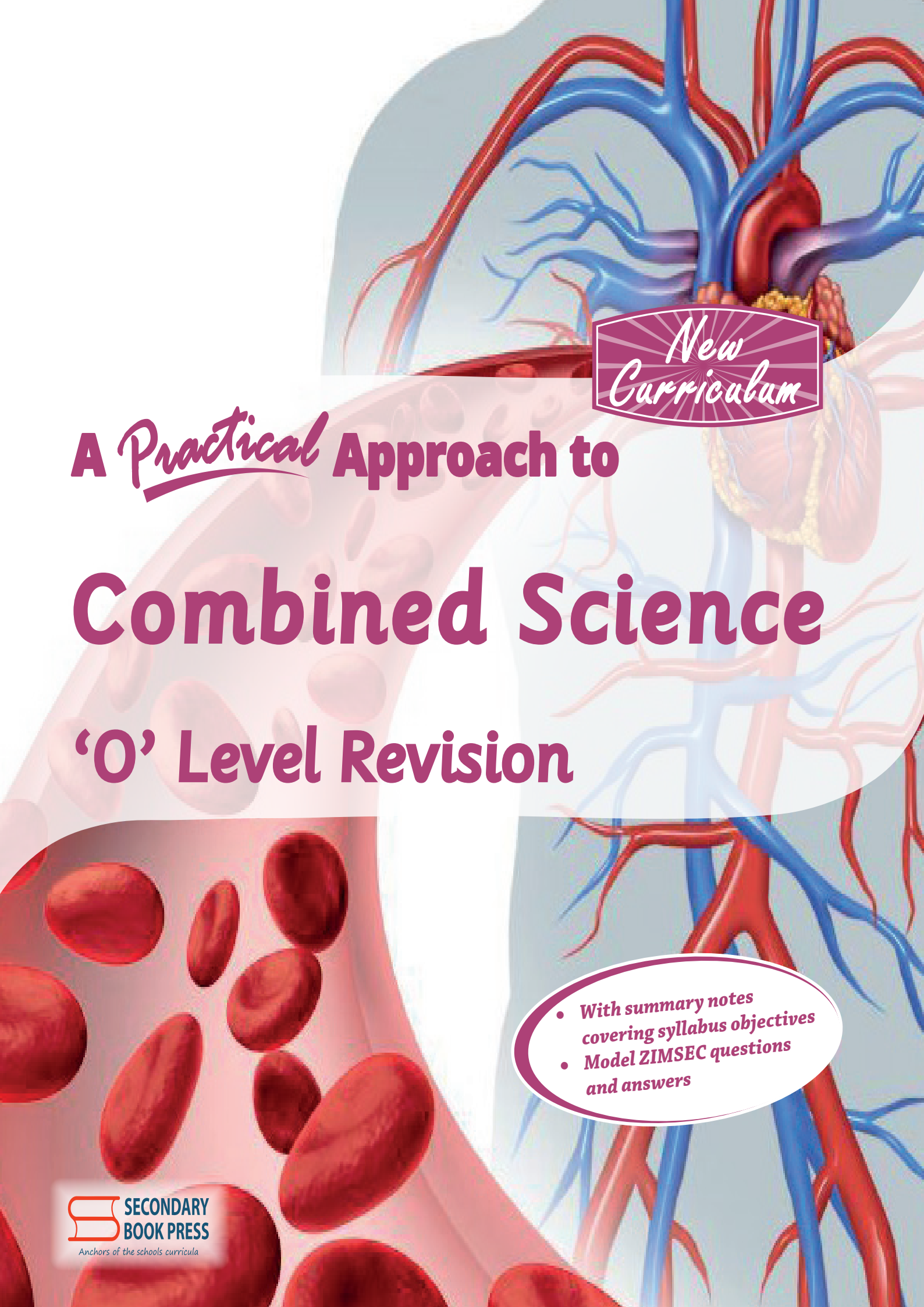

New Curriculum

A Practical Approach to

Combined Science

'O' Level Revision

- With summary notes covering syllabus objectives
- Model ZIMSEC questions and answers

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INTRODUCTION

Combined Science is a systematic study of the structure and behaviour of the physical and natural world through observation, experimentation and testing of theories against the evidence obtained. Combined Science O Level Revision Book covers all the topics and concepts that are found in the ZIMSEC Syllabus and are structured according to the New Curriculum expectations.

It summarises the main topics that are in the syllabus whilst equipping students with relevant information in their preparation for the O Level Combined Science examinations.

You must work your way through this study guide to improve your understanding, identify your areas of weakness and correct your own mistakes.

To ensure a high-quality pass, you should also substantiate your knowledge with other textbooks and your class notes. We are confident that this Combined Science study guide can help you prepare well so that you pass the ZIMSEC O Level examinations.

Overview of the examination for Combined Science 'O' Level Study Guide

The examination questions have been arranged topically and in the respective order in which they are taught, for example, Biology Section, Chemistry Section and Physics Section. The questions are structured typical of ZIMSEC exam standard.

Paper 1 (4003/1), theory, consists of 40 compulsory multiple choice questions that weighs 30% of the whole examination. All the sections are equally distributed throughout the paper in their order. It is written in an hour.

Paper 2 (4003/2), theory, consist of 15 questions, 6 of which are in section A and 3 questions for each section: B, C and D. In section A candidates are supposed to answer all questions which sums up to 40 marks and in Section B, C and D candidates are supposed to answer two questions which sum up to 20 marks for each section. Section A is a combination of Biology, Chemistry and Physics, Section B consists of Biology, Section C consists of Chemistry and Section D consists of Physics. It weighs 40% of the whole examination and it is written in 2 hours.

Paper 3 (4003/3), practical, consists of 2 compulsory questions of 20 marks each from any two sections of the syllabus. It weighs 30% of the whole examination and it's written in 1 hour 30 minutes.

How to use this study guide

This study guide covers selected aspects of the different topics from Form 1 to 4 Combined Science curriculum in the order that it is usually taught. The selected aspects of each topic are presented in the following way:

- An explanation of terms and concepts
- Worked examples to explain and demonstrate
- Answers for you to use to check your own work
- Typical **ZIMSEC** examination papers are included in the study guide for you to practice.

Top 10 study tips

Try these study tips to make learning easier

- Have all your materials ready before you begin studying that is pencils, calculator, pens, highlighters, paper and all the other necessary material.
- Be positive. Make sure your brain holds on to the information you are learning by reminding yourself how important it is to remember the work and get the marks.
- Take a walk outside. A change of scenery will stimulate your learning. You'll be surprised at how much more you take in being outside in the fresh air.
- Break up your learning sections into manageable parts. Trying to learn too much at one time will only result in a tired, unfocused and anxious brain.
- Keep your study sessions short but effective and reward yourself with short, constructive breaks.
- Teach your concepts to anyone who will listen. It might feel strange at first, but it is worth reading your revision notes aloud.
- Your brain learns well with colours and pictures. Try to use them whenever you can.
- Be confident with the learning areas you know well and focus your brain energy on the sections that you find more difficult to take in.
- Repetition is the key to retaining information you must learn. Keep going, don't give up.
- Sleeping at least 8 hours every night, eating properly and drinking plenty of water are all important things you need to do for your brain. Studying for exams is like strenuous exercise, so you must be prepared physically.

Question words to help you answer questions

It is important to look for the question words (words that tell you what to do) to correctly understand what the examiner is asking. Use the following table as a guide when answering questions.

Name – usually give a one word answer or a brief answer.

Define – give a concise and clear meaning.

Describe – give a detailed account of a matter concerned.

Explain – provide details in a chronological order. Include word equations where necessary.

Give – to state facts without discussions or explanations (note that you may be asked to 'give a reason').

Identify – name a feature from the source material.

Calculate – first give a formula and present a clear substitution on the formula. Go ahead and make the calculation in a step by step presentation of work.

Outline – give a general description or explanation.

Study skills to boost your learning

This guide makes use of two study techniques you can use to help you

Learn the material:

- Mobile notes
- Mnemonics

Mobile notes

Mobile notes are excellent tools for learning all the key concepts in the study guide. Mobile notes are easy to make and you can take them with you wherever you go:

1. Fold a blank piece of paper in half. Fold it in half again. Fold it again.
2. Open the paper. It will now be divided into 8 parts.
3. Cut or tear neatly along the folded lines.
4. On one side, write the basic concept.
5. On the other side, write the meaning or the explanation of the basic concept.
6. Use different colours and add pictures to help you remember.
7. Take these mobile notes with you wherever you go and look at them whenever you can.
8. As you learn, place the cards in three different piles:
   - I know well
   - Getting there
   - I need more practice
9. The more you learn them, the better you will remember them.

Mnemonics

A mnemonic code is a useful technique for learning information that is difficult to remember. This is an example of a word mnemonic using the word MAPPING where each letter of the word stands for something else:

M – **M**ake an effort

A – **A**pply yourself to your studies

P – **P**ractise

P – **P**repare well for the exams

I – **I**gnite your passion for Combined Science

N – **N**otice your subject around you

G – **G**o for it – the stars are the limit!

Mnemonics code information and make it easier to remember. The more creative you are and the more you link your 'codes' to familiar things, the more helpful your mnemonics will be. This guide provides several ideas for using mnemonics. Be sure to make up yours

Top 10 examination tips

1. Make sure you have all the necessary stationery for your examination, that is the pens, pencils, eraser, calculator (with new batteries), as well as your ID document and exam admission letter.
2. Arrive on time, at least one hour before the start of the exam.
3. Go to the toilet before entering the exam room. You don't want to waste valuable time going to the toilet during the exam.
4. Use the 10 minutes reading time to read the instructions carefully. This helps to 'open' the information in your brain. Start with the question you think is the easiest to get the flow going.
5. In a practical examination (paper 3), answer the questions in a context of the experiment concerned. Avoid general answers.
6. Try all questions. Each question has some easy marks in it so make sure that you do all the questions in the exam.
7. Never panic, even if the question seems difficult at first. It will be linked with something you have covered. Find the connection.
8. Manage your time properly. Don't waste time on questions you are unsure of. Move on and come back if time allows.
9. Check weighting – how many marks have been allocated for your answer? Take note of how marks are allocated to the questions in this study guide. Do not give more or less information than is required.
10. Write big, bold and clear answers. You will get more marks if the marker can read your answer clearly.

Common errors

- Candidates deliberately ignore reading examination instructions.
- In paper 2, some candidates answer questions from one section or answer only three questions instead of two questions.
- Improper numbering or failure to number their presentation properly.
- Candidates fail to comply with the demands of the question.
- Candidates forget questions once left for later revisits.


BIOLOGY

TOPIC 1 Laboratory rules and safety

Topic objectives

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

- *explain laboratory rules.*
- *identify laboratory apparatus.*
- *demonstrate use of laboratory apparatus.*

Laboratory rules and safety

Important insights

- Laboratory safety rules are guidelines that are designed to help keep people safe while they are carrying out experiments in the science laboratory.
- Laboratory safety rules are important as some equipment and chemicals in a science laboratory can cause serious harm or injuries.
- It is always wise to follow all laboratory safety rules.
- The following are examples of safety procedures which can be applied in a science laboratory:
  - be neat when carrying out experiments to avoid spillage of chemicals.
  - be careful when handling chemicals and sharp objects to avoid burns and cuts.
  - wear protective clothing such as safety goggles, gloves and laboratory coats.
  - locate safety equipment which include fire extinguishers, sand buckets and fire blankets.
- laboratory safety rules include the following:
  - do not eat or drink while in the laboratory.
  - do not taste any chemicals or substances you are working with.
  - do not use your mouth for pipetting substances.
  - do not handle broken glass and chemicals with bare hands.
  - do not pour chemicals down the drain without permission.
  - do not operate laboratory equipment without permission.
  - do not perform your own experiments unless given permission.
  - do not leave any heated materials unattended.
  - do not place flammable substances near heat.
  - do not engage in pranks while in the laboratory.

Laboratory apparatus

Important insights

- There is a wild range of apparatus that biology students must have knowledge of in order to describe and carry out experimental and measuring techniques.

- The following are some of the apparatus that can be used in a biology laboratory.

Beaker

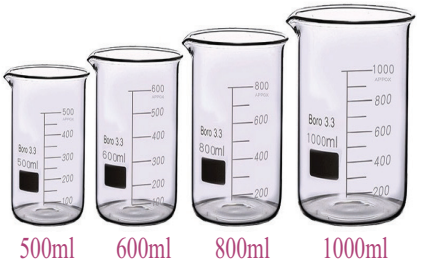


Fig. 1.1 Beakers

- Beakers are cylindrical utensils that are made up of glass, they have a flat bottom and an upper opening, which may or may not have a spout or pouring lip.
- Beakers are used to hold, mix or heat substances.
- There are of varying sizes of beakers and these can range from tiny 20 ml to 500 ml.

Balance scales

Fig. 1.2 Scale

- Scales are used to measure mass.
- When we perform experiments in the laboratories, there are very small quantities usually in the units of micro or mini grams and these are measured using balance scales.

Measuring cylinder

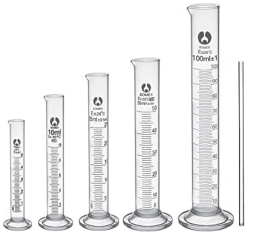


Fig. 1.3 Measuring cylinders

- A cylindrical container is used to measure the volume of liquid.
- Measuring cylinder can be made of plastic. These measuring cylinders have lines up the side to represent the volume in millilitres.

Dropper or pipette

Fig. 1.4 Droppers or pipettes

- A dropper is a thin, tapering glass or plastic tube used to eject or suck in a small amount of fluid.
- The dropper is a common small apparatus that is usually made up of plastic or glass. They have a small nozzle on one side and a rubber holder on the other.
- They are also used to put liquids or solutions in any medium one drop at a time.

Test tube

Fig. 1.5 Test tubes

- A test tube is a thin, cylindrical container, usually made of glass.
- A test tube is used to hold chemical and biological substances.

Bunsen burner

Fig. 1.6 Bunsen burner

- A bunsen burner is one of the most important laboratory apparatus.
- It is a gas burner that produces a single open gas flame.
- A bunsen burner acts as a source of heat to perform sterilisation, boiling and melting of substances.
- Gases such as liquified petroleum gas, propane, butane and natural gas can be used as fuel to the bunsen burner.

Thermometer

Fig. 1.7 Thermometer

- The thermometer is one of the most crucial laboratory apparatus.
- These are the sensing devices that are used to determine the temperature of an object.

Funnel

Fig. 1.8 Funnels

- A funnel is a tube that is wide at one end and narrow at the other.
- Funnels are used to move liquids or particles through a narrow opening.

Syringe

Fig. 1.9 Syringe

Syringes are used in research labs for multiple tasks that include injection of gases or liquids into chromatographs, chemical apparatus or animals.

Microscope

Fig. 1.10 Microscope

- A microscope is a basic apparatus in a biology laboratory.
- A simple light microscope or compound microscope is the one mostly used in schools and colleges and it uses natural or artificial light and a series of magnifying lenses to observe specimen.
- This is a device that uses lenses to magnify items that are normally too small for the human eye to see for example, cells.

Petri dish

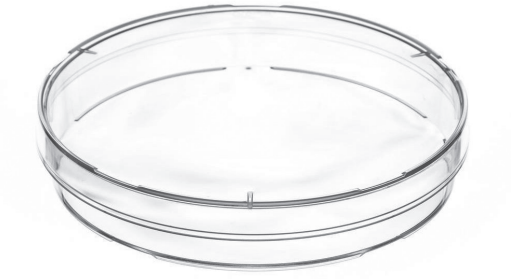


Fig. 1.11 Petri dish

- A petri dish is a shallow, transparent, cylinder-shaped lidded dish.
- A petri dish is mainly used to culture different types of cells that include bacteria, fungi and moulds.

TOPIC 2 Cells and levels of organisms

Topic objectives

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

- *describe the structure of a plant and an animal cell.*
- *list similarities and differences between plant and animal cells.*
- *identify specialised cells.*
- *draw and label specialised cells.*
- *state the function(s) of the specialised cells in relation to structure.*
- *use a microscope to observe cell structure.*
- *state differences among living organisms.*
- *compare continuous and discontinuous variation.*
- *draw bar graphs to show variations in living organisms.*
- *explain the term ecosystem.*
- *list components of an ecosystem.*
- *explain natural ecosystem.*
- *construct food chains, food webs and pyramids of biomass.*
- *explain how energy is lost in food chains and food webs.*
- *describe the carbon and nitrogen cycles.*
- *describe an artificial ecosystem.*
- *explain bio-diversity.*
- *identify problems caused by limited bio-diversity.*
- *state advantages of biodiversity.*

Plant and animal cell

Important insights

- Eukaryotes are organisms which are made up of large and complex cells.
- Eukaryotes are organisms whose cells have a nucleus and other organelles enclosed by a plasma membrane.
- Animal and plant are examples of eukarytotes and they both have eukaryotic cells.
- Plant cells and animal cells do not look exactly the same or have all of the same organelles, since they each have different needs. For example, plant cells contain chloroplasts since they need to perform photosynthesis, but animal cells do not.

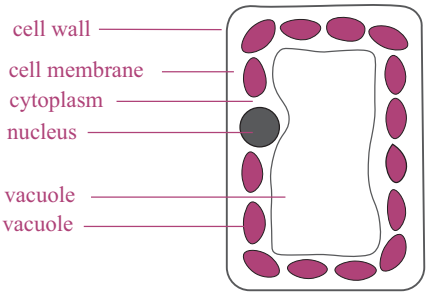


Fig. 2.1 Plant cell

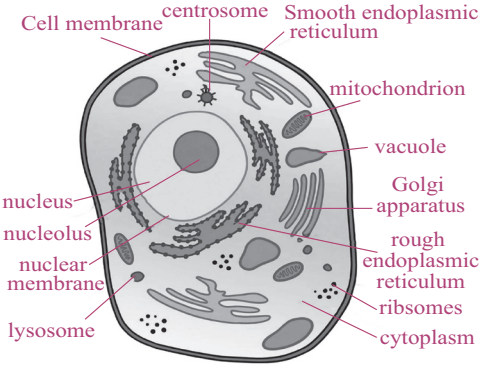


Fig. 2.2 Animal cell

TOPIC 5 Transport systems

Topic objectives

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

- *describe water movement in plants.*
- *identify components of blood stating the functions of each component.*
- *outline the internal structures of a root and stem.*
- *describe water and ion uptake by plants.*
- *draw and label the structure of the heart.*
- *name the main blood vessels to and from the heart.*
- *state the functions of the heart.*
- *explain the process of transpiration.*
- *state factors affecting the rate of transpiration.*
- *measure transpiration in a plant.*
- *outline the importance of transpiration.*
- *explain the terms plasmolysis and turgidity.*
- *describe the effects of water loss and water gain in plant cells.*
- *describe the double circulatory system.*
- *describe the adaptations of plant leaves to reduce transpiration.*
- *state the functions of blood.*
- *describe the structure of blood vessels.*
- *draw and label the structure of blood vessels.*
- *outline the differences among blood vessels.*

Respiratory organs

Important insights

- Transport refers to the movement of materials from one part of the organism to another.
- In animals, transport systems include blood circulatory organs while in plant the include xylem and phloem vessels.

The medium of transport

The medium of transport in plants and animals is water and blood.

The channels of transport

The channels of transport in animals, are blood vessels. In plants, there is a vascular system or system of xylem and phloem vessels.

Energy

Circulation of blood in animals requires energy that is supplied from respiration and used in pumping of blood by the heart and for muscle contractions.

The mammalian heart

- The heart performs a function of pumping blood around the body.
- The heart is made of tissues that are called cardiac muscles which have the potential to contract rapidly.

- There are different types of blood vessels and these include: arteries, arterioles, capillaries, venules and veins.
- Arteries carry blood away from the heart.
- The main artery is the aorta which divide into a number of main branches called arteries.
- Arteries branch into smaller vessels called arterioles.
- Arterioles split up into tiny blood vessels called capillaries which supply the entire body tissues with blood. It is from these capillaries that movement of substances to and from the body takes place.
- Capillaries join together to form larger vessels that are called venules which join together to form veins. Veins carry blood towards the heart.
- There is a tendency of blood not moving forward due to reduced pressure within veins. The valves within veins stop the flow back of blood so that it is forced in one direction to the heart.
- Valves open to allow blood flow to the next point of the vein and close it. reverses its direction.

Illustration of blood vessel network in mammalian body

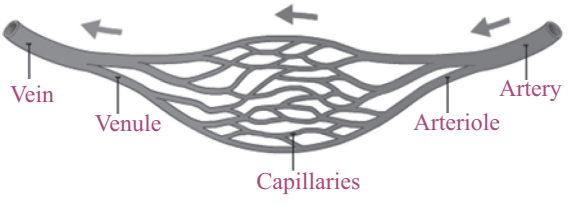


Fig. 5.2 Structure of a capillary

Diagram of an artery

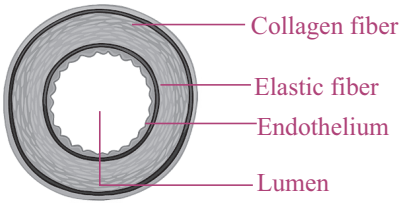


Fig. 5.3 Structure of an artery

Veins

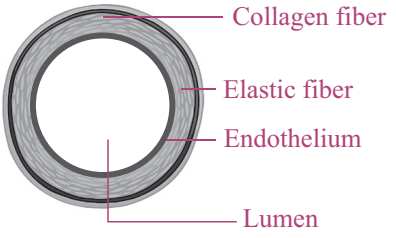


Fig. 5.4 Structure of veins

Differences between veins and arteries

Table 5.1 Comparison between veins and arteries

Veins	Arteries
Blood travels to the heart except for the pulmonary vein.	Blood travels away from the heart except for pulmonary artery.
They have a large lumen relative to their diameter	They have a narrower lumen than veins
They possess thin walls with few elastic fibres	They have thick walls with lots of elastic fibres
They have thin muscular walls	They have thick muscular layer
Valves are present along their entire length to prevent blood back flow	They have no valves except at the bases of the aorta and pulmonary artery
Blood travels constantly and there are no pulses	Blood travels in pulses

Carry blood under low pressure	Carry blood under high pressure
Blood moves slowly	Blood moves rapidly
They are not capable of constriction	They are capable of constriction
They transport deoxygenated blood from body tissues to the heart except the pulmonary vein which transports oxygenated blood from the lungs to the heart	They transport oxygenated blood from the heart to the body tissues except the pulmonary artery which transports deoxygenated blood from the heart to the lungs

Characteristics of capillaries

- They are tiny, very thin walled and penetrate deep into every organ.
- They are permeable and some blood components and other materials leak through them.
- The exchange of materials between blood and tissues take place through their walls.
- They do not have muscular walls.
- They do not have an elastic tissue.
- They have a very large lumen in relative to their diameter.
- They are not capable of constriction.
- They link arteries to veins through arterioles and venules.
- Blood flows slowly and there are no pulses.
- They do not have valves.

Veins, arteries and capillaries similarities

- All are tubular.
- All have endothelium or in lining.

Transport blood to the different organs of the body

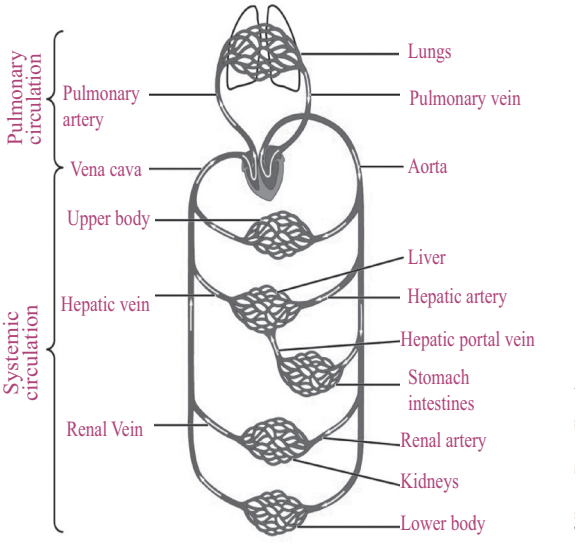


Fig. 5.5 Movement of blood through veins, arteries and capillaries.

- Blood is a fluid which blood cells and cell fragments called platelets.
- The blood cells and platelets make up for about 45% of blood volume and the plasma about 55%.

Functions of blood

- Blood has many different functions. These functions include:
  - Transport
  - Defense
  - Homeostasis
- Red cells are the body's oxygen carriers.
- They carry oxygen from the lungs to all the cells of the body.

Carriage of oxygen by blood

- The red cells pick up oxygen as blood passes through the lungs.
- The oxygen and haemoglobin join to form oxyhaemoglobin. This is bright red. As the blood passes around the

body, the haemoglobin breaks down and releases oxygen to the body cells. Then red cells return to the lungs for more oxygen.

Table 5.2 Materials carried by the blood.

What it carries	How carried
Carbon dioxide from the body to the lungs.	Mainly in plasma (as sodium bicarbonate).
Digested food from the gut to the liver and thereafter to the rest of the body.	In the plasma.
Wastes from the liver to the kidneys.	In the plasma.
Hormones from glands producing them to wherever they are needed.	In the plasma.
Heat from liver and muscles to the rest of the body so that the temperature of the body is kept uniform.	Blood.

- Substances like nutrients and excretions move in and out of the cell through:
  - active transport.
  - diffusion.
  - osmosis.
- Movement of substances depends on the permeability of the cell membrane or cell wall.

Osmosis

Important insights

- Osmosis is defined as the movement of water molecules through a semi permeable membrane into a solution of high concentration to equalise the concentrations of solute on the two sides of the membrane.
- A semi permeable membrane is one which can allow the passage of some material to occur and prevent others from passing across it.

Osmosis and plant cells

- Plant cells are surrounded by an inextensible, resistant and completely permeable cellulose cell wall.
- The centre of cells contains a vacuole, which contains cell sap which is a solution of salt, sugars and organic acid.
- Cell saps are surrounded by a semi-permeable tonoplast membrane.

Diagram of plant cell showing osmotically important parts

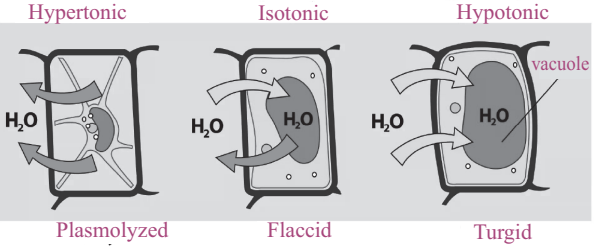
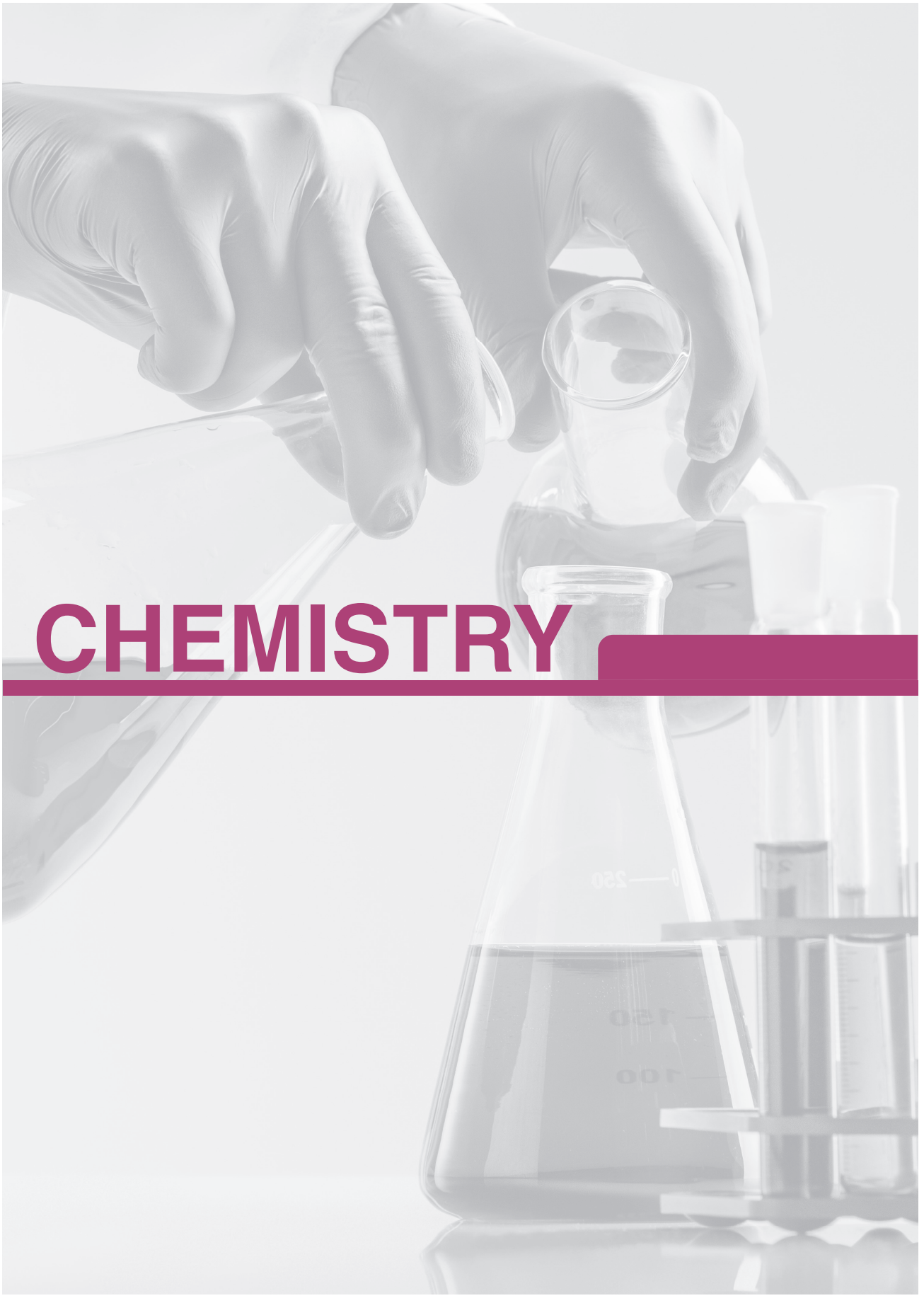


Fig. 5.6 Shape of a cell after osmosis

- When a plant cell is placed in a hypotonic solution for example, distilled water, it swells up hence increasing in size due to osmotic flow of water from the solution into the cell.
- As the cell gains water osmotically, it reaches a time when no more water enters it because the cell wall resists further expansion.
- At this stage, the cell is said to be at full turgor or fully turgid. At full turgidity the sap vacuole enlarges and pushes the cytoplasm against the cell wall.
- The pressure exerted outwards by vacuole is called turgor pressure.
- When a plant cell is in a hypertonic solution for example, strong sugar

Table 7.1 Common diseases in humans

Name of the disease	Causing agent/ pathogen	Vector/ mode of infection	Symptoms	Effects
Typhoid	salmonella typhi (bacteria)	by contaminated food and water	continued high fever, headache, stomach ache, constipation and loss of appetite	can be diagnosed by widal test. intestinal perforation in severe cases
Pneumonia	streptococcus pneumoniae, hemophilus influenzae (bacteria)	by inhaling droplets or aerosols released by an infected person or using infected utensils	fever, chills, cough and headache	respiration problems due to fluid that gets filled in the alveoli
Common cold	rhinoviruses	inhaling droplets or aerosols released as one by coughs, sneezes and touches contaminated objects.	nasal congestion and discharge, sore throat, cough, headache	nose and respiratory passage
Malaria	plasmodium falciparum, P. vivax (Protozoan)	female anopheles mosquito	high fever with chills	the parasite multiplies in liver cells, attacks RBCs and rupture
Amoebic dysentery	entamoeba histolytica (protozoan)	spread by mosquito bite	constipation, abdominal pain, mucous and blood in the stool	infection in the large intestine
Ascariasis	ascaris (helimenthes)	houseflies	muscular pain, internal bleeding, anaemia, fever	blockage of intestinal passage
Filariasis/ Elephantiasis	wuchereria bancrofti, w. malayi (helminthes)	spread by contaminated food by the faecal matter	inflammation of the lower limb and genital organs	lymphatic vessels, especially of the lower limbs, get blocked
Ringworms	microsporum, trichophyton, epidermophyton (fungi)	contaminated water, vegetables, fruits	dry scaly lesions, itchy skin in the groin or between the toes	effects skin, nail scalp



CHEMISTRY

TOPIC 8 Separation

Topic objectives

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

- *state methods of separating mixtures.*
- *state the applications of filtration, winnowing, magnetism and evaporation.*
- *describe the processes of distillation and fractional distillation.*
- *describe paper chromatography.*
- *state the application of paper chromatography.*

Separating mixtures

Important insights

- The choice of the method of separation depends on the nature of the substances that are being separated.
- Separation methods rely on the differences on physical properties of substances such as the boiling points of the substances being separated.

Mixtures of solids

- Differences in density, magnetic properties, sublimation and solubility can be used.
- For a difference in solubility, a suitable solvent must be chosen to ensure the desired substance only dissolves in it leaving the other substances or impurities.

Mixtures of liquids

- Immiscible liquids can be separated using a separating funnel or by decanting (pouring carefully).
- Examples include when an organic product is formed in aqueous conditions.

Filtration

- Filtration is used to separate an undissolved solid from a mixture of the solid and a liquid or solution for example, sand from a mixture of sand and water).
- Filter paper is placed in a filter funnel above another beaker.
- Mixture of an insoluble solid and liquid is poured into the filter funnel.
- Filter paper will only allow small liquid particles to pass through as the filtrate.
- Solid particles are too large to pass through the filter paper so will stay behind as a residue.

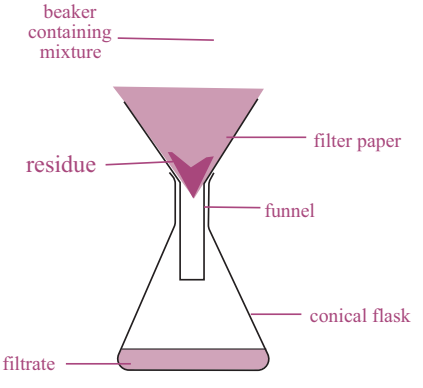


Fig. 8.1 Filtration of particles

Simple distillation

- Simple distillation is used to separate a liquid and soluble solid from a solution for example, water from a solution of saltwater) or a pure liquid from a mixture of liquids.
- The solution is heated and pure water evaporates producing a vapour which rises through the neck of the round-bottomed flask.
- The vapour passes through the condenser, where it cools and condenses, turning into pure water (H_2O) which is collected in a beaker.
- After all the water is evaporated from the solution, only the solid solute will be left behind.

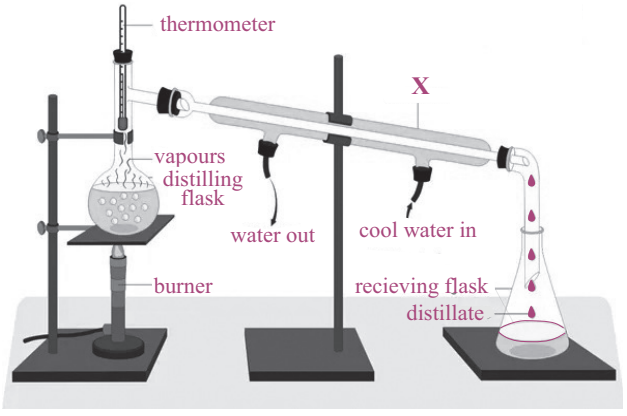


Fig. 8.2 Simple distillation

Fractional distillation

- Used to separate two or more liquids that are miscible with one another for example, ethanol and water from a mixture of the two.
- The solution is heated to the temperature of the substance with the lowest boiling point.
- This substance will rise and evaporate first and vapours will pass through a condenser, where they cool and condense, turning into a liquid that will be collected in a beaker.
- All of the substance is evaporated and collected, leaving behind the other component(s) of the mixture.
- For water and ethanol fractional distillation is used to separate the solution. Ethanol has a boiling point of 78ºC and water of 100ºC. The mixture is heated until it reaches 78ºC, at which point the ethanol boils and distils out of the mixture and condenses into the beaker.
- When the temperature starts to increase to 100ºC heating is stopped. Water and ethanol are now separated.

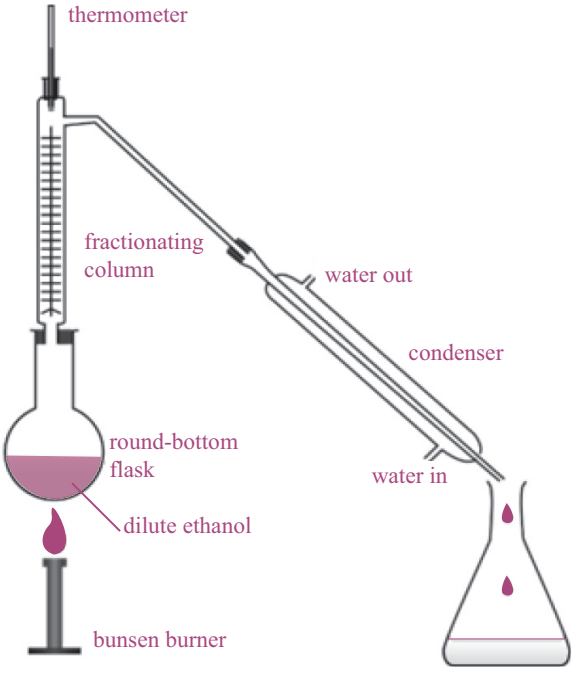


Fig. 8.3 Fractional distillation

Paper chromatography

- Paper chromatography is a technique used to separate substances that have different solubilities in a given solvent for example, different coloured inks that have been mixed to make black ink.
- A pencil line is drawn on chromatography paper and spots of the sample are placed on it. Pencil is

TOPIC 9 Matter

Topic objectives

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

- *identify the three state of matter.*
- *describe the arrangement of particles in solids, liquids and gases.*
- *describe properties of solids, liquids and gases in terms of kinetic theory of matters.*
- *describe the factors that affect solubility.*
- *identify mixtures, elements and compounds.*
- *identify metals and non-metals on periodic table.*
- *determine the concentrations by colour intensities of dissolved substances.*
- *determine the concentration of a substance by varying the amount of solute in a given solvent.*
- *define relative mass/ mass number.*
- *define the proton number/ atomic number.*
- *calculate the number of neutrons from given data.*
- *name the sub-atomic particles.*
- *state the relative charges and masses of sub-atomic particles.*
- *state relative position of sub-atomic particles within the atom.*
- *name the first 20 elements in the periodic table stating their symbols.*
- *write the electronic configuration of the first 20 elements.*
- *describe ionic and covalent bonding.*
- *define the avogadro number.*
- *state the relationship between the mole and molecular mass (MR) or atomic mass (AR).*
- *calculate empirical formula and molecular mass.*
- *calculate concentration of solutions in mol/dm^3 and g/dm^3.*
- *describe the properties of Group I, II, VII and VIII.*
- *state the use of halogens.*
- *describe the reactions of metals with water, steam, air and dilute acids.*
- *write equations for the reaction of metals with oxygen, dilute acids and water.*
- *list metals in order of decreasing reactivity.*
- *predict the reactivity of a metal from its position in the reactivity series.*

States of matter

Important insights

Matter is found in three main states which are solids, liquids and gases.

Solids

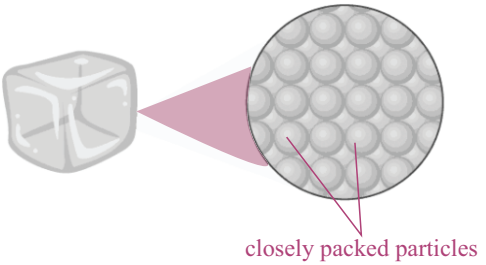


Fig. 9.1 Solid state of matter

- Boiling is when a liquid changes into a gas.
- Boiling requires heat which causes bubbles of gas to form below the surface of a liquid, allowing for liquid particles to escape from the surface and within the liquid.
- Occurs at a specific temperature known as the boiling point which is unique to each pure liquid.

Freezing

Fig. 9.6 Freezing

- Freezing is when a liquid changes into a solid.
- Freezing is the reverse of melting and occurs at exactly the same temperature as melting, hence the melting point and freezing point of a pure substance are the same. Water for example freezes and melts at 0ºC.
- Requires a significant decrease in temperature (or loss of thermal energy) and occurs at a specific temperature which is unique for each pure substance.

Evaporation

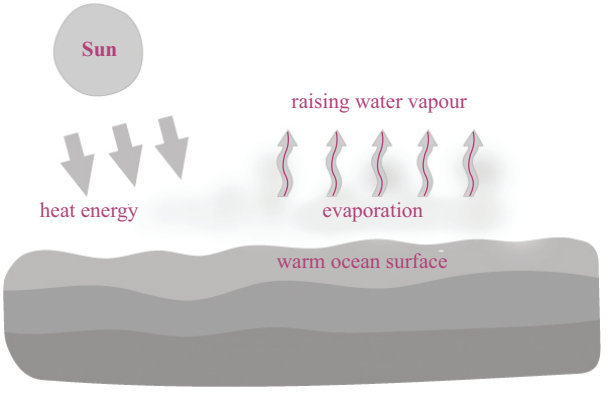


Fig. 9.7 Evaporation

- Evaporation is when a liquid changes into a gas. Evaporation occurs only at the surface of liquids where high energy particles can escape from the liquid's surface at low temperatures, below the boiling point of the liquid.
- The larger the surface area and the warmer the liquid, the more quickly a liquid can evaporate.
- No heat is required and evaporation can occur over a range of temperatures.

Condensation

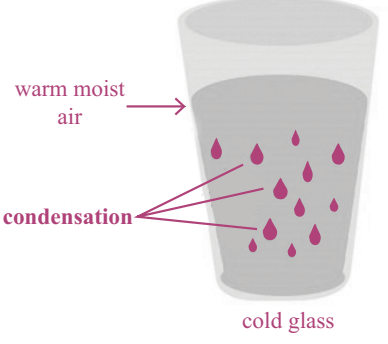


Fig. 9.8 Condensation

- Condensation is when a gas changes into a liquid, usually upon cooling. When a gas is cooled its particles lose

The Periodic Table of the Elements

I	II	Group										III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a X b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

Fig. 9.12 The periodic table of elements

- Periods are the horizontal rows that show the number of shells of electrons an atom has for example, elements in Period 2 have two electron shells, elements in Period 3 have three electron shells.
- Groups are the vertical columns that show how many outer electrons each atom has for example, Group IV elements have atoms with 4 electrons in the outermost shell, Group VI elements have atoms with 6 electrons in the outermost shell.
- Because there are patterns in the way the elements are arranged on the periodic table, there are also patterns and trends in the chemical behaviour of the elements.
- There are trends in properties down groups and across a period.
- All the Group I elements for example, react very quickly with water.
- In this way the periodic table can be used to predict how a particular element will behave.

The noble gases

- The atoms of the Group VIII or 0 elements all have 8 electrons in their outer shells, except for helium which has 2. But since helium has only 2 electrons in total and thus the first shell is full (which is the only shell), it is thus the outer shell so helium also has a full valency shell.
- All of the noble gases are unreactive as they have full outer shells and are thus very stable.
- All elements wish to fill their outer shells with electrons as this is a much more stable and desirable configuration.

TOPIC 11 Industrial processes

Topic objectives

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

- *outline the manufacture of soap.*
- *outline the production of nitrogen and oxygen.*
- *define electrolysis.*
- *label the general components of an electrolytic cell.*
- *describe the anode and cathode reactions for electrolysis of molten lead bromide.*
- *state observations for the electrolysis of molten lead bromide.*
- *describe the electrolysis of water.*
- *state the products formed during the electrolysis of water.*
- *state the uses of oxygen and hydrogen.*
- *state the cathode, anode and electrolyte.*
- *explain the cathode process.*
- *state the reasons for electroplating materials.*
- *list the raw materials used to manufacture ammonia.*
- *describe the manufacture of ammonia.*
- *state the conditions needed for the production of ammonia.*
- *state the industrial uses of ammonia.*
- *list the raw materials used to manufacture sulphuric acid.*
- *describe the manufacture of sulphuric acid.*
- *state the conditions needed for the production of sulphuric acid.*
- *state uses of sulphuric acid.*

Electrolysis

Important insights

- Electrolysis is the use of electricity to break down a compound or an electrolyte into its constituents.
- The process takes place in an electrolytic cell.
- The battery provides a source of electricity for reactions to occur.
- During the process, electrons flow from the positive terminal to the negative terminal of the battery.
- The electrodes used in electrolysis conduct electricity. Inert graphite or platinum electrodes are usually used.
- The electrode connected to the positive terminal of the battery is the anode and the electrode connected to the negative terminal of the battery is the cathode.
- Reduction occurs at the cathode while oxidation occurs at the anode.
- The electrolyte contains mobile ions which allow for electricity to flow through.
- It is usually an acid solution, or an ionic compound that is molten or dissolved in water.
- A solid ionic compound cannot be used as its ions are in fixed positions in the crystal lattice structure.
- Electrolysis of molten compounds for example, lead (II) bromide is shown on the next page.

- The gases collected during the electrolysis can be tested with a glowing splint (which will flame up in the presence of oxygen) and the burning splint (which will ignite hydrogen, causing an audible pop). H_2 gas is produced at twice the rate of O_2 gas in this reaction.

The manufacturing of ammonia

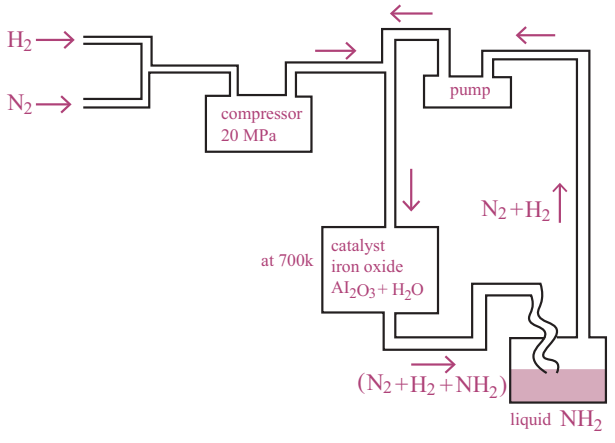


Fig. 11.3 The manufacture of ammonia

- Ammonia is an important chemical that is manufactured in large amounts through the haber process.
- It is produced from nitrogen gas and hydrogen gas.
- Nitrogen gas is obtained directly from the air and hydrogen gas is obtained from the cracking of large hydrocarbons.
- The formation of ammonia from hydrogen and nitrogen is a reversible process, reaction conditions are controlled to maximise the yield of ammonia.
  - nitrogen + hydrogen $\leftrightharpoons$ ammonia
  - $N_2 + 3H_2 \leftrightharpoons 2NH_3$
- The production of ammonia is favoured at low temperatures.
- These low temperatures however, are kinetically unfavourable as the reaction would proceed too slowly. Therefore a relatively high temperature of 450°C is used.
- Higher pressures result in a higher yield of ammonia.
- Despite this, it is expensive to generate and maintain the high pressures and have equipment that can withstand the extreme pressures.
- Considering these costs, the Haber process usually takes place at 250atm.
- An iron catalyst is also used to further increase the rate of reaction.
- Ammonia is displaced when ammonium salts react with alkalis.
- ammonium chloride + sodium hydroxide → ammonia + sodium chloride + water.

  $NH_4Cl + NaOH \rightarrow NH_3 + NaCl + H_2O$

Uses of ammonia

- Nitrogen is needed for the production of proteins for healthy plant growth. While nitrogen is abundant in the air, most plants cannot utilise atmospheric nitrogen.
- Nitrogen is supplied to plants in the form of ammonium salts and urea.
- Ammonium fertilisers cannot be added alongside agricultural lime (calcium hydroxide and calcium oxide) as ammonia would be displaced from ammonium salts.
- This causes a wastage of the fertiliser as ammonia gas cannot be utilised by plants.

The manufacturing of sulphuric acid

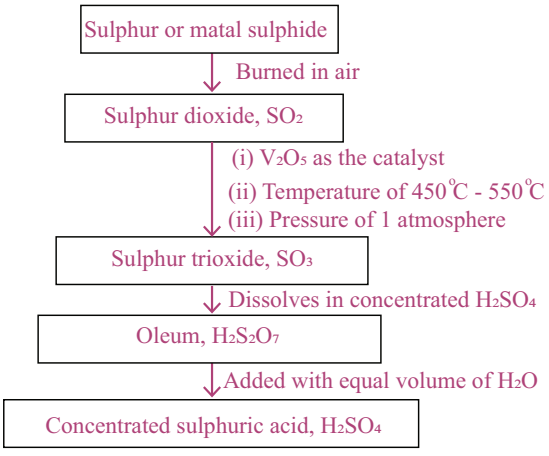


Fig. 11.4 The contact process

- Sulphuric acid is used in the manufacture of paints, detergents and fertilisers.
- The contact process demonstrates a reversible reaction used in the production of sulphuric acid.
- The contact process is used for making sulphuric acid. This is a process which involves a reversible reaction.
- The raw materials needed to make sulphuric acid are:
  - sulphur
  - air
  - water

Stage one – making sulphur dioxide

- In the first stage of the contact process, sulphur is burned in air to make sulphur dioxide:
  - sulphur + oxygen → sulphur dioxide
  - $S(l) + O_2(g) \rightarrow SO_2(g)$
- This is not a reversible reaction.
- Sulphur dioxide should not be released into the atmosphere as it contributes to acid rain.

Stage two – making sulphur trioxide

- In the second stage, sulphur dioxide reacts with more oxygen to make sulphur trioxide:
  - sulphur dioxide + oxygen ⇋ sulphur trioxide
  - $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$
- This reaction is reversible. The conditions needed for it are:
  - a catalyst of vanadium(V) oxide, V_2O_5.
  - a temperature of around 450°C.
  - a pressure of approximately 2 atmospheres (the increased pressure favours the formation of SO_3, but if the pressure is too high the risk of explosion is too high, given that SO_3 is a highly acidic gas).

Stage three – making oleum

- Sulphur trioxide reacts with concentrated sulphuric acid to produce oleum.
  $H_2O_{(l)} + SO_{3\,(g)} \rightarrow H_2SO_{4\,(aq)}$
- This is not a reversible reaction, just like the first stage.
- The direct addition of sulphur trioxide to water is highly exothermic and leads to the formation of clouds of sulphuric acid.
- This is highly dangerous. In industry, sulphur trioxide is added to highly concentrated sulphuric acid to form a highly corrosive liquid called oleum to minimise the risk:
  $SO_3 + H_2SO_4 \rightarrow H_2S_2O_7$
- Water is then added to the oleum to form sulphuric acid again:
  $H_2S_2O_7 + H_2O \rightarrow 2H_2SO_4$
- Oleum reacts with water to form sulphuric acid.

TOPIC 12 Oxidation and Reduction

Topic objectives

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

- *state the conditions necessary for rusting.*
- *explain the methods of preventing rusting.*
- *write simple word equations.*
- *define oxidation and reduction in terms of oxygen.*
- *distinguish between physical and chemical changes.*
- *define oxidation.*
- *define reduction.*
- *list the raw materials used in the extraction of iron and their sources.*
- *describe the reactions in the blast furnace.*
- *state the functions of the raw materials.*
- *describe how iron and slag separate.*
- *list down alloys of iron.*
- *state the percentage composition of alloys of iron.*
- *explain the uses and properties of alloys of iron.*

Oxidation and reduction

Important insights

- Oxidation is the gain of oxygen, the loss of hydrogen, the loss of electrons or the increase in the oxidation number of a substance.
- The reverse occurs in reduction. It is the loss of oxygen, the gain of hydrogen, the gain of electrons or the decrease in oxidation number of a substance.
- Oxidation and reduction take place together at the same time in the same reaction.
- These are called redox reactions.
- There are three definitions of oxidation. It is a reaction in which:
  - oxygen is added to an element or a compound.
  - an element, ion or compound loses electrons.
  - the oxidation state of an element is increased.
- There are three definitions of reduction. It is a reaction in which:
  - oxygen is removed from an element or a compound.
  - an element, ion or compound gains electrons.
  - the oxidation state of an element is decreased.

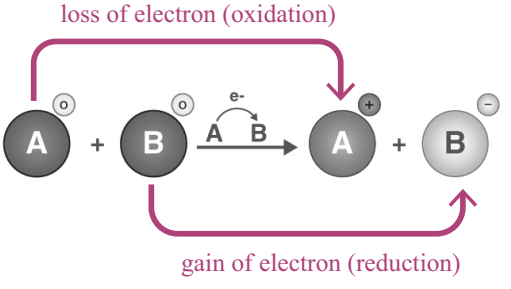


Fig. 12.1 Illustration of oxidation and reduction

Calculating oxidation numbers

- An element has an oxidation state of 0, regardless of whether it is found as individual atoms or in molecules. For example, neon (Ne) and chlorine (Cl_2) have oxidation states of 0.
- The sum of oxidation numbers of all atoms in an uncharged compound is 0. For a polyatomic ion, the sum of oxidation numbers of all atoms is equal to its charge.
- The oxidation state of an ion is given by its charge. For example, a magnesium ion Mg^{2+} and an oxide ion O^{2-} have oxidation states of +2 and -2 respectively.
- Some elements have fixed oxidation numbers in compounds. Oxygen usually has the oxidation state of -2 in its compounds. Hydrogen usually has the oxidation state of +1 in its compounds.

Oxidising and reducing agents

- An oxidising agent is a substance that causes oxidation to another substance
- A reducing agent is a substance that causes reduction to another substance.

Ionic equations

- Ionic equations are used to show only the particles that actually take part in a reaction.
- These equations show only the ions that change their status during a chemical reaction, that is their bonding or physical state changes.
- The other ions present are not involved and are called spectator ions.

Writing ionic equations

- For the neutralisation reaction between hydrochloric acid and sodium hydroxide:

  $HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$
- If we write out all of the ions present in the equation and include the state symbols, we get:

  $H^-_{(aq)} + Cl^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$
- The spectator ions are thus Na^+ and Cl^-. Removing these from the previous equation leaves the overall net ionic equation:

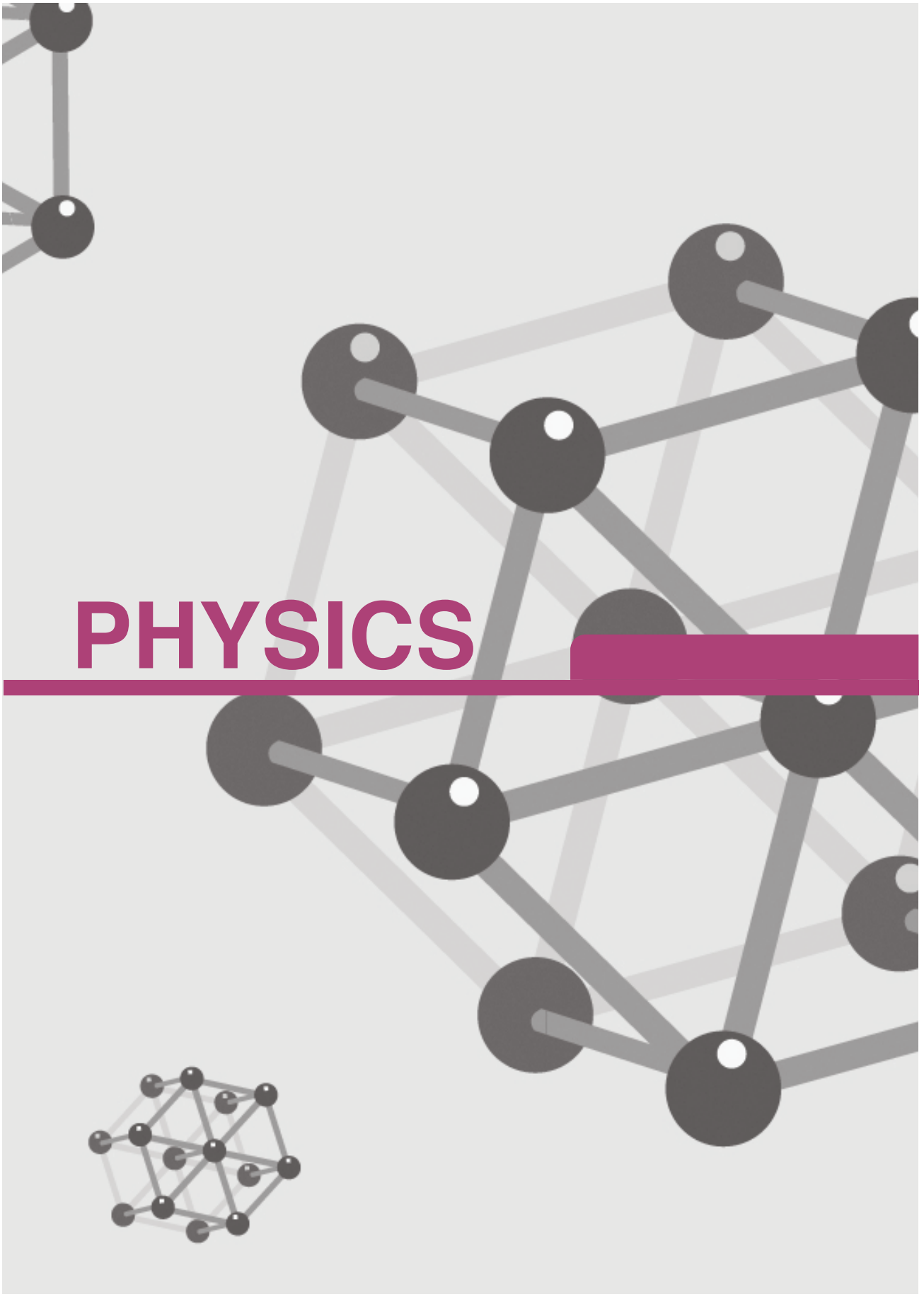
  $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$
- This ionic equation is the same for all acid-base neutralisation reactions.
- Example of a redox equation is when oxygen is lost or gained.

  Zinc oxide + carbon → zinc + carbon monoxide

  $ZnO + C \rightarrow Zn + CO$
- In this reaction, the zinc oxide is the oxidising agent and carbon is the reducing agent.
- Zinc oxide is reduced and carbon is oxidised.

Extraction of iron

- Iron is extracted from its ore, haematite which contains iron (III) oxide (Fe_2O_3) by heating with carbon.
- Haematite, coke (mainly carbon) and limestone calcium carbonate, ($CaCO_3$) are loaded at the top of the blast furnace while hot air is introduced at the bottom of the furnace.



PHYSICS

TOPIC 13 Data presentation

Topic objectives

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

- *present data in the form of tallies, tables and bar graphs.*
- *interpret data presented in the form of tallies, tables and bar graphs.*
- *construct a straight line graph from appropriate data.*
- *interpret straight line graphs.*
- *construct a pie chart.*
- *interpret and analyse data from pie charts and line graphs.*
- *construct, interpret and analyse pie charts and line graphs.*

Data presentation

Important insights

- Data can be presented in a variety of ways, such as on graphs, charts or tables.
- Tables can be applied to any experiment yield data.
- Graphs, on the other hand, are a little trickier depending on the type of data collected for example, quantitative and qualitative.
- Quantitative data uses numerical values.
- Qualitative data is observed but not measured with a numerical value; for example, colour.
- When presenting scientific data, the following may be included:
  - Tables
  - Graphs
  - Diagrams
  - Pie chart

Presenting data in a table

Table 13.1 Students' favourite sporting activities

Sport	Football	Hockey	Cricket	Basketball	Netball
Number of student	10	5	5	10	10

- When taking readings, a sensible range should be taken, and the values should all be stated to an appropriate number of significant figures or decimal places.
- This is usually the same number as the resolution of the measuring instrument.
- The columns in any table should have both a quantity and a unit in their heading.
- For data displayed in a table:
  - The first column should contain the independent variable.
  - The second column should contain the dependent variable.
- If repeat readings of the dependent variable are required, these should be included with a column for the mean value at the end.
- Any columns required for processing data for example, calculations should come after this.

Presenting data on a graph

- All readings, including suspected anomalous results, should be plotted on a graph so that they can be easily identified.
- When taking repeat readings, it is the mean value that is plotted.
- The way data is presented on a graph depends on the type of data.
- When presenting diagrams, such as apparatus set-up, all the relevant parts must be clearly labelled.
- After an experiment has been carried out, sometimes the raw results will need to be processed before they are in a useful or meaningful format.
- Sometimes, various calculations will need to be carried out in order to get the data in the form of a bar graph.

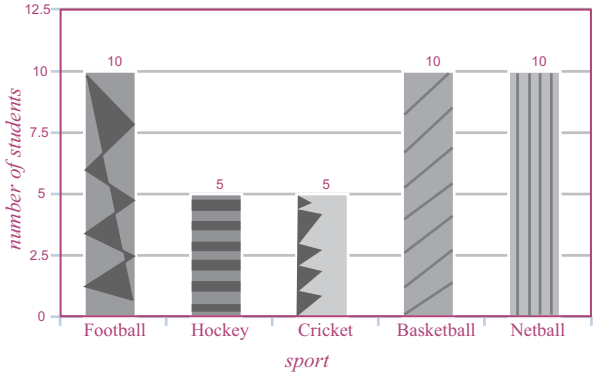


Fig. 13.1 Data presented on a bar graph

Presenting data on a pie chart

A pie chart is a type of graph that represents the data in the circular graph. The slices of pie show the relative size of the data, and it is a type of pictorial representation of data. A pie chart requires a list of categorical variables and numerical variables

You need to calculate the angle of a circle that represents the number of students in each sporting discipline as follows:

$$\frac{number\ of\ student\ playing\ football}{total\ number\ of\ students} \times 360$$

Table 13.2 Students' favourite sporting activities expressed in degrees

Football	Hockey	Cricket	Basketball	Netball	Total
10	5	5	10	10	40
90°	45°	45°	90°	90°	360°

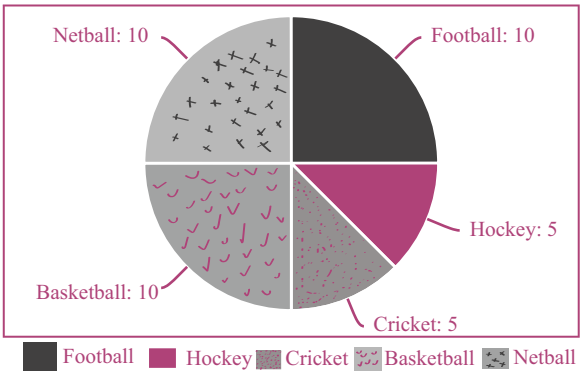


Fig. 13.2 A pie chart

TOPIC 14 Measurements

Topic objectives

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

- *estimate physical quantities.*
- *identify appropriate instruments for measuring physical quantities.*
- *measure accurately.*
- *identify types of errors in measurement.*
- *read an instrument scale to the nearest division.*
- *identify units including S.I units.*
- *convert units.*
- *measure mass of a liquid.*
- *measure the volume of an irregular object.*
- *determine the thickness, volume and mass of small objects.*
- *calculate density.*
- *measure physical quantities accurately using appropriate instruments.*
- *determine density of liquids.*
- *express derived quantities in terms of base units.*

Physical quantities

Important insights

- Physical quantities consist mainly of:
  - Numerical magnitude that denotes the size of the physical quantity.
  - Unit denotes the physical quantity it is expressing.

Table 14.1 SI units of measure

Fundamental Quantity		S.I. Unit	
Name	**Symbol**	**Name**	**Symbol**
Mass	m	kilogram	*kg*
Length	l	metre	m
Time	t	second	s
Current Temperature	I T	Ampere Kelvin	A K
Amount of Substance	n	mole	mol
Luminous Intensity	lv	candela	cd

- Physical quantities can be classified into:
  - Derived quantities which are defined in terms of the basic quantities through equations for example Density = $\frac{mass}{volume}$ (unit for mass is *kg*, unit for volume is m^3).
  - Therefore density = kg/m^3
  - SI units for these quantities are obtained from the basic SI units through the equations.

Units of measurements

- SI units are used as standardised units in all measurements in the world.
- SI is the short form for "International System of Units".
- Other units are on table 14.2.

Table 14.2 Units used to measure length

Length	Mass	Time
1*km* = 1000*m*	1*kg* = 1000*g*	1h = 60*min*
1*m* = 100*cm*	1g = 1000*mg*	1*min* = 60*sec*
1*cm* = 10 *mm*	1*tonne* = 1000*kg*	1 day = 24 hours

Examples of some derived quantities and their units:

Table 14.3 Units used to measure derived quantity

Derived Quantity	SI Unit
area	m^2
volume	m^3
density	kg/m^3
speed	*m/s*

- Measurements of quantities are made with the aim of finding the true value of that quantity.
- In reality, it is impossible to obtain the true value of any quantity, there will always be a degree of uncertainty.
- The uncertainty is an estimate of the difference between a measurement reading and the true value.
- A measuring instrument can give precise but not accurate measurements or accurate but not precise measurements.
  - Precision is how close the measured values are to each other but they may not necessarily cluster about the true value. Zero errors and parallax errors affect the precision of an instrument.
  - Accuracy is how close a reading is to the true value of the measurement. The accuracy of a reading can be improved by repeating the measurements.

Volume of an irregular object

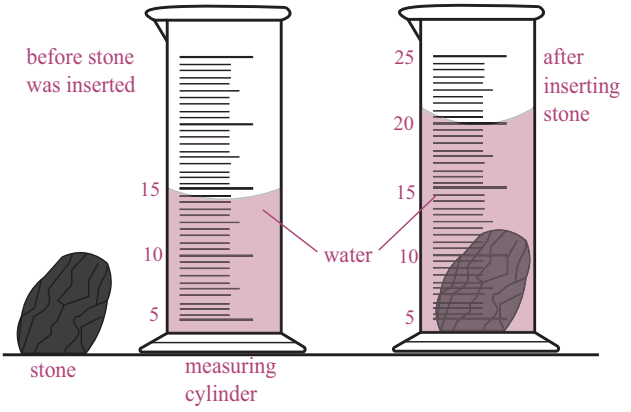


Fig. 14.1 Measuring the volume of an irregular object

This method is based on the fact that the volume of an irregular solid is equal to the volume of water displaced by it when it is immersed in water. The volume of displaced water is equal to the volume of an irregular body that displaced the water. To carry out the experiment, an irregular stone, sewing thread, and a measuring cylinder is used.

Common instruments used for measurement

- Metre rules – to measure distance and length.
- Balances – to measure mass.
- Protractors – to measure angles
- Stopwatches – to measure time.
- Ammeters – to measure current.
- Voltmeters – to measure voltage.
- More complicated instruments such as the micrometre screw gauge and vernier callipers can be used for accurately measuring length.
- Resolution is the smallest change in the physical quantity being measured that results in a change in the reading given by the measuring instrument.

TOPIC 16 Machines

Topic objectives

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

- *define a machine.*
- *construct a simple machine.*
- *describe the uses and applications of machines.*
- *determine Mechanical Advantage (MA), Velocity Ratio (VR) and efficiency of levers inclined plane, pulleys and gears.*
- *explain the energy losses in machines.*
- *describe the ways of improving efficiency in machines.*
- *describe the operation of a four-stroke petrol and diesel engine.*
- *explain the role of the fuel injector and carburettor.*
- *describe the operation of a modern petrol and diesel engine.*
- *outline the advantages of modern petrol engines over old petrol engines.*

Machines

Important insights

- A machine is a device which makes work easier.
- A simple machine is a non-powered mechanical device that changes the direction or magnitude of a force.
- Simple machines can be defined as the basic mechanical devices that use mechanical advantage (also called leverage) to multiply force.
- A simple machine uses a single applied force to do work against a single load force.
- Ignoring friction losses, the work done on the load is equal to the work done by the applied force.
- Examples of machines include a crowbar, a see-saw, a claw hammer, a pulley and or an inclined plane.
- Simple machine is any device, which requires single force in operation to simplify work for example, claw hammer, a pulley and an inclined plane.

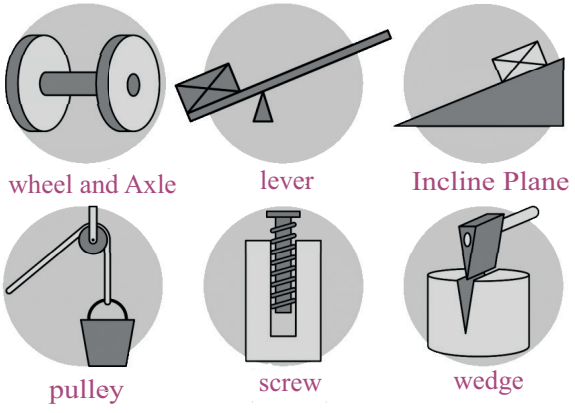


Fig. 16.1 Simple machines

- In a simple machine, a force is applied at one convenient point to overcome another force acting at another point.
- In fig. 16.2, force is applied at one end of the bar in order to exert an upward force on the stone. The down ward force is called effort and the weight of the stone is called load.

TOPIC 18 Magnetism

Topic objectives

By the end of the topic, you should be able to:

- *distinguish magnetic material from non-magnetic materials.*
- *identify the poles of a magnet.*
- *describe properties of magnets.*
- *state the law of magnetism.*
- *draw magnetic fields.*
- *describe hydro and thermal power generation.*

Laws of magnetism

Important insights

Properties of magnets

Fig. 18.1 A magnet

- A magnet has two poles where the magnetic forces are the strongest these are the North Pole and the South Pole.
- Magnets do not exist as monopoles (unlike electric charges).
- We can use arrows to indicate magnetic dipoles in a magnet. The arrow head indicates the North Pole.
- The law of magnetism states that like poles repel and unlike poles attract.
- Repulsion is the only way to test if an object is a magnet.

Induced magnetism

- A magnetic material becomes an induced magnet when placed in a magnetic field that is near a permanent magnet.
- The magnetic field from the magnet aligns the randomly arranged dipoles in the material.

Magnetisation using electricity

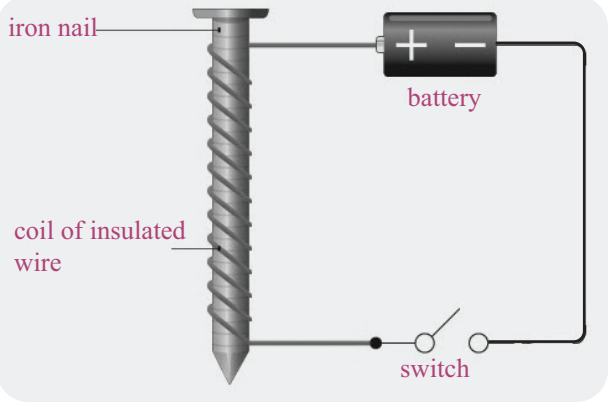


Fig. 18.2 Magnetisation by electricity

- To magnetise a steel bar, one can place it in a solenoid that is connected to a DC power source.
- The magnetic field produced by the solenoid magnetises the steel bar.

EXAMINATION PRACTICE 1

PAPER 1

TIME: 1 hour

Answer **all** questions.

1. The diagrams below show different types of apparatus.

A. 

B. 

C. 

D. 

Which of the apparatus **A**, **B**, **C** or **D** is the most suitable to view microscopic organisms?

2. Which of the following specialised cell is suitable for movement?

A. Sperm cell **B.** Muscle cell **C.** Red blood cell **D.** Palisade cell

3. Which adaptation of a leaf does not increase the rate of photosynthesis?

A. Air spaces **B.** Thick cuticle **C.** Numerous stomata **D.** Large surface area

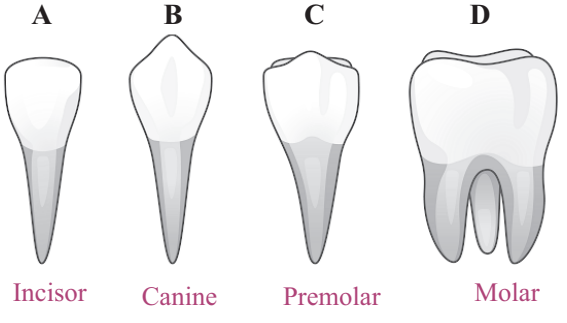
4. The atmospheric condition that reduces the rate of water uptake in plants is

A. high humidity **B.** high wind speed
C. high temperature **D.** high light intensity

5. An end product of photosynthesis is

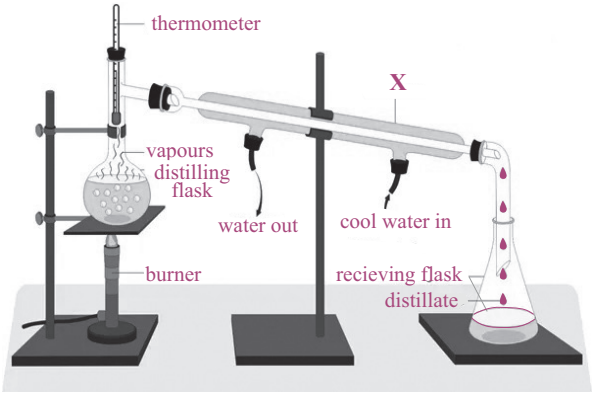
A. carbon dioxide **B.** water **C.** glucose **D.** sunlight

6. The following diagram shows the types of teeth.



Which of the teeth **A**, **B**, **C**, or **D** is suitable for biting and chewing

14. The diagram shows simple distillation apparatus.



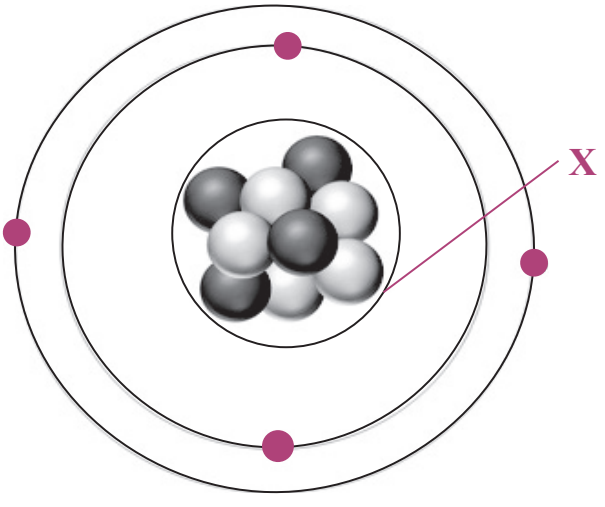
What happens in **X**?

A. Vapour is converted to liquid.
B. Vapour is directed into the container.
C. Salt and the distillate are being separated.
D. The distillate is warmed.

15. From the element $12C_6$, which of the following is correct?

A. Electron number is 6
B. Proton number is 6
C. Neutron number is 6
D. Nucleon number is 6

16. The diagram shows an atom.



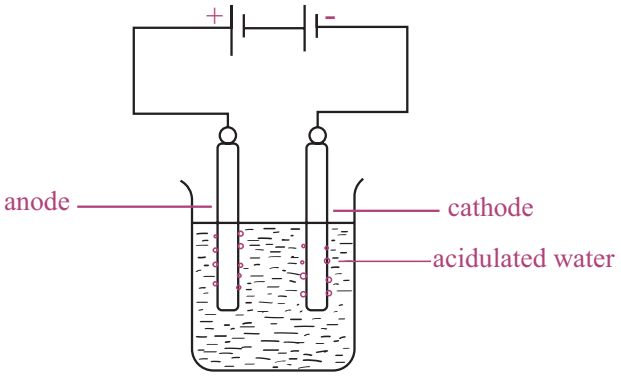
Which particles are found in the part labelled **X**?

A. Protons and electrons.
B. Nucleons and protons.
C. Nucleons and electrons.
D. Neutrons and proton.

17. Which statement is not correct about neutralisation?

A. Acids and carbonate combine to form salt and water.
B. Solute and water are products.
C. It is a reaction between an acid and a base.
D. It is a reaction between a hydroxide and an acid.

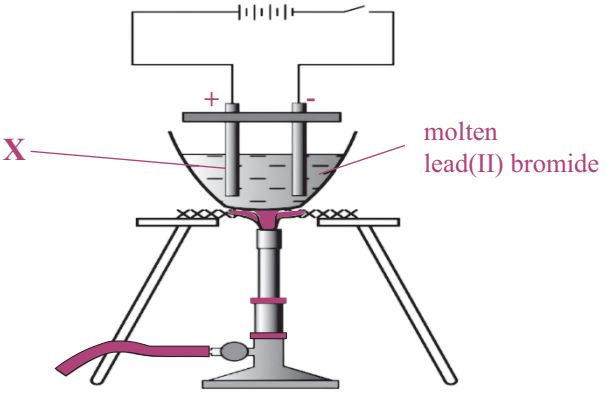
18. The diagram shows the electrolysis of water.



Hydrogen and oxygen are formed in the ratio _____ respectively.

A. 1:2 **B.** 2:1 **C.** 1:3 **D.** 3:1

19. The diagram shows the electrolysis of molten lead bromine.



What is produced at electrode **X**?

A. Lead bromide gas **B.** Lead oxide **C.** Carbon dioxide **D.** Bromine

20. Iron is extracted from its ore in a blast furnace by

A. oxidation **B.** reduction **C.** crushing **D.** heating

21. Which statement is true about hydrocarbons?

A. They are made up of hydrogen and oxygen only.
B. They are made up of hydrogen and carbon only.
C. They are made up of hydrogen only.
D. They are made up of hydrogen, carbon and oxygen.

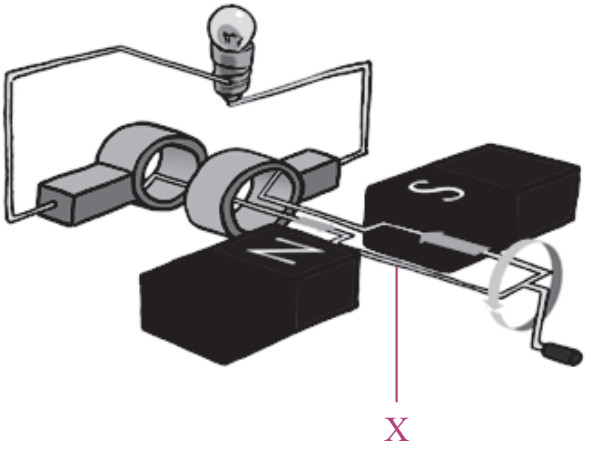
22. Which of the following organic compound is saturated?

A. Propene **B.** Propane **C.** Propanol **D.** Propanoic acid

23. Which separation technique is used to separate plant pigment?

A. Crystalisation **B.** Chromatography
C. Filtration **D.** Pigmentation

35. The diagram below shows an AC generator.



The rotation of a coil **X** is not affected by

A. Strength of a magnetic field
B. types of the ammeter used to measure current
C. amount of current passed.
D. number of turns of the coil

36. The unit of power is

A. joules **B.** newtons **C.** watts **D.** kilojoules

37. Fig. 37.1 shows a three pin plug

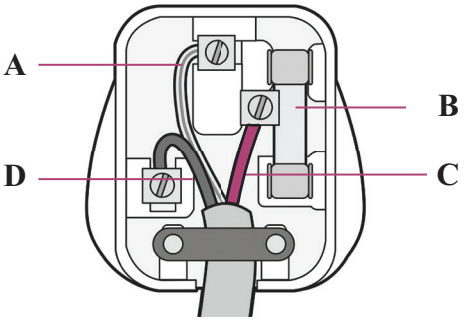


Fig. 37.1

Which of the parts labelled **A**, **B**, **C** or **D** is the live wire?

38. What is the energy conversion in a generator?

A. Electrical energy to kinetic energy.
B. Electrical energy to mechanical energy.
C. Mechanical energy to electrical energy.
D. Mechanical energy to potential energy.

39. Electricity costs 10 cents per kilowatt per hour (*kw/h*). How much does it cost to run 750*W* machine for 20 hours?

A. $0,375
B. $1,50
C. $7,50
D. $15,00

40. Fig 40.1 shows a solar cooker.

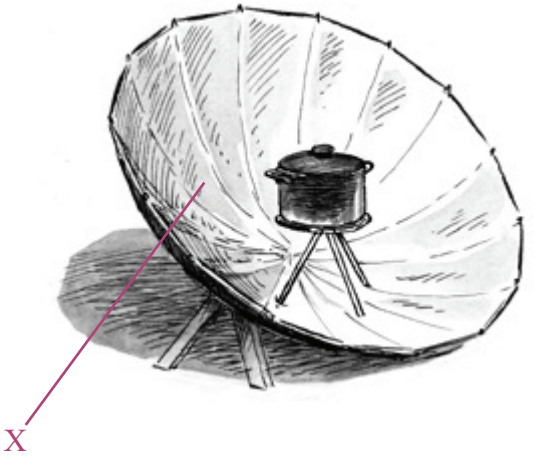


Fig. 40.1

Why the part labelled **X** is shiny?

A. To reflect heat.
B. To conduct heat.
C. To absorb heat.
D. To concentrate heat.

EXAMINATION PRACTICE 1

PAPER 2

TIME: 2 hours

In Section A answer **all** questions, Section B, C and D answer any **two** questions.

Section A: Answer all questions

1. **(a)** **(i)** Define photosynthesis. [1]

(ii) State the word equation for photosynthesis. [2]

(b) Outline the fate of photosynthesis end products. [4]

2. **(a)** Fig. 1.1 shows a palisade cell.

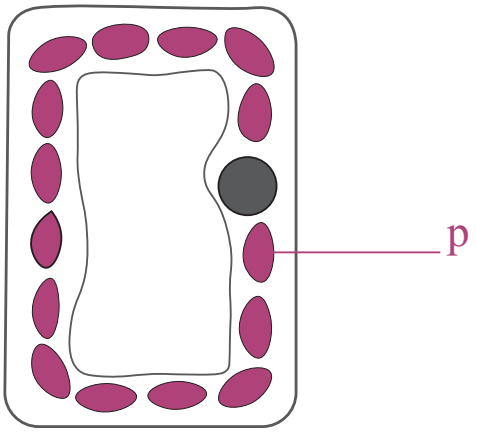


Fig. 1.1

(i) Identify a structure labelled **P**. [1]

(ii) Explain how a palisade layer is adapted to its functions. [4]

(b) State the any two nutritional deficiencies in humans. [2]

3. Fig. 3.1 shows an atom.

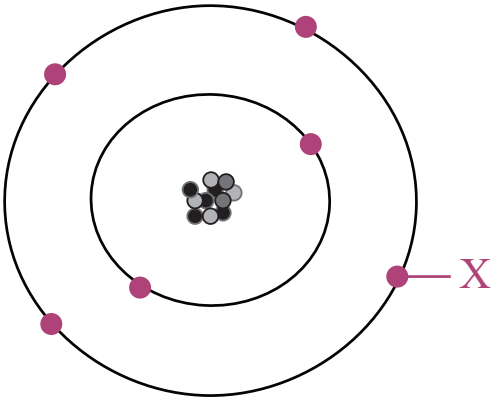


Fig. 3.1

(a) Name the part labelled **X**. [1]

(b) (i) Draw a dot and cross diagram to show bonding in sodium oxide. [3]

(ii) State two properties of sodium oxide. [2]

4. (a) State the separation method used to separate plant pigmentation or dyes. [1]

(b) (i) Write down the balanced chemical equation for the reaction between sulphuric acid and calcium carbonate. [3]

(ii) State any two conditions needed for the Haber process. [2]

5. (a) Define the term inertia. [1]

(b) (i) State newton's third law of motion. [1]

(ii) How is newton's third law of motion applied? [1]

(c) Distinguish between mass and weight. [4]

6. (a) A box measuring 0,3*m* wide, 0,5*m* long and 0,6*m* high has a weight 20*N*. The box rests on the table.

(i) Define the term weight and pressure. [2]

(ii) Calculate the pressure exerted by the box when it rests on the 0,5*m* and 0,6*m* face. [2]

(iii) Explain how the pressure calculated in *(ii)* compares with the pressure exerted when the box rests on the 0,3*m* by 0,5*m* face. [2]

(b) Name the instrument used to measure fluid pressure. [1]

Section B: Answer any two questions

7. (a) Plants need water to survive. State two functions of water in plants. [2]

(b) (i) Describe the structure of ileum. [2]

(ii) Explain how the structure of ileum is adapted to its function. [2]

(c) Explain why chemical digestion is needed in the alimentary canals of consumers. [2]

(d) (i) State why deforestation can disrupt the food chains in a forest. [1]

(ii) State one other harmful effect of deforestation. [1]

8. (a) (i) State any two sexually transmitted infections. [2]

(ii) Give the causative agent for each sexually transmitted infections named in *(i)* above. [2]

(b) Describe and explain how cholera is treated. [4]

(c) State any two effects of tobacco smoking on health. [2]

9. **(a)** Fig. 9.1 shows the carbon cycle.

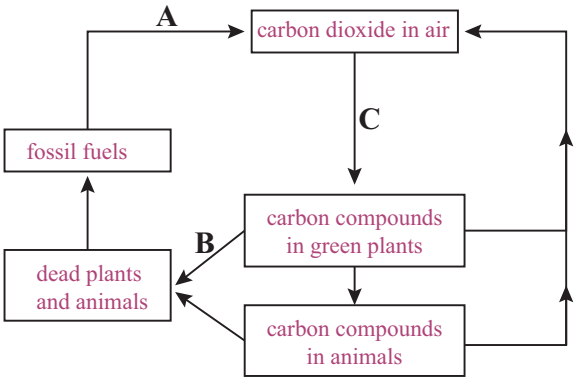


Fig. 9.1.

(i) Identify the processes labelled **A** and **B**. [2]

(ii) Describe process **C**. [2]

(b) **(i)** State one process which increase the amount of nitrogen in the atmosphere. [1]

(ii) State two processes which reduces the amount of nitrogen in the atmosphere. [2]

(c) **(i)** State one problem caused by limited biodiversity. [2]

(ii) Give any one advantage of biodiversity. [1]

Section C: Answer any two questions

10. Fermentation of glucose solution produces dilute ethanol (C_2H_5OH).

(a) **(i)** Name a physical process by which pure ethanol can be obtained from the dilute ethanol. [1]

(ii) Describe the process named in *(i)*. [3]

(b) **(i)** State any two uses of ethanol. [2]

(ii) Calculate the molecular mass of ethanol. [2]

(iii) Calculate the percentage of carbon in ethanol. [2]

11. Fig. 3.1 shows the electrolytic cell used for the electrolysis of molten lead bromide.

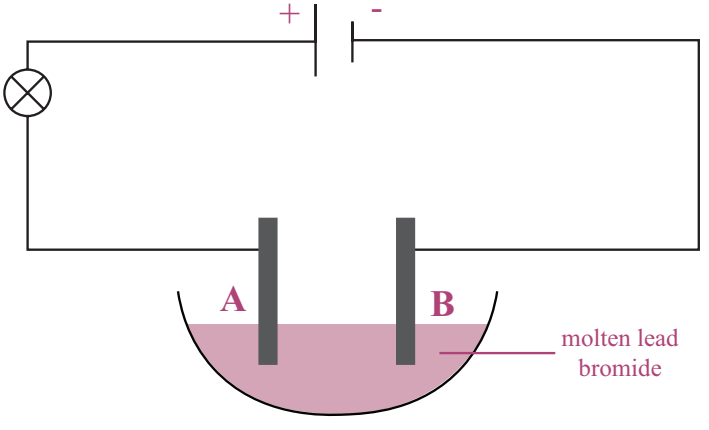


Fig. 3.1

(a) Define the term electrolysis. [2]

(b) **(i)** State the name given to electrode **A**. [1]

(ii) Name the product formed et electrode **B**. [1]

(iii) Write an equation for the reaction which occurs at **B**. [2]

(c) **(i)** Give any two raw materials used in blast furnace. [2]

(ii) State the uses of the materials given in *(i)* above. [2]

12. **(a)** An iron oxide consists of 30% oxygen. Calculate its empirical formular. [4]

(b) Sulphuric acid is produced by the contact process.

(i) State the role of vanadium **(v)** oxide. [1]

(ii) Explain why sulphur trioxide is not directly added to water. [2]

(iii) Define the terms exothermic and reversible. [2]

(iv) Name the substance which is formed at the absorption tower. [1]

Section D: Answer any two questions

13. Fig. 13.1 shows the apparatus to measure the volume of an irregular stone.

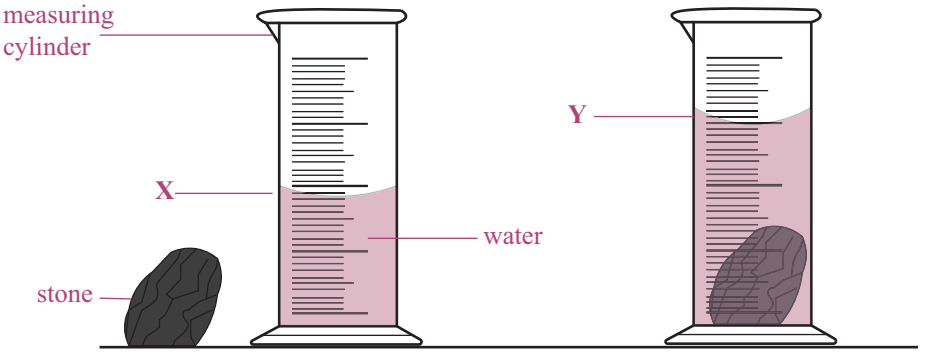


Fig. 13.1.

(a) **(i)** Name the process demonstrated in the diagram. [1]

(ii) Explain how the volume of the stone is calculated. [2]

(b) Suppose the mass of the stone is 250g and its volume is 100cm^2, calculate its density. [3]

(c) State three precautions taken against lightning. [3]

(d) Name the device which can be used to determine whether or not a glass rod is charged. [3]

14. **(a)** A diesel engine undergoes a four-stroke cycle during its operation.

(i) Describe what happens during the intake stroke of a diesel engine. [3]

(ii) Explain why the diesel engine does not have a spark plug. [2]

(b) A hand feels hot when placed above an electric heater which is switched on.

(i) Describe how the heat reaches the hand. [3]

(ii) Calculate the energy drawn by the electric heater if it is connected to 240V main supply and draws a current of 6A for 1 minute. [2]

EXAMINATION PRACTICE 8

PAPER 3

TIME: 1 hour 30 minutes

Answer **all** questions.

1. In this practical, you are required to determine the effect of stirring on solubility.

(a) Measure 5*g* of fine salt and place in a conical flask. And 20*ml* of dissolved. Stir consciously till all the salt dissolve, simultaneously start a stopwatch record the time taken for it to dissolve. Repeat the procedure with another 5*g* sample, but do not stir.

(i) Stirred _____ minutes

(ii) Not stirred_____ minutes. [4]

(a) Account for your observations. [4]

(b) Explain any five factors which affect solubility. [10]

(c) How can the results of the experiment be improved. [2]

(d) In this experiment, you are required to determine the acid-base nature of different solutions. You are provided with three solutions **A**, **B** and **C** in beakers. Label three test tubes **X**, **Y** and **Z**. Place 2*ml* of each solution in the respective test tubes. Add two drops of universal indicators solution into each test tube and record your results in the test tube below.

Solution	Observations	Deductions (acid-base nature
X		
Y		
Z		

[10]

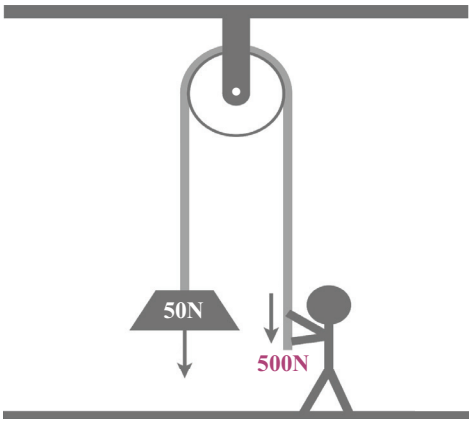
2. **(a)** State any three other reagents that can be used to determine the acid-base nature of substance.

Reagent	Colour in acid	Colour in base
(i)		
(ii)		
(iii)		

[9]

(b) State any one safety precaution to consider in this experiment. [1]

35. What is the mechanical advantage of a system used to lift 50N using an effort of 500N?



A. 1 **B.** 2 **C.** 10 **D.** 550

36. Which type of a machine is shown on fig. 36.1 below?

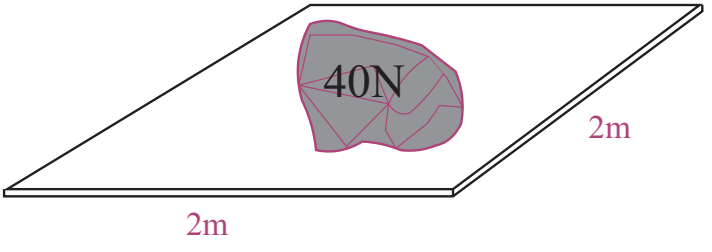
Fig. 36.1

A. lever. **B.** inclined plane.
C. gear. **D.** pulley.

37. What is the velocity ratio of a single fixed pulley?

A. 0 **B.** 1 **C.** 2 **D.** 3

38. What is the pressure exerted by a stone to a tile in the diagram below?



A. 4*Pa* **B.** 10*Pa* **C.** 20*Pa* **D.** 160*Pa*

39. Fuse is connected to

A. the live wire. **B.** the earth wire.
C. the neural wire. **D.** the casing of the plug.

40. Gas pressure is measured by

A. hydraulic jack. **B.** pump. **C.** manometer. **D.** electroscope.

EXAMINATION PRACTICE 10

PAPER 2

TIME: 2 hours

In Section A answer **all** questions, Section B, C and D answer any **two** questions.

Section A: Answer all questions

1. **(a)** Explain the fate of end products of photosynthesis. [4]

(b) Outline the role of the liver. [3]

2. **(a)** Describe the structure of the female sex cell. [3]

(b) **(i)** Explain malnutrition. [2]

(ii) Give two examples of malnutrition. [2]

3. **(a)** State the reasons for electroplating. [2]

(b) **(i)** Define electrolysis. [1]

(ii) Describe the anode and cathode reaction for the electrolysis of molten lead bromide. [4]

4. **(a)** **(i)** State the constituent elements of hydrocarbons. [2]

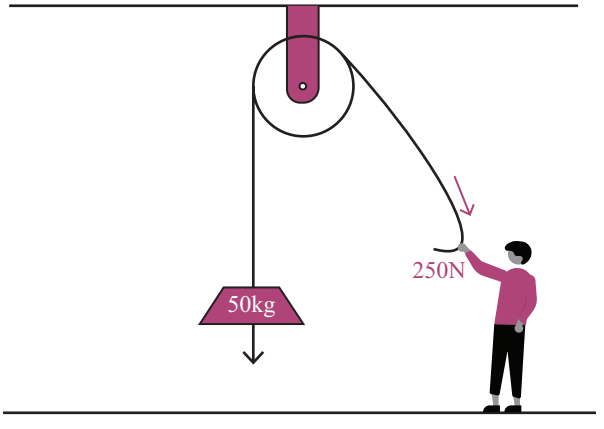
(ii) State any two uses of hydrocarbons. [2]

(b) Draw the structural formula for propene. [3]

5. **(a)** **(i)** Define a simple machine. [1]

(ii) State any two examples of simple machines. [2]

(b) Calculate the mechanical advantage of a pulley system which is used to raise 50*kg* using an effort of 250*N*. [3]



6. **(a)** **(i)** What is pressure? [2]

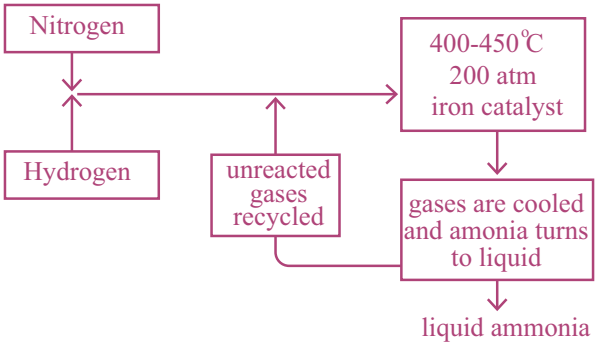
(ii) State the instrument which is used to measure pressure in fluids. [1]

(b) **(i)** Explain the effect of depth on pressure. [2]

(ii) Give one application of the scientific principle explained in *(i)* above. [2]

Section C: Answer any three questions

10. (a) (i) The diagrams shows an industrial process. Name the process. [1]



(ii) The process is a reversible reaction. Explain this concept. [2]

(b) Give the difference between an exothermic reaction and an endothermic reaction. [4]

(c) Give any three uses of sulphuric acid. [3]

11. (a) A blast furnace is used to get purify iron from its ore.

(i) Name three raw materials that are put in the blast furnace. [3]

(ii) Describe the function of each of the raw material named in *(i)* above. [3]

(b) Give any two alloys of iron. [2]

(c) Give any two properties of metals. [2]

12. (a) What are the stages involved in the extraction of nitrogen from the air? [4]

(b) Oxygen can be obtained from the electrolysis of acidified water.

(i) Give the acid used to acidify water. [1]

(ii) Explain why water is acidified. [2]

(iii) Explain why the volume of obtained during the electrolysis process is half that of oxygen. [2]

(iv) State any one use of oxygen. [1]

Section D: Answer any two questions

13. (a) Fig. 13.1 shows a circuit with a 3,0*V* and 1,2*A* lamp using a 1,5*V* battery.

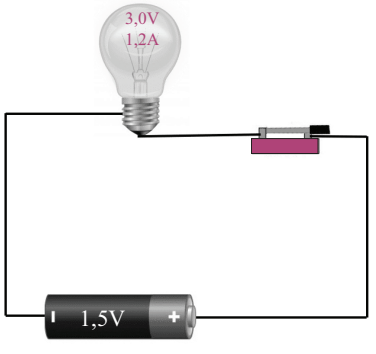


Fig. 13.1

(i) Explain why two cells are needed to light this lamp. [2]

Answers for exam 1: Paper 2

Section A

1. **(a)** **(i)** Define photosynthesis. [1]

Photosynthesis is the process by which plants use sunlight, water and carbon dioxide to create oxygen and energy in the form of sugar

(ii) State the word equation for photosynthesis. [2]

Water + carbon dioxide = carbohydrates + oxygen.

(b) Outline the fate of end products of photosynthesis. [4]

- Glucose is stored and used in translocation.
- Water is reused in the photosynthesis process.
- Oxygen released in some amount is used in respiration process.
- The sugars formed during photosynthesis are used to make cellulose which builds cell walls.

2. **(a)** **(i)** Identify the structure marked **P**. [1]

Chloroplasts

(ii) Explain how a palisade layer is adapted to its functions. [4]

- It is column shaped – for exposure to sunlight.
- It has numerous chloroplasts for maximum absorption of light.
- Large permanent vacuole – to keep the cell turgid.

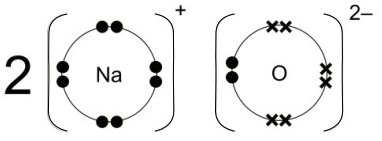
(b) State any two nutritional deficiencies in humans. [2]

- Kwashiorkor
- Goitre
- Rickets
- Scurvy
- Anaemia
- Night blindness.

3. **(a)** Name the part labelled **X**. [1]

Electron.

(b) **(i)** Draw a dot and cross diagram to show bonding in sodium oxide.[3]



Correct formula (Na_2O) and a diagram with brackets and charges of the ions indicated.

(ii) State any two properties of sodium oxide. [2]

- High melting point.
- High boiling point.
- Conduct electricity when in aqueous state.

4. **(a)** State the separation method used to separate plant pigmentation or dyes.[1]

Paper chromatography.

(b) **(i)** Write down the balanced chemical equation for the reaction between sulphuric acid and calcium carbonate. [3]

- $H_2SO_{4(aq)} + CaCO_3(s) \rightarrow CaSO_4(s) + H_2O(l) + CO_{2(g)}$.

(ii) State any two conditions needed for the Haber process. [2]

- Iron as a catalyst.
- 200*atm* of pressure.
- Temperature of 450^0C to 500^0C.

- Current $= \frac{V}{R}$

  $= \frac{12}{1,6}$

  $= 7,5A$

(b) Describe the operation of a lift pump. [4]

- During upstroke, piston moves up and a partial vacuum is created in the cylinder and atmospheric pressure forces water into the cylinder through the cylinder valve.
- Piston valve remains closed and water passes out through the nozzle.
- During down stroke, piston moves down and a partial vacuum is created in the cylinder above the piston.
- Pressure below the piston closes the cylinder valve and forces the piston valve open. Water moves through piston valve and fills the cylinder above the piston.
- Continuous upstroke and down strokes will result in continuous flow of water. It should be noted that the lift pump cannot pump more than 10*m* high.

(b) Justify the design of a solar cooker. [4]

- Is made up of large, curved reflectors (mirror) which focuses solar radiation on to the pot.
- Radiant energy falls on mirrors and is reflected. The reflected radiation is concentrated and focused at one point.
- This produces intense heat which can reach temperature of up to 200°**C.** The cooking point has a dark surface in order to increase heat absorption.

Answers for exam 3: Paper 3

1. In this reaction, you are required to analyse acid-base reactions. You are provided with 2M of HCl and 1,5M of NaOH solution. Measure 5*ml* of HCl and place in a beaker labeled S. Measure 5*ml* of NaOH and add in beaker **S**. Shake the contents of beaker **S**.

(a) Sate any one safety precaution to consider when carrying out this experiment.[1]

- Put on safety goggles.
- Put on latex gloves.

(b) Write a balanced chemical equation for the reaction above. [4]

$NaOH + HCl \rightarrow NaCl + H_2O$ and state symbols.

(c) Calculate the number of moles of each solution in beaker S. [2]

(i) HCl n = vxc

$V = \frac{5}{1000}$

(ii) NaOH n = vxc

$V = \frac{5}{1000}$

(d) Heat the contents of beaker S till all the liquid evaporates. Record your observations. [2]

Results are centre dependent.

(e) State the name of the substances that remained in the evaporating dish. [1]

Salt or sodium chloride.

(f) Write down the general word equation for the reaction taking place in **S**. [2]

acid + base → salt + water

(g) In a similar reaction, sodium hydroxide was replaced with calcium carbonate. Write down a balanced chemical reaction with HCl. [3]

$CaCO_3 + 2HCl \rightarrow CaCl + H_2O + CO_2$ and state symbols.

(h) **(i)** State any two applications of acid base reactions. [2]

- Making salts.
- Making fertilsers.
- Neutralisation reactions.

(ii) State one reagent that can be used to determine the acid–base nature of a solution. [1]

- Universal indicator solution.
- Methyl orange.

2. **(a)** In this experiment, you are required to determine the volume of an irregular stone. You are provided with an irregular stone, sewing thread, and 50*ml* measuring cylinder. Using the materials provided, design and carry out an experiment to determine the volume of the stone given. [14]

- Aim
- Apparatus
- Procedure
- Results
- Conclusion or deductions

(b) Dry the stone and measure its mass using a digital balance. [2]

Finding mass with units stated.

(c) How do the mass of the stone compare to the volume of the stone? [1]

1gram is equivalent to 1ml

(d) What can be deduced from your observations above? [1]

1*g* is equivalent to 1*ml*.

(e) State one source of error from your experiment. [1]

Parallax error.

(f) State how the results of the experiment could be improved. [1]

Repeating the experiment.

Answers for exam 4: Paper 2

Section A

1. **(a)** Name one instrument that can be used to view specialised cells. [1]

- Microscope.
- Bio-viewer.
- Hand lens.

(b) **(i)** State any three specialised cells and their functions. [3]

- Root hair cells
- Muscle cells.
- Red blood cells.
- Palisade cells.

(ii) For the cells stated in *(i)* above, state their functions. [3]

- Root hair cells – for absorption.
- Muscle cells – for movement.
- Red blood cells – for transportation of oxygen.
- Palisade cells – for photosynthesis.

2. **(a)** **(i)** Define the term photosynthesis. [1]

The process by which green plants use sunlight to synthesise nutrients from carbon dioxide and water.

(ii) Write down the word equation for photosynthesis. [2]

- The equation to involve raw materials.
- The word equation to include raw materials, conditions and products.

(b) Explain any two factors that affect the rate of photosynthesis. [4]

- Temperature.

- Chlorophyll concentration.
- Light intensity.

3. (a) Explain the of concept simple distillation. [4]

- Separation is dependent on difference in temperature, both mixtures are heated, vapours of the best solution rise up and are condensed in the condenser
- The distillate is collected in the collecting can.

(b) State the subatomic particles and their charges. [3]

Sub atomic particles	Charge
(i) Protons	Positive
(ii) Electrons	Negative
(iii) Neutrons	Neutral

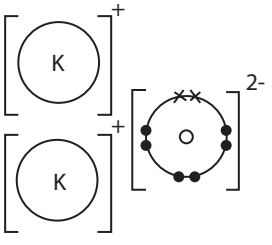
4. (a) (i) Name the type of bonding being shown in the diagram. [1]

Covalent bonding

(ii) Describe the bonding named in *(i)* above. [2]

- Electrons are shared.
- Occurs between non-metals

(b) Draw a dot and cross diagram to show bonding in potassium oxide. [3]



- Correct formula K_2O.
- Correct charges and square brackets.

5. (a) State any three methods of data presentation. [3]

- Bar graphs
- Pie charts
- Line graphs

(b) The statistics of apparatus in the science department is as follows beakers = 25, test tubes = 45, measuring cylinders = 20 and syringes = 10

(i) Show the information on a pie chart. [3]

Calculation of angles of each segment.

(ii) Calculate the percentage represented by the measuring cylinder. [1]

Measuring cylinder/total apparatus times 100%

$= \frac{20}{100} \times 100$

$= 20\%$

6. (a) (i) Define a machine. [1]

An object or mechanical device that receives an input amount of work and transfers the energy to an output amount of work.

(ii) Explain why machines are not 100% efficient. [2]

- Some of the energy is lost as heat.
- Some of the energy is lost through friction.

(b) Identify any three ways of improving the efficiency of machines. [3]

- Lubrication
- Use of ball bearings
- Mass reduction.

Section B

7. (a) (i) State any three types of teeth in humans. [3]

- Molar.
- Premolar.
- Incisor.
- Canine.