.

Handle glassware and electrical equipment carefully. Do not use cracked glassware or faulty equipment.

Keep floors dry and clean.

Immediately clean up any spills to prevent slipping accidents.

Avoid playing with flames.

Do not leave burning candles or Bunsen burners unattended. Open flames can easily start fires.

Do not insert objects into electrical sockets.

Inserting metallic or foreign objects into sockets can cause electric shock or fire.

Dispose of broken glass properly.

Broken glass should be placed in designated containers to prevent cuts and injuries.

Importance of safety and prevention of laboratory accidents

Safety in the laboratory and school environment is important because it:



- ❖ Prevents accidents and injuries.
- ❖ Prevents damage to laboratory equipment and school property.
- ❖ Ensures a safe and healthy working environment.
- ❖ Protects learners, teachers, and laboratory staff.
- ❖ Promotes responsible and disciplined behaviour.

Assess Yourself

1. What is a laboratory?
2. Name two places where laboratories can be found.
3. What is meant by laboratory safety?
4. Give three reasons why laboratory safety is important.
5. State four general laboratory safety rules.
6. What is a laboratory hazard?
7. Name three types of laboratory hazards.
8. What is first aid?
9. State two causes of burns in the laboratory.
10. Give two first aid steps for a person who has a cut.
11. Why should you not run in the laboratory?
12. Mention three items found in a first aid kit and state their uses.

1.3 laboratory apparatus and instruments

1.3.1 Basic Skills in Science

Manipulative skill – Handling apparatus correctly.

Observation skill – Using senses to gather information.

Measurement skill – Measuring using correct units.

Classification skill – Grouping items according to similarities.

Prediction skill – Saying what may happen.

Communication skill – Recording and sharing results.

Conclusion skill – Giving a final answer based on results.

These skills help learners carry out investigations correctly.

1.3.2 Uses and Care for Apparatus in the Laboratory

Laboratory Apparatus and Their Uses

1. Apparatus for Measuring Volume

Measuring cylinder – Measures liquid volume.

Beaker – Holds and mixes liquids (approximate measurement).

Conical flask – Used for mixing without spilling.

Pipette – Measures fixed small volumes accurately.

Burette – Measures liquid accurately (used in titration).

Volumetric flask – Prepares solutions of exact volume.

Syringe – Measures small liquid or gas volumes.

Eureka can – Measures volume of irregular solids.



2. Apparatus for Measuring Mass

Beam balance – Measures mass in grams (g).

Electronic balance – Digital measurement of mass.

3. Apparatus for Measuring Temperature

Thermometer – Measures temperature in degrees Celsius ($^{\circ}\text{C}$).

4. Apparatus for Measuring Length

Ruler / Metre rule – Measures length in centimetres (cm) or metres (m).

Vernier calipers – Measures small lengths accurately.

Micrometer screw gauge – Measures very small objects like wires.

5. Apparatus for Measuring Time

Stopwatch – Measures time in seconds (s).

6. Apparatus for Measuring Weight

Spring balance – Measures weight in newtons (N).

7. Apparatus for Heating

Bunsen burner – Produces flame for heating. (Yellow flame – Safety flame, Blue flame – Heating flame)



Tripod stand – Supports apparatus during heating.

Wire gauze – Spreads heat evenly.

8. Apparatus for Magnification

Hand lens – Magnifies small objects.

Light microscope – Magnifies very tiny objects.



<https://youtu.be/V4EbtRKQHkE?si=or75GK6J9jXFNgJF>

Parts of a Bunsen Burner

Base:

Provides stability to ensure the burner remains upright and safe during use.

Barrel:

Allows proper upward flow and mixing of gas and air to produce a steady flame.

Air hole:

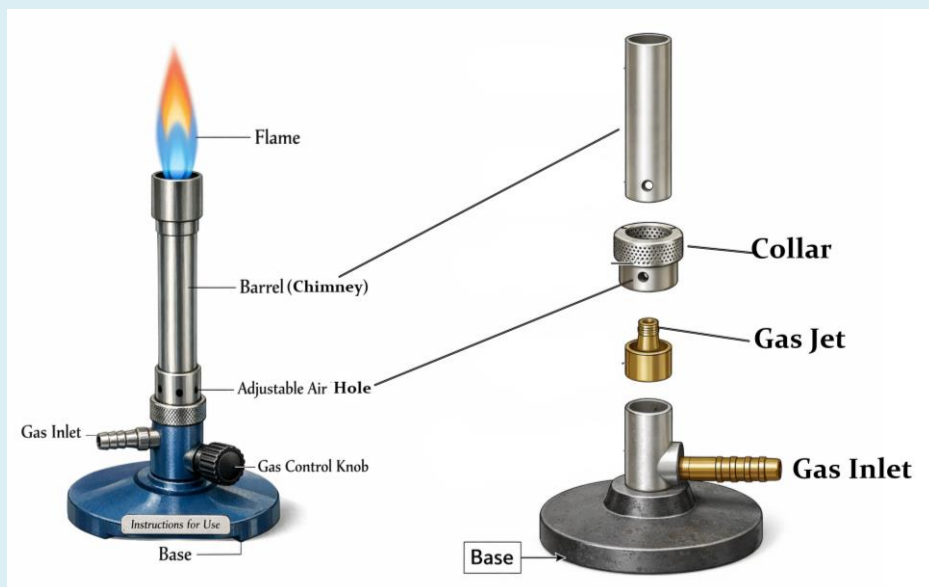
Regulates oxygen entry to control the temperature and quality of the flame.

Collar:

Adjusts the size of the air opening to control flame intensity and combustion.

Gas inlet:

Supplies and controls the flow of gas necessary for combustion.



Parts of a Light Microscope

- ❖ **Eyeiece:** Magnifies the image formed by the objective lens so it can be clearly observed.
- ❖ **Objective lenses:** Provide different levels of magnification to allow detailed viewing of specimens.
- ❖ **Stage:** Supports and holds the specimen slide in position for observation.
- ❖ **Mirror / Light source:** Provides and directs light through the specimen to make it visible.
- ❖ **Coarse adjustment knob:** Moves the stage or body tube rapidly for rough focusing of the specimen.
- ❖ **Fine adjustment knob:** Makes small, precise focus adjustments to produce a sharp and clear image.
- ❖ **Arm:** Supports the upper parts of the microscope and is used for carrying it safely.
- ❖ **Base:** Provides stability and supports the entire microscope.



How **How to Carry and Care for a Light Microscope**

How to Carry It

- ❖ Use **both hands**
- ❖ One hand holds the **arm**
- ❖ The other hand supports the **base**

How to Clean It

- ❖ Use **lens paper only**
- ❖ Do NOT touch lenses with fingers
- ❖ Do NOT use tissue or cloth

Before Storing

- ❖ Rotate to **low power objective**
- ❖ Raise the body tube
- ❖ Clean lenses
- ❖ Cover with dust cover

Store in a cool, dry place



1.3.3 International System of Units (SI Units)

Basic Quantities and Units

Quantity (Full Name)	SI Base Unit	Symbol	Common Sub-units	Symbols	Conversions
Length (distance)	metre	m	kilometre, centimetre, millimetre	km, cm, mm	1 km = 1000 m 1 m = 100 cm 1 m = 1000 mm
Mass (amount of matter)	kilogram	kg	gram, milligram, tonne	g, mg, t	1 kg = 1000 g 1 g = 1000 mg 1 tonne = 1000 kg
Time (duration)	second	s	minute, hour, millisecond	min, h, ms	1 min = 60 s 1 h = 3600 s 1 ms = 0.001 s
Electric current	ampere	A	milliampere, microampere	mA, μ A	1 mA = 0.001 A 1 μ A = 0.000001 A
Thermodynamic temperature	kelvin	K	degree Celsius (relative)	$^{\circ}$ C	$^{\circ}$ C = K – 273.15 0 $^{\circ}$ C = 273.15 K
Amount of substance	mole	mol	millimole	mmol	1 mol = 1000 mmol
Luminous intensity	candela	cd	millicandela	mcd	1 cd = 1000 mcd

Derived Quantities

Quantity (Full Name)	SI Unit	Symbol	Common Sub-units	Symbols	Conversions
Area (surface)	square metre	m ²	square kilometre, square centimetre, square millimetre	km ² , cm ² , mm ²	1 km ² = 1,000,000 m ² 1 m ² = 10,000 cm ² 1 m ² = 1,000,000 mm ²
Volume (space)	cubic metre	m ³	litre, millilitre	L, mL	1 m ³ = 1000 L 1 L = 1000 mL
Speed (velocity)	metre per second	m/s	kilometre per hour	km/h	1 m/s = 3.6 km/h 1 km/h = 0.2778 m/s
Density (mass per unit volume)	kilogram per cubic metre	kg/m ³	gram per cubic centimetre	g/cm ³	1 kg/m ³ = 0.001 g/cm ³ 1 g/cm ³ = 1000 kg/m ³

1.3.4 Practical activities

FILTRATION EXPERIMENT

1. Aim of the Experiment

To separate an insoluble solid (sand) from a liquid (water) using the method of filtration.

2. Materials Used

- (i) Filter paper
- (ii) Funnel



- (iii) Measuring cylinder
- (iv) Beaker
- (v) Glass rod
- (vi) Sand
- (vii) Water
- (viii) Electronic balance

3. Procedure (Steps Followed)

- (i) Measured **50 ml of water** using a measuring cylinder.
- (ii) Measured **20 g of sand** using an electronic balance.
- (iii) Mixed the sand and water in a beaker.
- (iv) Stirred the mixture using a glass rod to form a suspension.
- (v) Folded the filter paper into a cone shape and placed it inside the funnel.
- (vi) Set up the filtration apparatus by placing the funnel in a beaker.
- (vii) Carefully poured the sand-water mixture into the funnel.
- (viii) Allowed the mixture to stand until filtration was complete.

4. Observations

Clear water passed through the filter paper into the beaker.

Sand particles remained on the filter paper.

5. Results

The liquid that passed through the filter paper is called the **filtrate**.

The solid that remained on the filter paper is called the **residue**.



6. Conclusion

Filtration is a method used to separate an insoluble solid from a liquid. In this experiment, sand (insoluble solid) was successfully separated from water through filtration.

7. Precautions

- ❖ Ensure the filter paper fits properly inside the funnel.
- ❖ Do not overfill the funnel while pouring the mixture.
- ❖ Pour the mixture slowly along a glass rod to avoid splashing.
- ❖ Make sure the apparatus is clean before use.

<https://youtu.be/CBUl2gdULDk?si=X9WtxHrEcFBI1r8l>

HOW TO READ A MEASURING CYLINDER

Place it on a flat surface.

Position your eye level with the liquid.

Read at the **lower meniscus**.

Avoid parallax error.

<https://youtu.be/SE-nUsrbELE?si=L5TwyHITsmtWevM3>

HOW TO USE A PIPETTE

1. Aim

To accurately measure and transfer a specific volume of liquid using a pipette.



2. Procedure (Steps to Follow)

- (i) Pour distilled water into a beaker.
- (ii) Attach a pipette filler (or bulb) to the pipette.
- (iii) Squeeze the filler and gently release it to draw water into the pipette.
- (iv) Fill the pipette until the bottom of the meniscus reaches the calibration mark.
- (v) Remove the pipette filler and quickly close the top of the pipette with your thumb.
- (vi) Transfer the pipette to the receiving container.
- (vii) Gently lift your thumb to allow the liquid to flow out slowly.
- (viii) Allow the pipette to drain completely (do not blow out unless it is a blow-out pipette).

3. Important Notes

- ❖ Always read the volume at **eye level** to avoid parallax error.
- ❖ The correct reading is taken at the **bottom of the meniscus**.
- ❖ Hold the pipette in a vertical position when measuring.

CARE OF A PIPETTE

- ❖ Handle carefully to prevent breakage.
- ❖ Wash thoroughly after use.
- ❖ Rinse with distilled water before and after use.
- ❖ Dry the pipette on a drying rack.
- ❖ Store safely in a pipette holder or rack.

<https://youtu.be/Pg9WHKYL8g8?si=AFI44etgJslBVFc6>

HOW TO USE A BURETTE

1. Aim

To accurately measure and deliver a known volume of liquid using a burette.

2. Procedure (Steps to Follow)

- (i) Place the retort stand on a flat and stable surface.
- (ii) Clamp the burette vertically onto the stand.
- (iii) Ensure the tap (stopcock) is closed.
- (iv) Fill the burette with water slightly above the zero mark using a funnel.
- (v) Open the tap to allow some liquid to flow out until the lower meniscus is exactly at the zero mark. (This also removes air bubbles.)
- (vi) Place a measuring cylinder or conical flask under the burette.
- (vii) Open the tap gently to allow water to flow into the container.
- (viii) Close the tap when the required volume has been delivered.
- (ix) Read the final burette reading at eye level.
- (x) Calculate the volume delivered:
- (xi) $\text{Volume delivered} = \text{Final reading} - \text{Initial reading}$

3. Important Notes

- ❖ Always read the burette at eye level to avoid parallax error.
- ❖ Take readings at the bottom of the meniscus.
- ❖ Ensure there are no air bubbles in the burette tip before starting.

https://youtu.be/dJAWyvoSoLU?si=W6VRQ_BBKeTGCHP1



CARE OF A BURETTE

- ❖ Close the tap gently to avoid damage.
- ❖ Wash thoroughly after use.
- ❖ Rinse with distilled water before storage.
- ❖ Dry properly before keeping it away.
- ❖ Store vertically in a safe, cool, and dry place.

HOW TO USE A VOLUMETRIC FLASK

1. Aim

To accurately measure and prepare a solution of a specific volume.

2. Procedure (Steps to Follow)

- (i) Place the volumetric flask on a working table, ensuring it is not at the edge.
- (ii) Using a funnel, add water (or solution) into the flask.
- (iii) Fill carefully until the liquid reaches the calibration (marked) line.
- (iv) Read the lower meniscus at eye level to ensure accurate measurement.
- (v) If preparing a solution, stopper the flask and gently invert it several times to mix thoroughly.

3. Important Notes

- ❖ Always place the flask on a flat, stable surface.
- ❖ Do not exceed the marked calibration line.
- ❖ Ensure the outside of the flask is dry before taking readings.

<https://youtu.be/g5yRka-WoEQ?si=xa9LvKJQeh2239bt>



CARE OF A VOLUMETRIC FLASK

- ❖ Clean thoroughly after use.
- ❖ Rinse with distilled water before storing.
- ❖ Dry on a rack upside down.
- ❖ Store in a cool, dry place.
- ❖ Handle carefully since glass is delicate and can easily break

USING A SPRING BALANCE

1. Purpose

A spring balance is used to measure **weight**, which is the force exerted on an object due to gravity. Weight is usually measured in **Newtons (N)**.

2. Steps for Using a Spring Balance

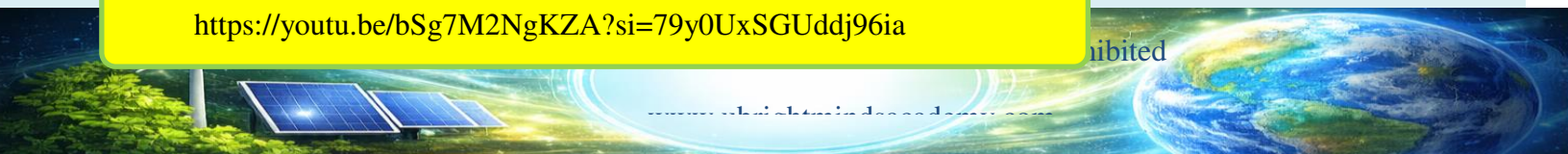
- (i) Ensure the reading is at zero before use. (Adjust if necessary.)
- (ii) Hold or hang the spring balance vertically.
- (iii) Attach the object to the hook at the bottom.
- (iv) Allow the object to hang freely without touching anything.
- (v) Read the measurement at eye level.
- (vi) Record the weight in Newtons (N).

3. Important Notes

- ❖ Keep the balance vertical for accurate readings.
- ❖ Make sure the object is not swinging when taking the reading.
- ❖ Always read the scale at eye level to avoid error.

<https://youtu.be/bSg7M2NgKZA?si=79y0UxSGUddj96ia>

hibited



Care of a Spring Balance

- ❖ Do not exceed the maximum weight limit indicated on the scale.
- ❖ Handle carefully to avoid damaging the spring.
- ❖ Do not drop the instrument.
- ❖ Store it in its case after use.
- ❖ Keep in a cool, dry place to prevent rusting.

USING AND CARING FOR MASS MEASURING INSTRUMENTS

Instruments for Measuring Mass

- ❖ Electronic balance
- ❖ Top pan balance
- ❖ Beam balance

Mass is measured in **grams (g)** or **kilograms (kg)**.

USING AN ELECTRONIC BALANCE

Steps to Follow

- (i) Place the balance on a flat, stable surface.
- (ii) Switch on the electronic balance.
- (iii) Press the **zero (tare)** button to set the reading to 0.00 g.
- (iv) Place the object (e.g., a beaker or solid substance) gently on the pan.
- (v) Wait for the reading to stabilize.
- (vi) Record the mass displayed on the screen.
- (vii) Remove the object after measurement.



- (viii) Clean the pan if necessary and switch off the balance.

Important Notes

- ❖ Do not exceed the maximum mass limit indicated on the balance.
- ❖ Always zero (tare) the balance before measuring.
- ❖ If using a container, place it on the pan first and press **tare** before adding the substance.
- ❖ Avoid placing hot or wet objects directly on the pan.

<https://youtu.be/0UymyTJATLc?si=292AmLfuHQEESCpR>

CARE OF MASS MEASURING INSTRUMENTS

- ❖ Handle carefully to avoid damage.
- ❖ Clean using a soft, dry cloth.
- ❖ Do not spill chemicals on the balance.
- ❖ Keep away from water and moisture.
- ❖ Store properly in a safe, dry place.

MEASURING TEMPERATURE

- (i) Pour water into a beaker.
- (ii) Set up the tripod stand, wire gauze, and Bunsen burner.
- (iii) Heat the water gently using the Bunsen burner.
- (iv) Place the thermometer in the water with the bulb fully immersed.
- (v) Ensure the bulb does not touch the sides or bottom of the beaker.
- (vi) Record the temperature at regular time intervals (e.g., every 30 seconds).
- (vii) Do not expose the thermometer directly to the flame.

<https://youtu.be/4hTOabXx0Cg?si=D8VCub5P9QPO-5u4>



Care of a Thermometer

- ❖ Handle carefully since it is very delicate.
- ❖ Dry after use.
- ❖ Store upright in its protective casing.

USING AND CARING FOR A STOPWATCH

Purpose

A stopwatch is used to measure **time intervals** accurately.

Time is usually recorded in **seconds (s)** or **minutes (min)**.

Steps for Using a Stopwatch

- (i) Ensure the stopwatch is set to **zero** before starting.
- (ii) Press the start button when the activity begins.
- (iii) Press the stop button when the activity ends.
- (iv) Read and record the time taken.
- (v) Reset the stopwatch to zero after recording.

<https://youtu.be/FLPAoU49jb4?si=q8n9ANauSk2OD8Yt>

Care of a Stopwatch

- ❖ Handle carefully to avoid damage.
- ❖ Do not drop the stopwatch.
- ❖ Keep away from water and moisture.
- ❖ Replace batteries when necessary (for digital stopwatches).
- ❖ Store in a cool, dry place after use.

USING AN AMMETER

1. Purpose

An **ammeter** is used to measure **electric current** in a circuit. Current is measured in **amperes (A)**.

2. Apparatus Needed

- ❖ Ammeter
- ❖ Connecting wires
- ❖ Power source (battery or power supply)
- ❖ Resistor or electrical component

3. Steps for Using an Ammeter

- (i) **Switch off** the circuit before connecting the ammeter.
- (ii) Connect the ammeter **in series** with the component whose current is to be measured.
- (iii) Ensure the **positive terminal (+)** of the ammeter is connected to the positive side of the circuit, and the **negative terminal (-)** to the negative side.
- (iv) Switch on the circuit.
- (v) Observe and record the current reading on the ammeter.
- (vi) Switch off the circuit after measurement.

4. Important Notes

- ❖ Never connect an ammeter **in parallel**; this can damage the instrument.
- ❖ Ensure the current does not exceed the maximum rating of the ammeter.
- ❖ Read the scale at eye level to avoid parallax error.



<https://youtu.be/Ex5z-xVeF98?si=dyFKLRtyAG24F5Zs>

5. Care of an Ammeter

- ❖ Handle carefully; it is a delicate instrument.
- ❖ Store in a dry, safe place when not in use.
- ❖ Avoid exposing it to excessive current beyond its range.
- ❖ Clean terminals if necessary to ensure good contact.

Area

RECTANGLES

Area of a rectangle is the product of the base length and its height.

Example

A rectangle whose length is 8 metres has an area of 32 square metres. Calculate the width.

Solution.

let the width of the rectangle be x

$$A = l \times w$$

$$32 = 8 \times (\text{dividing both sides by } 8)$$

$$x = 4 \text{ metres}$$

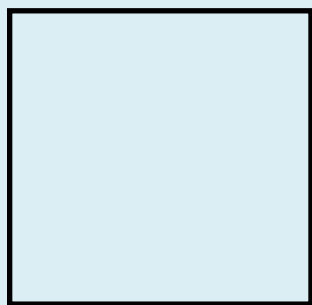
SQUARES

A square is a special rectangle where all sides are equal

$$A = \text{side} \times \text{side}$$

Example

Calculate the area of the parallelogram drawn below.



6 cm



Solution.

$$A = s \times s$$

$$A = 6\text{cm} \times 6\text{cm}$$

$$A = 36\text{ cm}^2$$

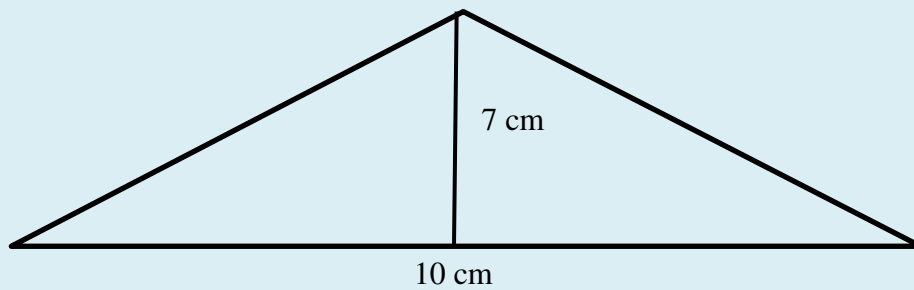
TRIANGLES

Area of a triangle is $\frac{1}{2}$ (base $\times$ height).

The base and height always make an angle of 90°

Example

Calculate the area of the triangle shown below



Solution

$$A = \frac{1}{2} (\text{base} \times \text{height}).$$

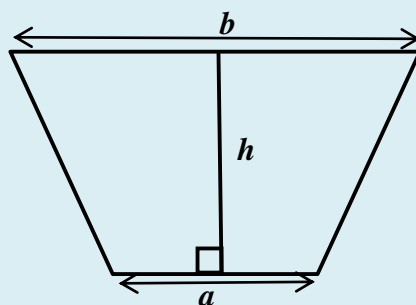
$$A = \frac{1}{2} (10 \times 7).$$

$$A = 35\text{ cm}^2.$$

TRAPEZIUM.

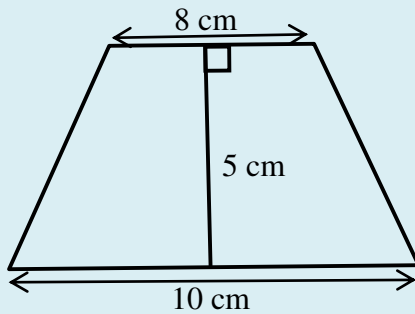
A trapezium is a four sided figure in which two sides are parallel. Area of a trapezium is given by the formula,

$$A = \frac{(a+b)}{2} \times h$$



Example 3.14

Find the area of the trapezium shown below.

**Solution.**

$$A = \frac{(a+b)}{2} \times h$$

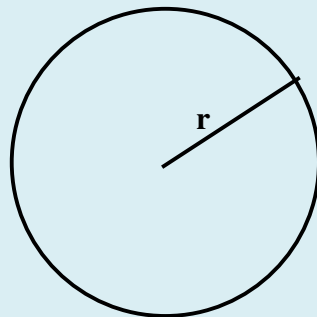
$$A = \frac{(10+8)}{2} \times 5$$

$$A = \frac{18}{2} \times 5$$

$$A = 9 \times 5 = 45\text{cm}^2$$

CIRCLES

$A = \pi r^2$ where r is the radius of the circle.

**Example**

A circle has a diameter of 70 m, calculate the area of the circle.

Solution.

The diameter = 70 m, so the radius = 35 m.



$$A = \pi r^2$$

$$A = \frac{22}{7} \times 35m \times 35m$$

$$A = 3850m^2$$

AREA OF IRREGULAR OBJECT

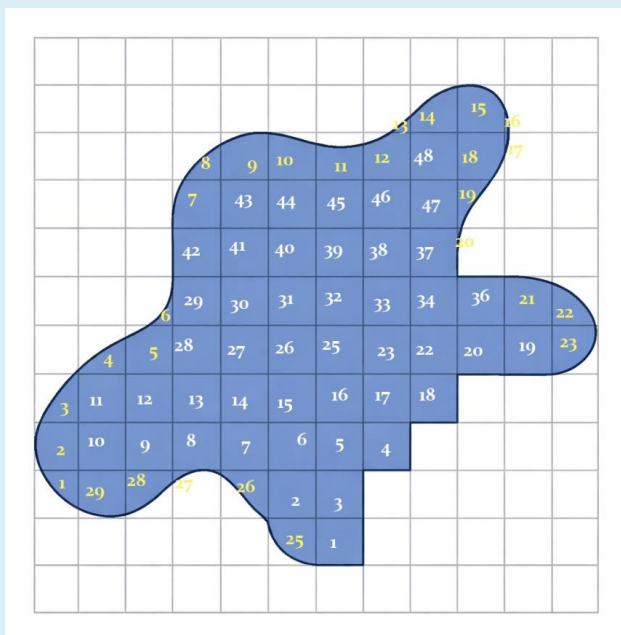
The steps are:

- (i) Count Full Squares
- (ii) Count Partial Squares
- (iii) Find the Area using the formula:

$$A = \text{number of full squares} + \frac{\text{number of partial squares}}{2}$$

EXAMPLE

Find the area of the figure below



Solution

$$A = \text{no. of complete squares} + \frac{\text{no. of incomplete squares}}{2}$$

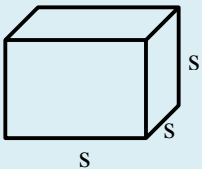
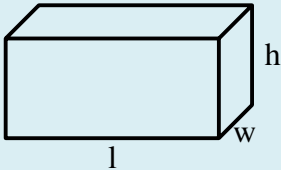
$$A = 48 + \frac{29}{2}$$

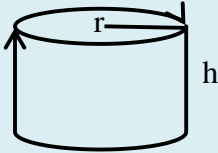
$$A = 48 + 14.5$$

$$A = 62.5 \text{ sq units}$$

VOLUME OF REGULAR OBJECTS.

The table below shows the formulae used in calculating volumes of cubes, cuboids and cylinders.

Object	Diagram	Formula used to calculate volume.
Cube	 A 3D diagram of a cube. The front bottom edge is labeled 's', the right bottom edge is labeled 's', and the right vertical edge is labeled 's'.	$V = s^3$ s is the length of side. Note: all sides are equal in length
Cuboid	 A 3D diagram of a cuboid. The front bottom edge is labeled 'l', the right bottom edge is labeled 'w', and the right vertical edge is labeled 'h'.	$V = l \times w \times h$ l is length w is width h is height

Cylinder 		$V = \pi r^2 h$ r is radius h is height
--	--	---

Example

Calculate the volume of a cube of side 5 cm.

Solution.

Volume of cube $= s^3$

Volume $= 5\text{cm} \times 5\text{cm} \times 5\text{cm}$

Volume $= 125\text{ cm}^3$

Example

Calculate the volume of the cuboid measuring 140 cm by 30 cm by 70 cm in cubic metres.

Solution.

To get the answer in cubic metres, we convert all measurements to metres by dividing by 100

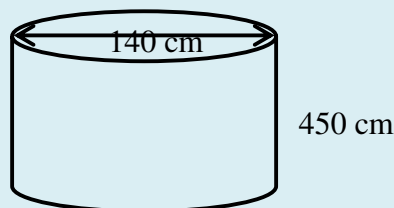
$$\begin{aligned}
 V &= l \times w \times h \\
 V &= \frac{140}{100} \text{ m} \times \frac{30}{100} \text{ m} \times \frac{70}{100} \text{ m} \\
 V &= \frac{294\,000}{1\,000\,000} \text{ m}^3 \\
 V &= 0.294 \text{ m}^3
 \end{aligned}$$



Example

A cylindrical tank has a diameter of 140 cm and a height of 450 cm. Calculate the volume of the tank in cubic centimetres.

Solution.



The diameter is 140 cm, therefore the radius is 70 cm

$$V = \pi r^2 h$$

$$V = \frac{22}{7} \times 70\text{cm} \times 70\text{cm} \times 450\text{cm}$$

$$V = 6\,930\,000\text{cm}^3$$

Density

Definition

- ❖ **Density** is the **mass of a substance per unit volume**.
- ❖ It tells us **how tightly matter is packed** in a substance.
- ❖ It is a **physical property** of matter.

Formula:

$$\text{density}(\rho) = \frac{\text{Mass}(m)}{\text{Volume}(V)}$$

SI Unit

Kilogram per cubic meter (kg/m³) is the SI unit of density.

Other common units include:

grams per cubic centimeter (g/cm³)

$$1\text{g/cm}^3 = 1000\text{kg/m}^3$$



Rearranged Formulas

Sometimes, you can calculate **mass** or **volume** if density is known:

$$\text{mass} = \text{volume} \times \text{density}$$

$$\text{Volume} = \frac{\text{mass}}{\text{density}}$$

Example Calculations

Example

A substance has a mass of 200 g and a volume of 50 cm³. Find its density.

Solution

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{density} = \frac{200\text{g}}{50\text{cm}^3}$$

Example

A block of metal has a volume of 0.02 m³ and a density of 8000 kg/m³. Find its mass.

Solution

$$\text{mass} = \text{volume} \times \text{density}$$

$$\text{mass} = 160\text{kg}$$



Determining Density of Irregular Objects Using Eureka Method

<https://youtu.be/pN5S95G4vBM?si=dJcNGy1YisJxQPwD>

1. Principle

The **Eureka method** (also called **water displacement method**) is based on **Archimedes' principle**:

An object submerged in a fluid **displaces a volume of fluid equal to its own volume**.

This method is used when the object **does not have a regular shape**, so its volume cannot be measured using a formula.

2. Apparatus

Eureka can (overflow can)

Measuring cylinder

Thread or string

Balance (to measure mass)

Irregular object

3. Procedure

Measure the mass of the object using a balance.

Fill the Eureka can with water until it reaches the spout.

Suspend the object using a thread and gently lower it into the Eureka can **without touching the sides**.



Collect the displaced water in a measuring cylinder.

Measure the volume of the displaced water

Volume of water displaced=volume of the object

Calculate the density using the formula: $\rho = \frac{m}{v}$

4. Example

An irregular rock has a mass of 300 g. When submerged in a Eureka can, it displaces 100 cm³ of water.

Solution

$$\rho = \frac{m}{v}$$
$$\rho = \frac{300\text{g}}{100\text{cm}^3}$$

5. Key Points / Tips

- ❖ The object **must be fully submerged**.
- ❖ Avoid **splashing** to get an accurate volume measurement.
- ❖ Ensure the measuring cylinder measures **displaced water accurately**.
- ❖ This method works for **solids that do not dissolve in water**.

Speed

1. Definition

- ❖ **Speed** is the **distance travelled by an object per unit time**.
- ❖ It tells us **how fast an object is moving**, without considering direction.
- ❖ It is a **scalar quantity** (has magnitude only).



Formula:

$$\text{speed} = \frac{\text{distance (d)}}{\text{time(t)}}$$

2. SI Unit

- ❖ **Meter per second (m/s)** is the SI unit of speed.

Other common units:

- ❖ Kilometers per hour (km/h) $\rightarrow 1 \text{ m/s} = 3.6 \text{ km/h}$
- ❖ Centimeters per second (cm/s)

3. Rearranged Formulas

If speed, distance, or time is unknown, you can calculate it as:

$$\text{distance} = \text{speed} \times \text{time}$$

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

4. Example Calculations**Example 1:**

A car travels 150 km in 3 hours. Find its speed.



Solution

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

$$\text{speed} = \frac{150\text{km}}{3\text{h}}$$

Example 2:

A cyclist travels at 5 m/s for 20 seconds. Find the distance covered.

Solution

$$\text{distance} = \text{speed} \times \text{time}$$

$$\text{distance} = 100\text{m}$$

5. Key Points

- ❖ Speed is a **scalar** (only magnitude, no direction).
- ❖ Make sure **distance and time units are compatible** before calculating.

Assess Yourself

1. What is a manipulative skill in science?
2. Name three basic science skills.
3. Which apparatus is used to measure:
 - (a) Volume of a liquid
 - (b) Mass
 - (c) Temperature
 - (d) Time
4. What is the use of a Bunsen burner?
5. Name two parts of a light microscope.
6. Why should you read a measuring cylinder at eye level?
7. State two safety rules when using a pipette or burette.
8. What is the SI unit of:
 - (a) Length
 - (b) Mass
 - (c) Time
 - (d) Temperature
9. What is filtration?
10. What is density?
11. Write the formula for calculating:
 - (a) Speed
 - (b) Density
12. A car travels 60 km in 2 hours. Calculate its speed.

2.0 mixtures, elements and compounds

2.1 Mixtures

1. Introduction

- ❖ A **mixture** is a combination of two or more substances that **are not chemically bonded** and **can be separated by physical methods**.
- ❖ **Homogeneous mixtures:** This is a mixture whose composition is **uniform throughout**.
Example: salt dissolved in water, brass (copper + zinc).
- ❖ **Heterogeneous mixtures:** This is a mixture whose Composition is **not uniform**. Example: oil and water, sand and water.

Types of Mixtures

Solid–Liquid Mixtures

Mixture	Type
Salt + water	Homogeneous (soluble)
Sugar + water	Homogeneous (soluble)
Sand + water	Heterogeneous (insoluble)
Flour + water	Heterogeneous (insoluble)
Charcoal powder + water	Heterogeneous (insoluble)

Key Points:

- ❖ Soluble solids → homogeneous mixtures
- ❖ Insoluble solids → heterogeneous mixtures

Liquid–Liquid Mixtures

Mixture	Type
Ethanol + water	Homogeneous
Distilled water + cooking oil	Heterogeneous
Orange juice + water	Homogeneous
Vinegar + water	Homogeneous
Distilled water + ink	Homogeneous
Distilled water + kerosene	Heterogeneous

Solid–Solid Mixtures

Mixture	Type
Maize + beans	Heterogeneous
Sand + common salt	Heterogeneous
Sulphur + iron filings	Heterogeneous
Cement	Homogeneous
Brass (copper + zinc)	Homogeneous



Solvent, Solute, and Solution

- ❖ **Solute:** Substance that dissolves (e.g., sugar, salt).
- ❖ **Solvent:** Liquid that dissolves the solute (e.g., water).
- ❖ **Solution:** Homogeneous mixture formed (e.g., sugar solution, salty water).

2.2 Separation of Mixtures

1. Simple Distillation

Definition:

- ❖ Simple distillation is a method used to **separate a solvent from a solution** based on differences in **boiling points**. It is most suitable for **homogeneous solid–liquid mixtures** where the solid does not evaporate. It is also suitable for **homogeneous liquid-liquid mixture** for liquids of different boiling points.

Purpose / Used to separate:

- ❖ Homogeneous **liquid–liquid mixtures** with **different boiling points**
- ❖ Example: **Separating acetone from water** (acetone boils at 56°C, water at 100°C)

Apparatus:

- i. Distillation flask (contains the mixture)
- ii. Heat source (Bunsen burner or electric heater)
- iii. Condenser (to cool and condense the vapour)
- iv. Receiving flask (to collect the distilled liquid)
- v. Thermometer
- vi. Broken porcelain or boiling chips



Procedure:

- i. Pour the liquid mixture (acetone + water) into the distillation flask.
- ii. Add **broken porcelain / boiling chips** to the flask. Prevent sudden vigorous boiling (“bumping”) which can cause splashing.
- iii. Heat the flask slowly.
- iv. **Acetone evaporates first** because it has a lower boiling point (56°C).
- v. The vapour passes into the condenser, where it **cools and condenses** into a liquid.
- vi. Collect the condensed liquid (acetone) in the receiving flask.
- vii. This liquid is **pure acetone**, separated from water.

Key Points / Observations:

- ❖ The separation works because **acetone has a lower boiling point than water**.
- ❖ Broken porcelain prevents bumping during heating.
- ❖ The remaining liquid in the distillation flask is mostly water.
- ❖ This method can be applied to **any mixture of liquids with significantly different boiling points**.

<https://youtu.be/V5ep0-ojPGw?si=vFK6BpRLA6ShyK59>

Applications:

- ❖ Obtaining drinking water from salt water
- ❖ Purifying water in laboratories
- ❖ Separating alcohol from aqueous solutions (when using fractional distillation for closer boiling points)



2. Crystallisation

Definition:

- ❖ Crystallisation is a method used to **obtain pure solid crystals from a saturated solution**. It is commonly used for **homogeneous solid–liquid mixtures** where the solute can form crystals on cooling or evaporation of the solvent.

Purpose / Used to separate:

- ❖ Homogeneous solid–liquid mixtures
- ❖ Example: **Obtaining copper (II) sulphate crystals** from its solution

Apparatus:

- ❖ Beaker or crystallisation dish
- ❖ Glass rod
- ❖ Heat source (Bunsen burner or water bath)
- ❖ Filter paper and funnel (optional, for removing impurities)

Procedure:

- Prepare a **saturated solution** by dissolving the solute (e.g., copper (II) sulphate) in the minimum amount of hot solvent (water).
- Filter** the solution if necessary to remove insoluble impurities.
- Pour the solution into a **crystallisation dish**.
- Allow the solution to **cool slowly**.
- Dip a glass rod** into the solution to check if it is saturated and to **initiate crystal formation** (seeding).
- As the solution cools, the solute **crystallises out**, forming **pure crystals** on the surface or at the bottom.
- Carefully **collect the crystals** and dry them using filter paper.

Key Points / Observations:



- ❖ **Seeding:** Dipping a glass rod provides a nucleation point for crystal growth.
- ❖ **Purity:** Only pure solute forms crystals; impurities remain in the solution (mother liquor).
- ❖ **Slow cooling:** Produces larger, well-formed crystals.
- ❖ **Type of mixture separated:** Homogeneous solid–liquid mixture
- ❖ **Result:** Pure crystals of the solute, separated from the solvent

https://youtu.be/QdwKhbtzsug?si=jvivmeTRxChHNUR_

Applications:

- ❖ Obtaining pure **copper (II) sulphate** crystals in the lab
- ❖ Purifying **sugar** or **salt**
- ❖ Producing pure **chemical compounds** in chemistry experiments

3. Sublimation

Definition:

- ❖ Sublimation is a method used to **separate a solid–solid mixture** in which **one solid sublimates (changes directly from solid to gas) while the other does not.**

Purpose / Used to separate:

- ❖ Solid–solid mixtures where **one solid is volatile** and can **sublime**
- ❖ Example: **Separating iodine from salt**

Apparatus:

- ❖ Conical flask or beaker (contains the mixture)
- ❖ Round-bottomed flask or inverted funnel (to collect sublimed solid)
- ❖ Heat source (Bunsen burner or water bath)
- ❖ Stand and clamp (to hold the apparatus)



Procedure:

- i. Place the mixture (e.g., iodine + salt) in a beaker.
- ii. Set up a **round-bottomed flask or inverted funnel** above the mixture to collect the sublimed solid.
- iii. Heat the mixture gently.
- iv. **Iodine sublimes** (solid $\rightarrow$ gas) because it is volatile.
- v. Salt does not sublime and remains as a **white solid in the beaker**.
- vi. The iodine gas rises and **cools on the surface of the flask or funnel**, undergoing **deposition** (gas $\rightarrow$ solid).
- vii. Collect the **purple/black iodine crystals** formed on the cooler surface.

Key Points / Observations:

- ❖ **Sublimation:** Direct conversion of solid to gas without becoming liquid.
- ❖ **Deposition:** Gas to solid upon cooling.

Separation:

- ❖ White solid left in beaker $\rightarrow$ salt
- ❖ Coloured solid on flask $\rightarrow$ iodine
- ❖ Useful for **purifying solids that sublime**

<https://youtu.be/6YYrcHLckMw?si=HtubZTC93SEd7ssS>

Applications:

- ❖ Purifying **iodine** from salt
- ❖ Producing **mothballs (naphthalene)** from mixtures
- ❖ Separating **volatile solids from non-volatile solids in labs**



4. Solvent Extraction

Definition:

- ❖ Solvent extraction is a method used to **separate a substance from a mixture based on its solubility in a particular solvent.**
- ❖ It is often used to extract **desired substances from solids or liquids.**

Purpose

- ❖ Separates substances that are **soluble in a particular solvent but not in others**
- ❖ Example: **Extracting oil from groundnuts using propanone**

Apparatus:

- ❖ Beaker or container (contains the solid mixture, e.g., groundnuts)
- ❖ Solvent (e.g., propanone)
- ❖ Filter paper (optional, to remove insoluble solid particles)
- ❖ Evaporating dish or tray (to recover the extracted substance)

Procedure:

- Place the **solid mixture** (e.g., groundnuts) in a beaker.
- Add a suitable **solvent** (e.g., propanone) that **dissolves the desired substance** (oil).
- Stir or shake the mixture to allow **maximum dissolution** of the oil in the solvent.
- Filter the mixture if necessary to remove **insoluble solid residue.**
- Allow the solvent to **evaporate naturally or gently heat it** in an evaporating dish.
- The **oil remains** after the solvent has evaporated.



Key Points / Observations:

- ❖ The solvent selectively **dissolves the substance** to be separated.
- ❖ **Evaporation of the solvent** leaves behind the desired substance.
- ❖ Paper test: When oil is applied to paper, it becomes **translucent**, confirming the presence of oil.

<https://youtu.be/kKQxOgt4wyk?si=RIh-a0fKZiaQkPux>

Applications:

- ❖ Extracting **edible oils** from seeds (groundnuts, sunflower, etc.)
- ❖ Making **perfumes and essential oils**
- ❖ Extracting **plant chemicals for medicines or dyes**
- ❖ **Here's an expanded and detailed version of Paper Chromatography for your notes:**

5. Paper Chromatography**Definition:**

- ❖ Paper chromatography is a method used to **separate the components of a mixture based on their solubility and movement on a special paper**.
- ❖ It is commonly used for **analyzing coloured substances** like inks, dyes, and plant pigments.

Purpose

- ❖ Used to separate Components of a **homogeneous mixture** based on **solubility and adsorption**
- ❖ Example: **Separating ink dyes into individual colours**

Apparatus:

- ❖ Chromatography paper (filter paper or special strip)
- ❖ Beaker or container
- ❖ Solvent (e.g., water, alcohol)
- ❖ Pencil (to draw baseline)
- ❖ Capillary tube or dropper (to place sample)



Procedure:

- i. Draw a **baseline** near the bottom of the chromatography paper using a pencil.
- ii. Place a **small drop of the mixture** (e.g., black ink) on the baseline.
- iii. Place the paper in a **beaker containing a small amount of solvent**, ensuring the baseline is **above the solvent level**.
- iv. Allow the solvent to **rise up the paper by capillary action**, carrying the components of the mixture with it.
- v. Observe the **separation of components**:
- vi. Most soluble component moves **furthest** up the paper.
- vii. Least soluble component remains **near the baseline**.
- viii. Remove the paper once the solvent front reaches a desired height and allow it to **dry**.

Key Points / Observations:

- ❖ The method works because **different components have different solubility and attraction to the paper**.
- ❖ Separation is visible as **different coloured spots** on the paper.
- ❖ **Distance travelled** by a component depends on its **solubility in the solvent**.

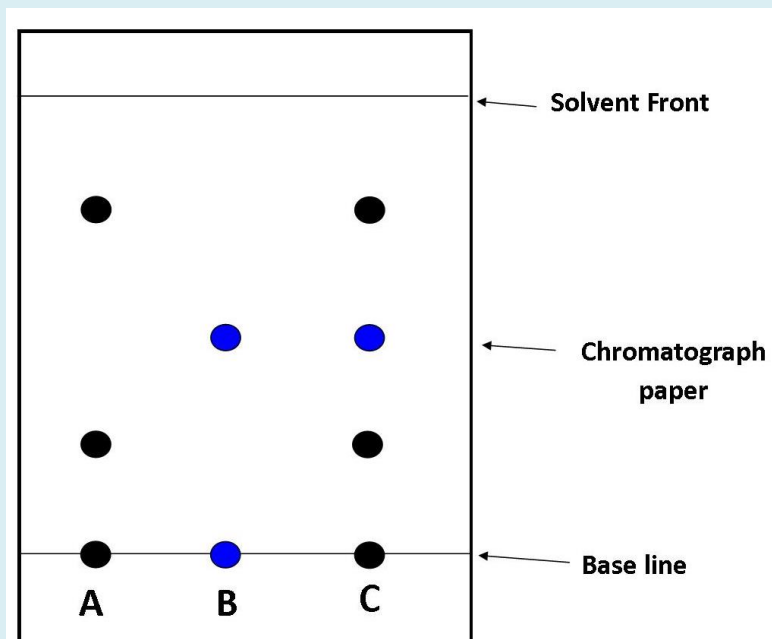
https://youtu.be/ZCzgQXGz9Tg?si=71d435Yxw_iaIDxS

Applications:

- ❖ Detecting **illegal drugs in athletes**
- ❖ Separating and identifying **food colourings**
- ❖ **Forensic investigations** (e.g., analysing inks, blood pigments)



Studying plant pigments and chemical composition



NOTE

Sample C contains element B. Sample A does not contain element A. If B was an illegal drug for example, we will conclude that C has the drug while A does not have the drug

6. Evaporation

Meaning

- ❖ Evaporation is a method used to separate a **solvent** from a **solution** by heating or leaving it exposed to air.
- ❖ It is used to Separate a **solvent** from a solution. Example: Obtaining **salt from sea water**.
- ❖ When sea water is heated or left in shallow ponds under the sun, the water evaporates and salt crystals remain.

Key Points

- ❖ The **liquid (solvent)** changes into vapour.
- ❖ The **solid (solute)** remains behind as crystals.

- ❖ Evaporation occurs faster when:
- ❖ Temperature is high
- ❖ Surface area is large
- ❖ Wind is blowing

Other Applications

- ❖ Drying grains after harvesting.
- ❖ Drying clothes under the sun.
- ❖ Making salt in salt pans.

7. Fractional Distillation

Meaning

- ❖ Fractional distillation is a method used to separate **two or more liquids that are miscible (mixed together)** and have **close boiling points**.
- ❖ It is used to Separate Liquids with **close boiling points**. For Example, Separating **ethanol from water** and Refining **crude oil** into useful products such as petrol, diesel, and kerosene.

Key Points

- ❖ Separation is based on **differences in boiling points**.
- ❖ Ethanol boils at about **78°C**, while water boils at **100°C**.
- ❖ The liquid with the **lower boiling point** evaporates first.
- ❖ A **fractionating column** is used to improve separation.
- ❖ In oil refining, different fractions are collected at different temperatures.

https://youtu.be/9DWcZRWwXvQ?si=Brm5M-Ek6nltLAf_

Products from Crude Oil

- | | | |
|---------------------|-------------------|-----------|
| ❖ Petrol (gasoline) | ❖ Diesel | ❖ Bitumen |
| ❖ Kerosene | ❖ Lubricating oil | |



Assess Yourself

1. Define a mixture.
2. State the difference between a homogeneous mixture and a heterogeneous mixture.
3. What is a solute? Give one example.
4. Name two products obtained from crude oil by fractional distillation.
5. Explain why salt + water is a homogeneous mixture but sand + water is a heterogeneous mixture.
6. Why does acetone evaporate before water during simple distillation?
7. Describe what happens during sublimation using iodine and salt as an example.
8. Which method would you use to obtain salt from sea water? Explain your answer.
9. A student wants to separate ink into different colours. Which method should they use and why?
10. How would you separate oil from groundnuts in a laboratory? Name the method and outline one key step.
11. Compare simple distillation and fractional distillation. How are they similar and how are they different?
12. Analyse why slow cooling is important during crystallisation. What might happen if the solution is cooled too quickly?
13. During crystallisation, impurities remain in the mother liquor. Why do they not form crystals with the pure solute?
14. A student uses evaporation instead of crystallisation to obtain copper(II) sulphate crystals.

2.2 ACIDS, BASES AND INDICATORS

Introduction

- ❖ Acids and bases are important chemical substances found in our homes, laboratories, industries, and even in our bodies.
- ❖ They have distinct properties and can be identified using special substances called **indicators**.

Acids

- ❖ An **acid** is a substance that produces hydrogen ions when dissolved in water.

Physical Properties of Acids

- ❖ Have a **sour taste**
- ❖ Turn **blue litmus paper red**
- ❖ Are **corrosive** (can cause burns)
- ❖ Conduct electricity when dissolved in water
- ❖ React with some metals to produce hydrogen gas

Examples of Acids include: Lemon juice, Vinegar, Orange juice, Fermented milk and Dilute hydrochloric acid (laboratory acid)

Uses of Acids

- ❖ **Vinegar** – Food preservation
- ❖ **Sulfuric acid** – Car batteries
- ❖ **Nitric acid** – Fertiliser production
- ❖ Food flavouring (citric acid in fruits)

Bases

A **base** is a substance that produces hydroxide ions when dissolved in water.



Physical Properties of Bases

- ❖ Have a **bitter taste**
- ❖ Turn **red litmus paper blue**
- ❖ Feel **slippery or soapy**
- ❖ Conduct electricity in solution
- ❖ Can neutralise acids

Examples of Bases include: Soap solution, Baking soda solution, Toothpaste, Wood ash solution, Bleach and Antacids

Uses of Bases

- ❖ **Toothpaste** – Neutralises acids in the mouth
- ❖ **Antacids** – Reduce excess stomach acid
- ❖ **Soap and detergents** – Cleaning
- ❖ **Fertilisers** – Improve soil conditions

Neutral Substances

- ❖ A **neutral substance** is neither acidic nor basic.
- ❖ Examples include: Distilled water, Sugar solution and Common salt solution
- ❖ Neutral substances do **not change** red or blue litmus paper.

Indicators

- ❖ An **indicator** is a substance that changes colour to show whether a substance is acidic, basic, or neutral.
- ❖ Indicators include:



(a) Litmus Paper

Litmus is the most common indicator used in laboratories. It changes colour according to the following rules.

Substance Type	Red Litmus	Blue Litmus
Acid	Remains red	Turns red
Base	Turns blue	Remains blue
Neutral	No change	No change

<https://youtu.be/3BfxiSJ5-hY?si=ktUAo5CiSkHV2M7t>

(b) Plant Extract Indicators

Some plant extracts can also act as indicators.

In Acids they Show one colour change, in Bases they show Show a different colour change and in Neutral there is No colour change

△ Plant extracts must be freshly prepared and are less reliable than litmus paper.

<https://youtu.be/MVOBiC0iCnU?si=HLWkAxuHQ23ljn8P>

EXPERIMENT: Testing Electrical Conductivity of Acids and Bases

Aim

- ❖ To investigate whether **hydrochloric acid (HCl)** and **sodium hydroxide (NaOH)** conduct electricity when dissolved in water.

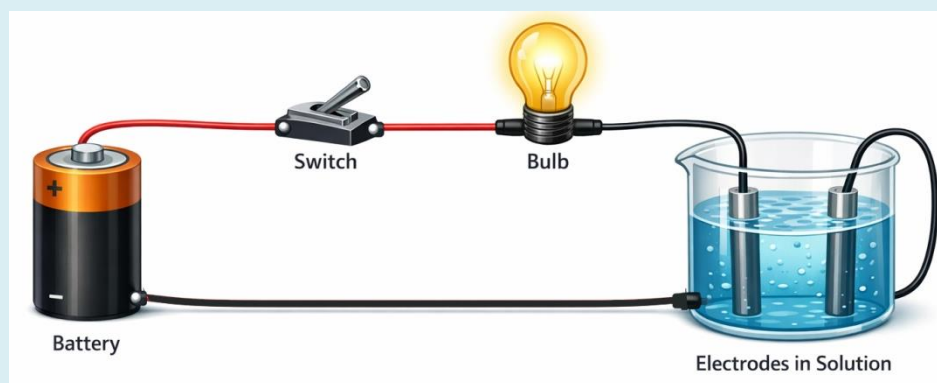


Apparatus and Materials

- ❖ Dilute hydrochloric acid (HCl)
- ❖ Dilute sodium hydroxide (NaOH)
- ❖ Distilled water (control)
- ❖ Beakers (3)
- ❖ Two graphite electrodes (or carbon rods)
- ❖ Connecting wires
- ❖ Battery (low voltage, e.g., 3–6 V)
- ❖ Bulb or LED
- ❖ Switch
- ❖ Retort stand (optional)

Experimental Setup

The circuit should be arranged as shown



Procedure

- i. Set up the electrical circuit with the bulb and battery.
- ii. Pour dilute HCl into a beaker.
- iii. Dip the two electrodes into the acid solution (do not allow them to touch).
- iv. Close the switch and observe the bulb.

- v. Record your observation.
- vi. Repeat the procedure using dilute NaOH solution.
- vii. Finally, repeat using distilled water as a control experiment.

Observations

Solution	Observation	Conclusion
Dilute HCl	Bulb lights	Conducts electricity
Dilute NaOH	Bulb lights	Conducts electricity
Distilled water	Bulb does not light	Does not conduct electricity

Explanation

- ❖ Acids or bases produce free-moving ions which carry electric current through the solution.

Conclusion

- ❖ Both acids and bases conduct electricity when dissolved in water because they produce **free-moving ions**. Pure water does not conduct electricity effectively.

Safety Precautions

- ❖ Use dilute solutions only.
- ❖ Handle HCl and NaOH carefully; they are corrosive.
- ❖ Do not touch the solution while the circuit is connected.
- ❖ Wash hands after the experiment.

https://youtu.be/hcCPUnA5In8?si=2QovNiet3_aYSHDR

Neutralisation

- ❖ Neutralisation is the reaction between an **acid and a base** to form **salt and water**.
- ❖ $\text{Acid} + \text{Base} \rightarrow \text{Salt} + \text{Water}$

This reaction is useful in:

- ❖ Treating acidic soils
- ❖ Relieving stomach acidity (antacids)
- ❖ Industrial chemical processes

Safety Precautions

- ❖ Do not taste chemicals.
- ❖ Handle acids and bases carefully.
- ❖ Wear protective gear when working in the laboratory.
- ❖ Wash spills immediately with plenty of water.



Assess Yourself

1. Define an acid.
2. Define a base.
3. What is an indicator?
4. State two physical properties of acids.
5. State two physical properties of bases.
6. Give two examples of acids found at home.
7. What happens to blue litmus paper when it is placed in an acid?
8. What happens to red litmus paper when it is placed in a base?
9. Explain why acids and bases can conduct electricity when dissolved in water.
10. Why is distilled water used as a control in the electrical conductivity experiment?
11. Describe what happens during a neutralisation reaction.
12. A farmer adds lime (a base) to acidic soil. Explain why this is helpful.
13. Compare the properties of acids and bases. Give at least two differences.
14. A student tests an unknown solution. Red litmus paper turns blue. What can you conclude about the solution? Explain your answer.
15. Design a simple experiment to test whether a household liquid (e.g., lemon juice or soap solution) is acidic, basic, or neutral. List the materials, steps, and expected results.

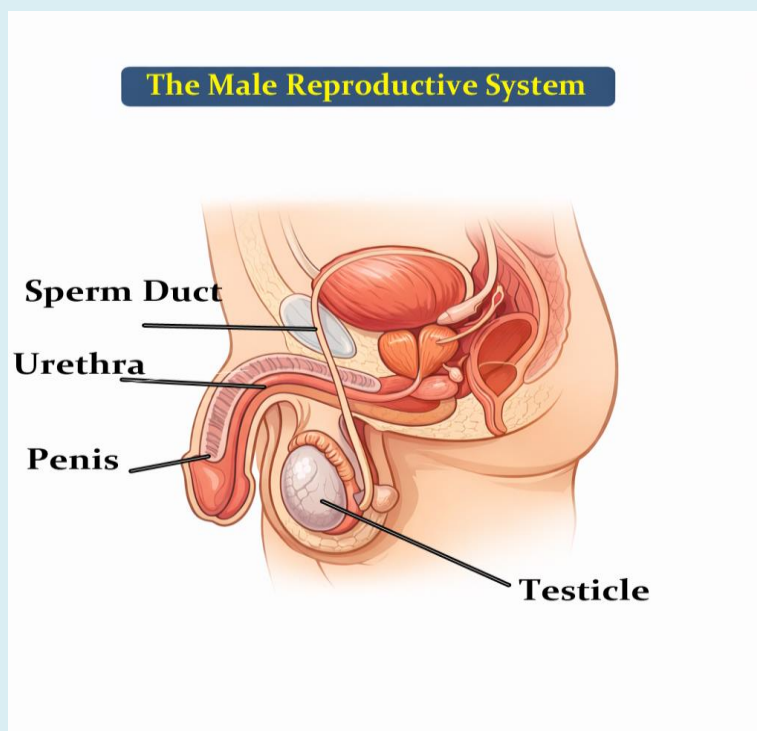
3.0 LIVING THINGS AND THEIR ENVIRONMENT

3.1 HUMAN REPRODUCTIVE SYSTEM

3.1.1. The Male Reproductive System

- ❖ The **male reproductive system** is designed to **produce male gametes (sperms)** and **deliver them into the female reproductive system** for reproduction.
- ❖ It also produces **male sex hormones** like testosterone, which regulate the development of male characteristics.

Main Parts and Their Functions



Part	Function	Additional Details
Penis	Deposits sperms into the vagina during sexual intercourse.	Also allows urine to leave the body through the urethra.
Urethra	Tube through which urine and semen leave the body.	It serves a dual purpose; a valve prevents urine and semen from mixing during ejaculation.
Testes (Testicles)	Produce sperms and the male hormone testosterone.	Testosterone controls development of male secondary sexual characteristics like deep voice, facial hair, and muscle growth.
Scrotum	Sac that holds and protects the testes.	Keeps testes slightly cooler than body temperature, which is essential for sperm production.
Sperm duct (Vas deferens)	Carries sperms from the testes to the urethra.	During ejaculation, sperm travel through the vas deferens and mix with fluids from glands to form semen.
Reproductive glands (seminal vesicles, prostate gland, bulbourethral gland)	Produce fluids that mix with sperms to form semen.	These fluids provide nutrients and a medium for sperm movement, and help neutralize acidic environments in the female reproductive tract.

Important Notes

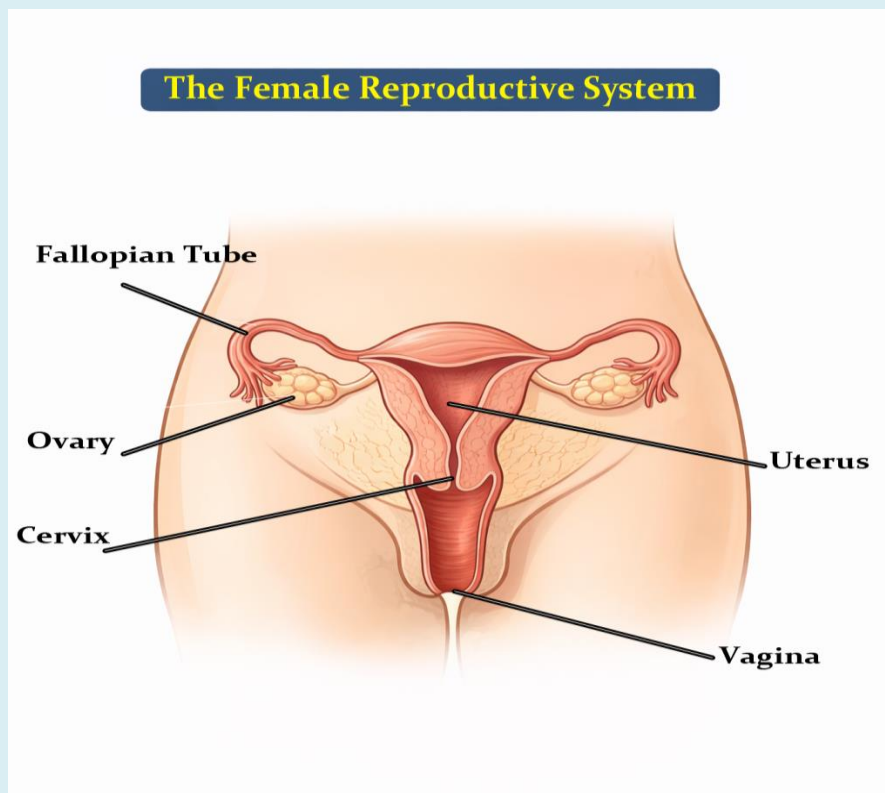
- ❖ **Semen** is a mixture of sperm cells and reproductive fluids.

- ❖ Sperm production begins at **puberty/adolescence** and continues throughout life.
- ❖ Healthy sperm production depends on proper **nutrition, temperature, and lifestyle**.

3.1.2. The Female Reproductive System

- ❖ The **female reproductive system** is responsible for **producing eggs (ova)**, facilitating fertilisation, and **supporting the development of a baby** during pregnancy.
- ❖ It also produces female sex hormones, mainly **estrogen** and **progesterone**, which regulate menstrual cycles and development of female characteristics.

Main Parts and Their Functions



Part	Function	Additional Details
Ovary	Produces eggs (ova) and female hormones.	Girls are born with immature eggs; a few mature and are released during each menstrual cycle.
Oviduct (Fallopian tube)	Connects ovary to uterus; fertilisation usually occurs here.	Tiny hair-like structures called cilia help move the egg toward the uterus.
Uterus	Organ where the baby develops during pregnancy.	Lined with endometrium , which thickens during the menstrual cycle to prepare for implantation.
Cervix	Narrow opening of the uterus; opens during childbirth.	Produces mucus that can help or block sperm movement depending on the cycle stage.
Vagina	Receives sperms during sexual intercourse; serves as the birth canal.	Also allows menstrual blood to leave the body.

Important Notes

- ❖ **Egg release (ovulation)** begins during adolescence, typically around 12–13 years of age.
- ❖ Each menstrual cycle, usually **one egg matures** and is released.
- ❖ The female reproductive system is also affected by hormones, which regulate **menstruation, pregnancy, and lactation**.

3.1.3 adolescence

- ❖ **Adolescence** is the transitional stage of life between **childhood and adulthood**. During this period:



- ❖ The **body undergoes physical changes** that prepare it for adulthood.
- ❖ **Reproductive organs mature**, enabling the individual to reproduce.
- ❖ **Emotional and social development** occurs, helping individuals form identity, self-confidence, and relationships.
- ❖ Adolescents gradually gain **independence** and develop decision-making skills.

Key Point: Adolescence usually occurs between **10–19 years of age**, though the exact timing can vary for each individual.

Physical Changes During Adolescence

Adolescence involves many **physical changes**, some unique to each gender and some common to both.

(a) Changes in Girls Only

- ❖ **Menstruation begins** – the first menstrual period.
- ❖ **Breast development** – breasts enlarge as a sign of sexual maturity.
- ❖ **Hips broaden** – preparing the body for potential childbearing.
- ❖ **Increased body fat distribution** – body shape becomes more adult-like.

(b) Changes in Boys Only

- ❖ **Voice deepens** – vocal cords grow, producing a lower pitch.
- ❖ **Adam's apple becomes noticeable** – part of larynx enlargement.
- ❖ **Shoulders broaden** – chest and shoulder muscles develop.
- ❖ **Increased muscle mass** – body becomes more muscular and strong.

(c) Changes in Both Boys and Girls

- ❖ **Increase in height and weight** – rapid growth spurt occurs.
- ❖ **Growth of pubic and underarm hair** – due to hormonal changes.
- ❖ **Acne (pimples)** – increased oil production in skin can cause breakouts.
- ❖ **Increased sweating and body odour** – sweat glands become more active.
- ❖ **Changes in body composition** – muscles, fat, and bone density adjust for adulthood.



Note: These changes are influenced by **genetics, nutrition, and overall health.**

Developmental Challenges During Adolescence

Adolescence is not only a period of physical growth but also **emotional and social adjustments.**

Challenges can be grouped as:

(a) Physical Challenges

- ❖ **Pimples and acne** – common due to hormonal changes.
- ❖ **Sweating and body odour** – more noticeable during puberty.
- ❖ **Menstrual pain** – cramps and discomfort during periods in girls.
- ❖ **Voice breaking** – sudden pitch changes in boys.
- ❖ **Rapid growth** – can cause temporary clumsiness or fatigue.

(b) Social Challenges

- ❖ **Peer pressure** – desire to fit in can lead to risky behaviour.
- ❖ **Influence from friends** – may affect choices, habits, and behaviour.
- ❖ **Withdrawal from adults** – teens may prefer friends over parents or teachers.
- ❖ **Changing relationships** – forming new social identities and roles.

(c) Emotional Challenges

- ❖ **Mood swings** – rapid changes in feelings due to hormonal shifts.
- ❖ **Shyness or social anxiety** – feeling self-conscious about body changes.
- ❖ **Low self-esteem** – comparing oneself to peers or media standards.
- ❖ **Confusion about identity** – figuring out personal values, beliefs, and goals.

Key Point: These challenges are **normal and part of growing up.** Support and guidance can help adolescents navigate them successfully.



Managing Developmental Challenges

Adolescents can **cope with these challenges** through healthy habits, guidance, and support:

- ❖ **Seek medical advice** when experiencing health or developmental issues.
- ❖ **Exercise regularly** – helps manage stress, builds strength, and improves mood.
- ❖ **Eat a balanced diet** – provides energy and nutrients for growth.
- ❖ **Maintain personal hygiene** – regular bathing, oral care, and skincare reduce discomfort.
- ❖ **Talk to parents, teachers, or trusted adults** – sharing feelings and experiences improves emotional health.
- ❖ **Choose good friends** – positive peer influence encourages healthy behaviour.
- ❖ **Participate in school and community activities** – promotes self-confidence, teamwork, and social skills.
- ❖ **Learn coping strategies** – such as relaxation, meditation, and time management.

Assess Yourself

1. Define adolescence.
2. State the function of the testes in the male reproductive system.
3. Name two parts of the female reproductive system.
4. What is semen?
5. State two physical changes that occur in boys during adolescence.
6. State two physical changes that occur in girls during adolescence.
7. Explain why the scrotum keeps the testes slightly cooler than body temperature.
8. Describe the function of the uterus.
9. Explain the dual role of the urethra in males.
10. Why does fertilisation usually occur in the oviduct (Fallopian tube)?
11. Compare the roles of hormones in males and females during adolescence.
12. Analyse why adolescence can be a challenging stage emotionally and socially.
13. A teenage boy is experiencing voice breaking and rapid growth. Explain why these changes are occurring.
14. A girl feels shy and develops low self-esteem because of body changes. Suggest two healthy ways she can manage these challenges and explain why they help.
15. Design a simple awareness poster for adolescents explaining how to manage physical and emotional changes during puberty. Include at least three key messages.

3.2 The human Excretory System

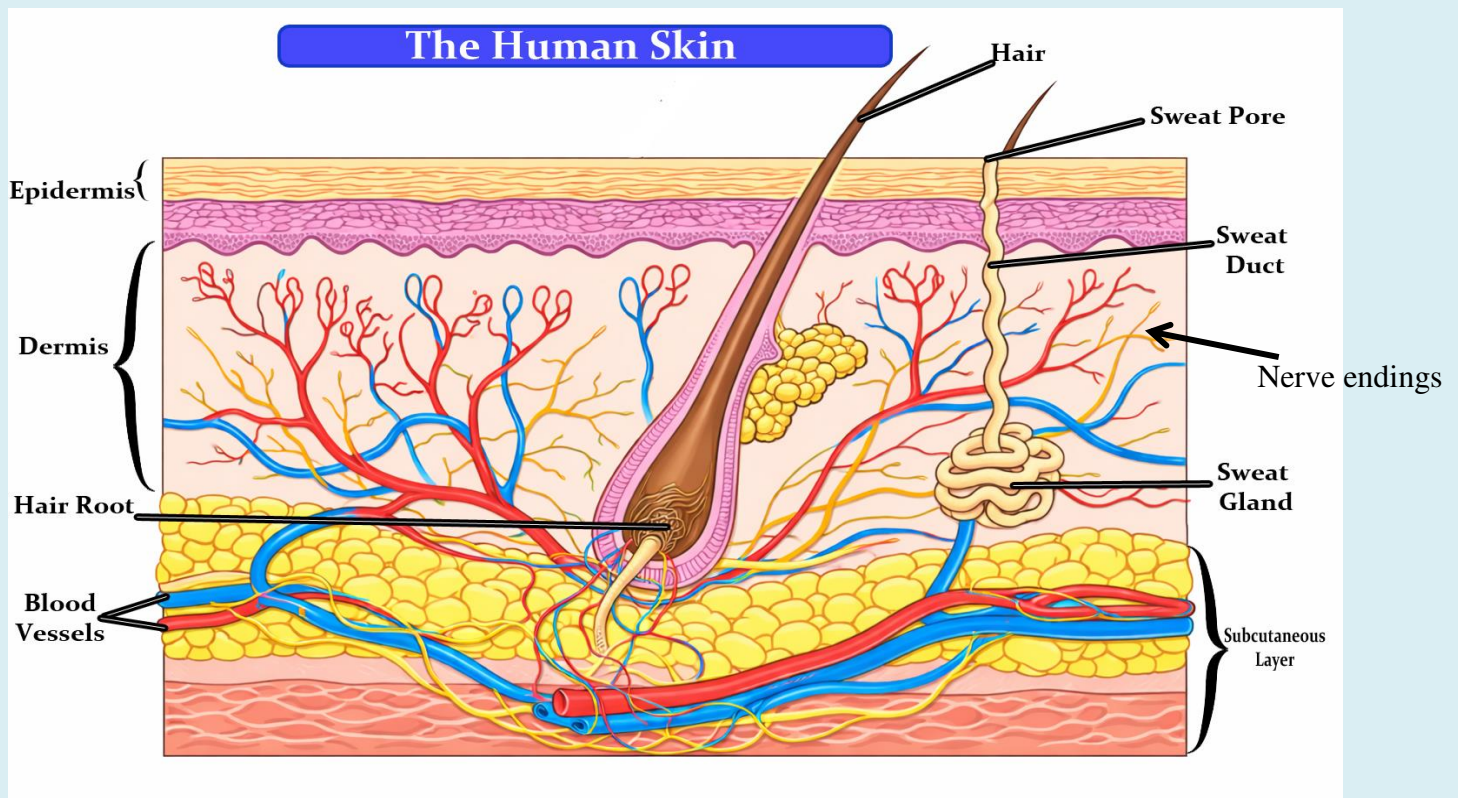
3.2.1 The human skin

The **skin** is the largest organ of the human body. It protects the body, helps regulate temperature, and plays a key role in excretion and sensation.

Main Functions of the Skin

- ❖ **Protection** – Acts as a barrier against injury, harmful microorganisms, and ultraviolet radiation.
- ❖ **Prevents water loss** – Reduces dehydration by limiting water evaporation.
- ❖ **Regulates body temperature** – Through sweating and adjusting blood flow to the skin.
- ❖ **Excretes waste** – Removes water, salts, and small amounts of urea through sweat.
- ❖ **Sensation** – Detects touch, pressure, pain, and temperature through nerve endings.

Parts of the Skin



Part	Description
Epidermis	Outermost layer; provides a protective barrier.
Dermis	Inner layer; contains blood vessels, nerves, and sweat glands.
Subcutaneous layer	Fat layer beneath the dermis; stores energy and cushions organs.
Sweat glands	Produce sweat for cooling and excretion of waste.
Sweat ducts	Channels that carry sweat from glands to skin surface.
Sweat pores	Openings on the skin through which sweat is released.
Hair	Provides protection and regulates temperature.
Hair roots	Embedded in the dermis; responsible for hair growth.
Blood vessels	Supply nutrients and oxygen; help regulate temperature.
Nerve endings	Detect touch, pain, and temperature changes.

Waste Products Excreted Through the Skin

- ❖ **Water** – helps cool the body.
- ❖ **Salts** – maintain electrolyte balance.
- ❖ **Small amounts of urea** – metabolic waste removed from the blood.

Functions of Sweat:

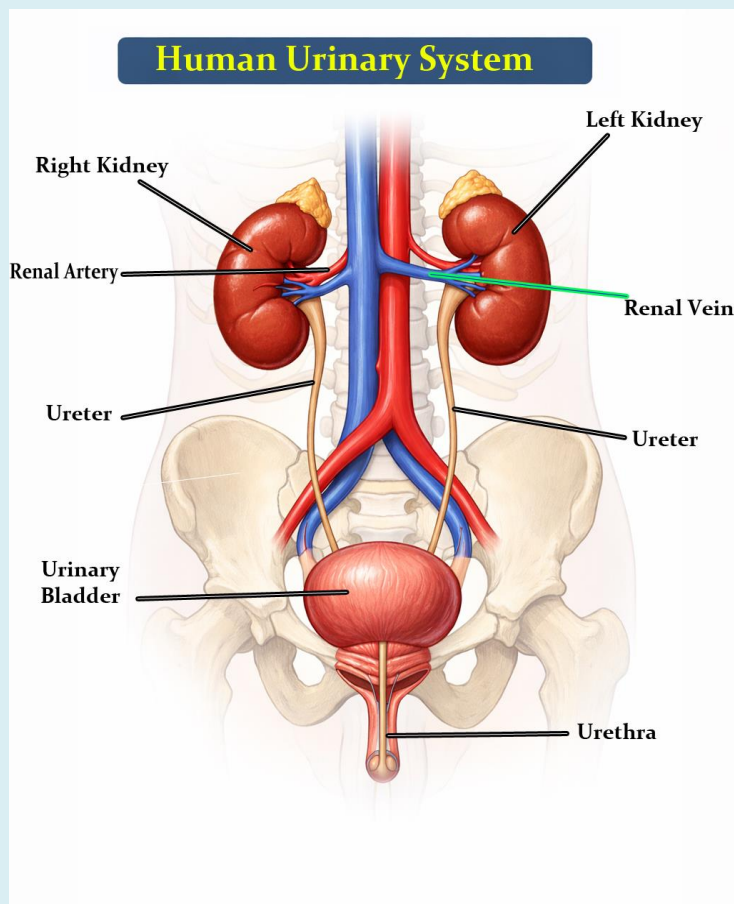
- ❖ **Cooling the body** through evaporation.
- ❖ **Excreting waste products** such as salts and urea.



3.2.2 Urinary System

The **urinary system** removes waste products from the blood, maintains water and salt balance, and regulates blood pressure.

Main Parts of the Urinary System



Part	Function
Right Kidney & Left Kidney	Filter blood, remove waste products, and produce urine.
Renal artery	Carries unfiltered blood from the heart to the kidneys.
Renal vein	Returns filtered blood from the kidneys to the heart.

Part	Function
Ureters	Carry urine from the kidneys to the urinary bladder.
Urinary bladder	Stores urine temporarily before excretion.
Urethra	Allows urine to leave the body.

Waste Products Excreted Through the Kidneys

- ❖ **Excess water** – maintains proper hydration.
- ❖ **Urea** – produced from protein metabolism.
- ❖ **Salts** – maintain electrolyte balance.

Kidney Disorders

Examples of Kidney Disorders

Disorder	Description
Chronic kidney failure	Gradual, long-term loss of kidney function, often requiring dialysis or transplant.
Nephritis	Inflammation of the kidneys, usually caused by infections or autoimmune responses.
Hypertension	High blood pressure can damage kidney blood vessels, reducing their filtering efficiency.
Diabetes	High blood sugar over time can harm kidney tissues, leading to diabetic nephropathy.
Kidney stones	Hard, solid deposits of salts and minerals form in the kidneys; they can cause severe pain and block urine flow.

Key Point: Kidney disorders can range from mild and manageable to severe and life-threatening. Early detection is critical.

Causes of Kidney Disorders

- ❖ **Infections** – bacterial or viral infections can damage kidney tissues.
- ❖ **Improper diet** – high intake of salt, sugar, or protein strains the kidneys.
- ❖ **Inadequate water intake** – dehydration reduces kidney filtration ability.
- ❖ **Prolonged use of certain medications** – such as painkillers or anti-inflammatory drugs.
- ❖ **High blood pressure** – constant pressure damages delicate kidney blood vessels.
- ❖ **Diabetes** – excess glucose can harm kidney cells over time.

Note: Some kidney disorders are preventable by maintaining a healthy lifestyle and monitoring predisposing health conditions.

Ways to Prevent Kidney Disorders

- ❖ **Drink plenty of clean water** – helps flush toxins and maintain kidney function.
- ❖ **Eat a balanced diet** – rich in fruits, vegetables, and fiber; limit salt, sugar, and processed foods.
- ❖ **Exercise regularly** – maintains healthy blood pressure and body weight.
- ❖ **Avoid smoking and excessive alcohol** – these substances damage kidneys and other organs.
- ❖ **Limit use of harmful drugs** – avoid overuse of painkillers and consult a doctor before prolonged medication use.
- ❖ **Maintain healthy body weight** – prevents strain on kidneys and reduces risk of hypertension and diabetes.
- ❖ **Attend regular medical check-ups** – early detection of kidney issues improves outcomes.
- ❖ **Practice good personal hygiene** – reduces risk of infections that can affect kidney health.

Healthy Lifestyles That Promote Skin and Kidney Health

A **healthy lifestyle** is essential for the proper functioning of the skin and kidneys. The following habits help maintain their health:



- ❖ **Eat healthy food** – supports immune system, organ function, and tissue repair.
- ❖ **Drink enough water** – keeps skin hydrated and helps kidneys filter blood efficiently.
- ❖ **Exercise regularly** – boosts circulation, strengthens muscles, and aids toxin removal.
- ❖ **Maintain personal hygiene** – prevents skin infections and reduces bacterial load on the body.
- ❖ **Avoid harmful substances** – tobacco, excessive sugar, alcohol, and recreational drugs can damage skin and kidneys.
- ❖ **Seek medical advice when necessary** – early detection of skin or kidney issues prevents complications.
- ❖ **Manage stress** – prolonged stress can affect hormone levels and overall health.
- ❖ **Get adequate sleep** – promotes repair of skin tissues and supports kidney function.

Assess Yourself

1. Name the largest organ of the human body.
2. State two main functions of the skin.
3. What waste products are removed from the body through sweat?
4. Name two main parts of the urinary system.
5. What is the function of the kidneys?
6. Describe the role of sweat glands in the skin.
7. Explain how sweating helps regulate body temperature.
8. Why is drinking enough water important for kidney function?
9. Compare the excretory functions of the skin and the kidneys.
10. Explain how high blood pressure can affect the kidneys.
11. Analyse how poor diet and dehydration can lead to kidney disorders.
12. A person sweats heavily during exercise. Explain what is happening in the body and why this is important.
13. A patient has kidney stones. Describe how this condition may affect urine flow and cause pain.
14. Suggest three lifestyle habits that help maintain healthy skin and kidneys, and explain why each is important.
15. Design a simple health awareness message for your school explaining how students can protect their skin and kidneys. Include at least three key points.

4.0 FORCE AND ENERGY

4.1 ELECTRICAL ENERGY

- ❖ Electricity is a **form of energy** that flows through wires and is used to make devices work. It helps us to **see, hear, cook, communicate, and do work**.
- ❖ Electricity powers many appliances used in **homes, schools, hospitals, offices, and industries**.

Electricity can produce:

- ❖ **Light** (bulbs, lamps)
- ❖ **Heat** (iron box, cooker)
- ❖ **Sound** (radio, television)
- ❖ **Motion** (fans, washing machines)

4.1.1 Sources of Electricity

Electricity can be produced from different **energy sources**, which may be renewable or non-renewable.

Solar Energy

- ❖ Comes from the **sun**.
- ❖ Solar panels absorb sunlight.
- ❖ The sunlight is converted into electricity.
- ❖ It is **clean, renewable, and environmentally friendly**.
- ❖ Used in homes, schools, street lights, and calculators.

Wind Energy

- ❖ Wind turns large blades called **turbines**.
- ❖ The turbines rotate generators.
- ❖ The generators produce electricity.
- ❖ Wind energy is **renewable** and does not cause pollution.



Hydroelectric Power

- ❖ Produced using **flowing or falling water**.
- ❖ Water turns turbines in power stations.
- ❖ Commonly produced at **dams**.
- ❖ It is one of the main sources of electricity in many countries.

Geothermal Energy

- ❖ Comes from **heat beneath the earth's surface**.
- ❖ Underground heat produces steam.
- ❖ Steam turns turbines connected to generators.
- ❖ It is reliable and renewable.

Biomass Energy

- ❖ Uses **plant and animal waste** such as wood, crop remains, and animal dung.
- ❖ The waste is burned to produce heat.
- ❖ Heat is used to generate electricity.
- ❖ It helps reduce waste.

Nuclear Energy

- ❖ Produced from **nuclear reactions**.
- ❖ The reaction produces a large amount of heat.
- ❖ Heat turns water into steam.
- ❖ Steam turns turbines to generate electricity.
- ❖ Produces a lot of power but must be handled carefully.

Fossil Fuels

- ❖ Includes **coal, oil, and natural gas**.
- ❖ These fuels are burned to produce heat.
- ❖ Heat is used to generate electricity.

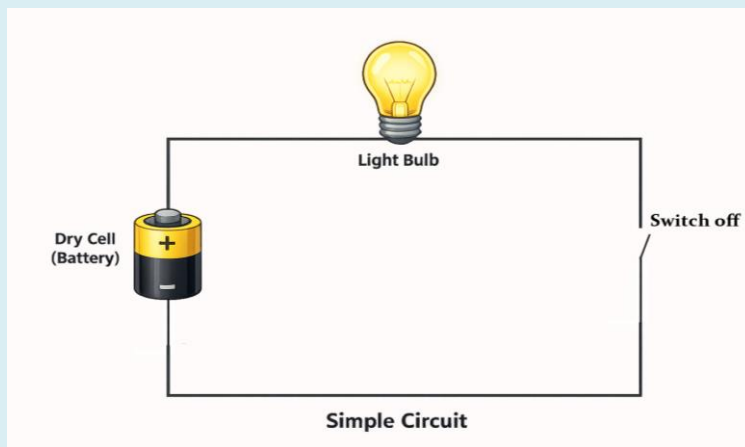


- ❖ They are **non-renewable** and cause pollution.

4.1.2 Simple Electrical Circuit

A **simple electrical circuit** is a **closed path** through which electric current flows from a power source, through a device, and back to the source.

Parts of a Simple Circuit



- ❖ **Dry cell (battery)** – supplies electrical energy
 - ❖ **Bulb** – uses electricity to produce light
 - ❖ **Switch** – opens or closes the circuit
 - ❖ **Connecting wires** – allow current to flow between parts
- ☐ If the circuit is **open**, electricity will not flow.
 - ☐ If the circuit is **closed**, electricity flows and the bulb lights.

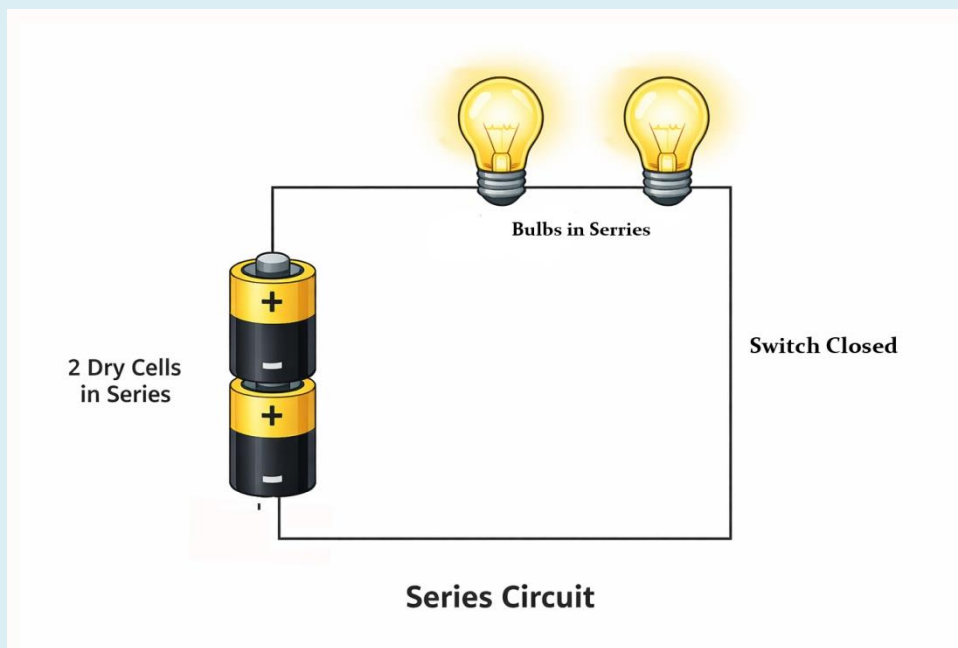
Series Connection

In a **series circuit**, components are connected in **one single path**.



Characteristics:

- ❖ Cells are connected **end to end** (+ to -).
- ❖ Bulbs share the same path.
- ❖ If **one bulb goes off**, all others go off.
- ❖ Adding more cells increases the **brightness**.
- ❖ Used in **torchlights** and simple devices.

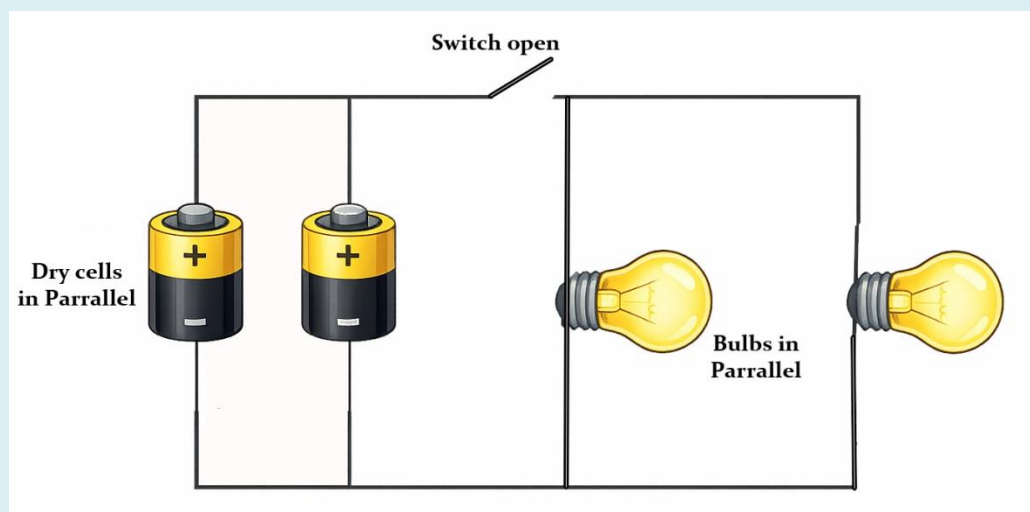
**Parallel Connection**

In a **parallel circuit**, components are connected in **separate paths**.

Characteristics:

- ❖ Like terminals are connected (+ to +, - to -).
- ❖ Each bulb has its **own path** for current.
- ❖ If one bulb fails, **others remain on**.
- ❖ All bulbs receive the same voltage.
- ❖ Commonly used in **homes and buildings**.





Electrical Appliances Used in Daily Life

Electrical appliances make work **easier and faster**.

Examples include:

- | | | |
|-------------------|-------------------|--------|
| ❖ Electric iron | ❖ Blender | ❖ Fan |
| ❖ Television | ❖ Washing machine | ❖ Lamp |
| ❖ Refrigerator | ❖ Electric kettle | |
| ❖ Electric cooker | ❖ Microwave | |

Each appliance converts electrical energy into **useful energy** such as heat, light, sound, or motion.

Safety Measures When Handling Electrical Appliances

Electricity can be **dangerous** if not handled properly. Always follow safety rules:

- ❖ Do not insert **metal objects** into sockets
- ❖ Switch off sockets when not in use
- ❖ Switch off appliances before plugging or unplugging
- ❖ Never use appliances with **wet hands**
- ❖ Do not overload sockets
- ❖ Repair or replace damaged wires and cords



- ❖ Follow manufacturer's instructions
- ❖ Call **qualified professionals** for repairs
- ❖ Keep water away from electrical appliances

Uses of Electricity in Daily Life

Electricity is used for:

- | | |
|---|---|
| ❖ Cooking food | ❖ Entertainment (TV, radio) |
| ❖ Lighting homes and streets | ❖ Communication (charging phones, computers) |
| ❖ Washing clothes | ❖ Running machines in factories and industries |
| ❖ Ironing clothes | |
| ❖ Refrigeration to preserve food | |

Assess Yourself

1. Define electricity.
2. Name two sources of renewable energy used to produce electricity.
3. State two non-renewable sources of electricity.
4. List the four main parts of a simple electrical circuit.
5. What happens when a circuit is open?
6. Describe how solar energy is converted into electricity.
7. Explain how hydroelectric power produces electricity.
8. Differentiate between a series circuit and a parallel circuit.
9. Why are parallel circuits commonly used in homes instead of series circuits?
10. Explain what happens to other bulbs in a series circuit if one bulb goes off.
11. Analyse why fossil fuels are harmful to the environment compared to renewable energy sources.
12. A student adds more dry cells to a torch in a series connection. Explain what will happen to the brightness of the bulb and why.
13. Suggest three safety measures to follow when handling electrical appliances and explain why each is important.
14. Compare renewable and non-renewable sources of electricity, giving two differences.
15. Design a simple electrical circuit that can light two bulbs in a house so that if one bulb fails, the other remains on. Describe the type of connection you would use and explain why.

4.2 MAGNETISM

A **magnet** is a material that **attracts magnetic materials** such as **iron, steel, cobalt, and nickel**.

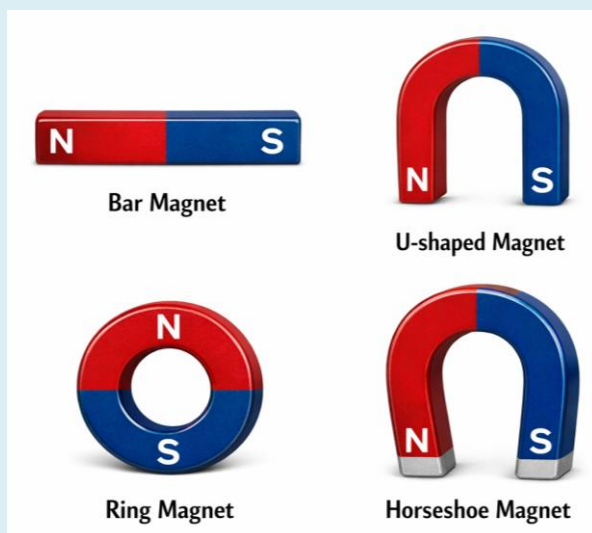
Magnets can be naturally occurring (like lodestone) or artificially made.

4.2.1 Types of Magnets

Magnets come in different shapes and forms, each with specific uses:

Type	Description
Bar Magnet	A rectangular magnet with poles at the ends.
U-shaped Magnet	Shaped like the letter U; concentrates magnetic force at the ends.
Ring Magnet	Circular magnet with a hole in the middle; often used in speakers.
Horseshoe Magnet	U-shaped magnet with stronger magnetic field due to close poles.

Note: Magnets always have **two poles**, a North (N) and a South (S) pole.



4.2.2 Properties of Magnets

- ❖ **Attraction** – Magnets attract magnetic materials like iron and steel.



- ❖ **Poles** – Every magnet has two poles: **North (N) and South (S)**.
- ❖ **Repulsion** – Like poles repel each other (N–N, S–S).
- ❖ **Attraction Between Unlike Poles** – North and South poles attract (N–S).
- ❖ **Strongest at Poles** – Magnetic force is strongest at the ends of the magnet.
- ❖ **Directional Property** – A freely suspended magnet aligns itself in the **North–South direction**.

Demonstrating Properties of Magnets

(a) Attractive Property

- ❖ Place a magnet near **nails or iron filings**.
- ❖ Observe that the magnet **attracts the materials**.
- ❖ Attraction is **strongest at the poles**.

(b) Repulsive Property

- ❖ Place the **North pole of one magnet near the North pole of another** – they repel.
- ❖ South–South also repels.
- ❖ North–South poles attract each other.

<https://youtube.com/shorts/EWrXi3E4kVc?si=fGvVDzE7GjagP>

(c) Directional Property

- ❖ Suspend a magnet freely using a string.
- ❖ Observe that it **settles pointing in the North–South direction**, showing the Earth's magnetic effect.

<https://youtu.be/BXbdojugsOs?si=y1A4tOWXqMJ0vlj6>

4.2.3. Magnetic vs Non-Magnetic Materials

Magnetic Materials	Non-Magnetic Materials



Magnetic Materials	Non-Magnetic Materials
Iron	Wood
Steel	Plastic
Cobalt	Glass
Nickel	Rubber
	Aluminium
	Paper
	Copper

Tip: Only materials containing **iron, cobalt, or nickel** are magnetic.

4.2.4 Uses of Magnets in Daily Life

Magnets are widely used in homes, schools, and industries:

- ❖ **Compass** – Helps in finding directions.
- ❖ **Door catches** – Fridge doors use magnets to stay closed.
- ❖ **Speakers and microphones** – Magnets help convert electrical signals into sound.
- ❖ **Electric motors and generators** – Use magnetic force to produce motion or electricity.
- ❖ **Cranes** – Lift scrap metal using strong electromagnets.
- ❖ **Magnetic toys** – Use magnets for movement or attachment.
- ❖ **Data storage** – Hard drives and memory devices store information using magnetic materials.
- ❖ **Separating mixtures** – Magnets separate magnetic substances from non-magnetic ones.
- ❖ **Doorbells** – Use magnets in the electromagnet system.
- ❖ **Bicycle dynamos** – Convert mechanical motion into electricity using magnets.



Assess Yourself

1. Define a magnet.
2. Name two types of magnets.
3. What are the two poles of a magnet called?
4. State two properties of magnets.
5. Give two examples of magnetic materials.
6. What happens when the North pole of one magnet is brought near the South pole of another magnet?
7. Describe what happens when a magnet is freely suspended using a string.
8. Explain why magnetic force is strongest at the poles of a magnet.
9. Differentiate between magnetic and non-magnetic materials, giving two examples of each.
10. Why does a fridge door stay closed using a magnet?
11. Analyse what will happen if you try to use a magnet to separate a mixture of sand and iron filings. Explain your answer.
12. A student places iron filings around a bar magnet. Describe the pattern formed and explain what it shows about magnetic force.
13. Compare the attraction and repulsion properties of magnets.
14. Suggest three uses of magnets in daily life and explain how magnets make each use possible.
15. Design a simple experiment to demonstrate the repulsive property of magnets. List the materials needed, steps, and expected results.

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