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# SECONDARY 1 SCIENCE SERIES

G2 & G3 | MOE Lower Secondary Science Syllabus

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- 16 Topical Notes pages across all 8 chapters
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# The complete Secondary 1 series

8 chapters. 3 separate saddle-stitched booklets per chapter. 24 booklets in total.



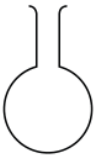
**EVERY CHAPTER: TOPICAL NOTES | WORKSHEET & TEST | ANSWER KEY**

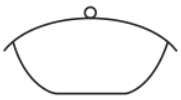
Optional G2 content is clearly identified within the materials.

## 1.7 LABORATORY APPARATUS AND THE BUNSEN BURNER

### Common Laboratory Apparatus

Know the names, uses and 2-D drawings of the common apparatus; exams ask you to name apparatus in a set-up or to draw them:

| Apparatus | Use |
|---|---|
|  **Test tube / boiling tube** | Holds or heats small amounts of substances (boiling tube: larger, stronger heating) |
|  **Beaker** | Holds, mixes or heats liquids; markings approximate: least accurate for measuring |
|  **Conical flask** | Holds and mixes liquids |
|  **Flat-bottomed flask** | Holds chemicals for preparing gases when no heating is required |
|  **Round-bottomed flask** | Holds chemicals when heating is required |
|  **Measuring cylinder** | Measures liquid volumes (~1 $cm^3$ accuracy) |

| Apparatus | Use |
|---|---|
|  **Pipette** | Measures a fixed volume accurately (e.g. exactly 25.0 $cm^3$) |
|  **Burette** | Delivers variable volumes accurately to 0.1 $cm^3$ |
|  **Filter funnel** | Separates an insoluble solid from a liquid |
|  **Evaporating dish / crucible** | Holds substances heated strongly/directly over a flame |
|  **Tripod stand + wire gauze** | Supports vessels above the flame; gauze spreads heat evenly |
|  **Gas syringe** | Collects and measures gas produced in a reaction |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## 1.4 MEASUREMENT: PHYSICAL QUANTITIES, SI UNITS AND INSTRUMENTS

- A measurement is a numerical value (the magnitude) together with a unit, for example 5.00 s.
- SI units are standardised units used worldwide as a common standard.

| Physical quantity | SI unit (symbol) | Other commonly used units |
|---|---|---|
| Length | Metre (m) | cm, mm, km |
| Mass | Kilogram (kg) | g, mg |
| Time | Second (s) | min, h |
| Temperature | Kelvin (K) | °C, °F |
| Volume | Cubic metre ($m^3$) | $cm^3$, mL |

**TAKE NOTE**

*The most heavily tested trap in this chapter: SI units are **metre (NOT cm), kilogram (NOT g), second (NOT min or h), kelvin (NOT °C)**. Gram, centimetre, minute, hour and degree Celsius are commonly used units, but they are NOT SI units. Volume in $m^3$ is a derived SI unit.*

### Choosing the Right Measuring Instrument

| Quantity | Instrument | Notes |
|---|---|---|
| Length (up to ~1 m, straight) | Metre rule / ruler | Reads to 0.1 cm; watch for parallax and worn ends |
| Length (long or curved: circumference of a ball/tree, height of a person) | Measuring tape | Flexible, wraps around curved surfaces |
| Small lengths (~1–15 cm), high precision | Digital calliper | External jaws: outer diameter/thickness (coin, test tube); internal jaws: inner diameter (beaker, tube); depth rod/tail: depth |
| Volume of liquid | Measuring cylinder | Accurate to ~1 $cm^3$; beaker markings are only approximate (least accurate) |
| Fixed accurate volume (e.g. exactly 25.0 $cm^3$) | Pipette | Delivers one fixed, accurate volume (e.g. 25.0 $cm^3$). |
| Variable, accurate volume (e.g. in titration) | Burette | Measures variable volumes to 0.1 $cm^3$ ; read the bottom of the meniscus. |
| Mass | Electronic balance | Reads directly in g; “tare” resets to zero |
| Time | Digital stopwatch | Digital display: no parallax error |
| Temperature | Laboratory thermometer | Read at eye level to avoid parallax. |


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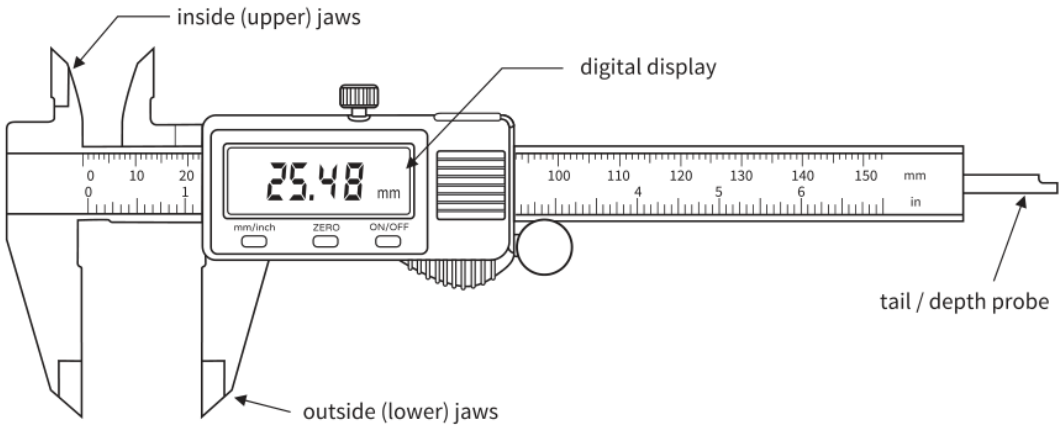


*Figure 2.3: Parts of a digital calliper.*

## Reading Scales Accurately

- First find the size of one small division: the gap between two labelled marks divided by the number of divisions between them. E.g. 10 $cm^3$ over 5 divisions gives 2 $cm^3$ each.
- Read liquid volume at the BOTTOM of the meniscus, eye level with it.
- **Parallax error** happens when your eye is not perpendicular to the scale. Position your eye directly in line with the reading.
- Record to the instrument's precision: a tape or rule reads to 0.1 cm (e.g. 44.3 cm) and callipers to 0.01 cm, so a reading like 24.123 cm is impossible with a tape.

Enrichment

## Accuracy, Precision and Other Instruments

- **Accurate** means close to the true value, while precise means the readings are close to each other (a small range). A set of readings can be precise but not accurate, and vice versa.
- A **micrometer screw gauge** measures very small lengths, such as a needle's diameter, to 0.01 mm, which beats callipers.
- To find the diameter of small identical spheres with a ruler, line several up, divide the total length by the number of spheres, then halve it to get the radius.
- A **displacement can** (eureka can) finds the volume of an object too big for a measuring cylinder. Fill it until the water just stops dripping, place a cylinder under the spout, then lower the object in. The water collected equals the object's volume.
- Note that it measures VOLUME only, not mass or density.

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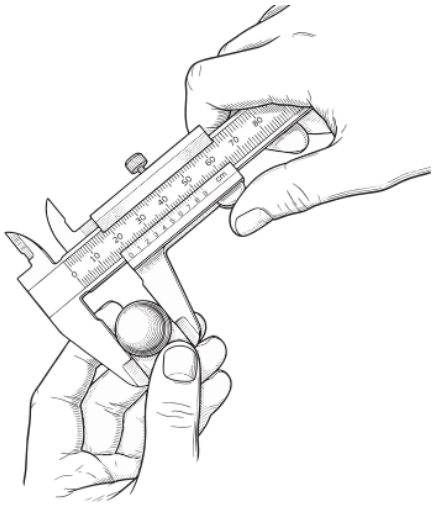
CHAPTER

# 2

# Exploring Diversity of Matter by Its Physical Properties

TOPICAL NOTES



Every material (metal, plastic, glass, ceramic, fibre) has its own **physical properties**. In this chapter, you will describe and measure them, calculate density, predict floating and sinking, and choose the right material for a job and for sustainable living.

## 2.1 CLASSIFYING MATERIALS

**Classifying** objects by their common characteristics lets us study them systematically and spot patterns.

- To classify, first identify the similarities and differences, then group similar objects together, and finally name each group.
- The same objects can be classified in many ways (by colour, material, or use), so there is no single "correct" way.
- One useful way is to classify by material, which gives five classes: **ceramic, metal, glass, fibres, plastic**.

| Material | Key physical properties |
|---|---|
| Ceramic | • Made from clay<br>• Hard<br>• Poor conductor of electricity<br>• High melting point<br>• Does not corrode<br>• Can be moulded into shapes<br>• Fragile (brittle) |
| Metal | • Shiny<br>• Good conductor of electricity and heat<br>• Can be moulded into shapes (malleable)<br>• Can be bent/drawn into wires without breaking (ductile)<br>• Generally high density and high melting point |
| Glass | • Transparent<br>• Poor conductor of electricity and heat<br>• High melting point<br>• Can be moulded into shapes<br>• Fragile (brittle) |

| Material | Key physical properties |
|---|---|
| Fibres | • Can be spun into threads and woven into fabrics<br>• Able to absorb dyes<br>• Flexible<br>• Strong<br>• Poor conductors of electricity and heat |
| Plastic | • Lightweight (low density)<br>• Does not corrode<br>• Can be moulded into shapes<br>• Generally low melting point (compared with metals, glass and ceramics)<br>• Poor conductor of electricity and heat<br>• Strong and durable |

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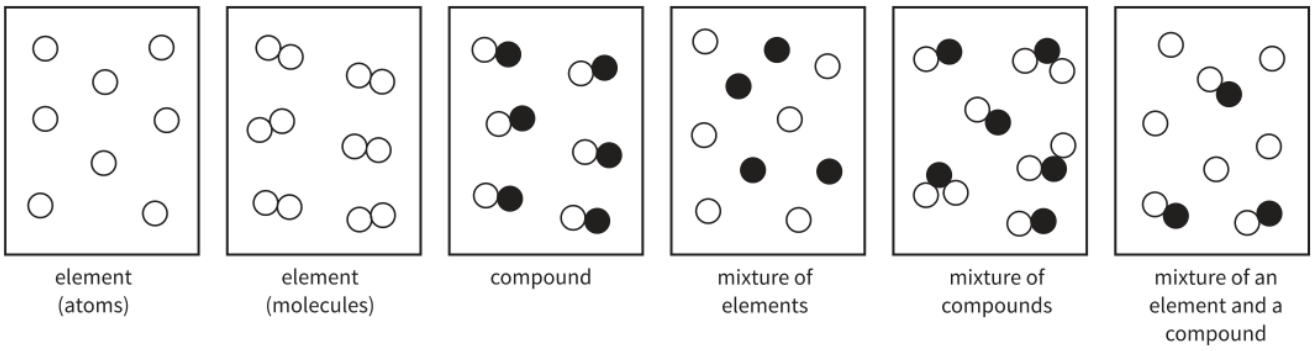


*Figure 3.2: Particle diagrams of elements, compounds and mixtures.*

## Classifying from Experimental Clues

- If it is attracted to a magnet and cannot be broken down further, it is an element (for example, iron).
- If it breaks down when heated or when electricity is passed through it, it is a compound.
- If its parts behave differently (for example, green dissolves but white does not, or black is magnetic but yellow is not), it is a mixture, because the constituents keep their own properties and are not chemically combined.
- A metal burned in oxygen (for example, magnesium → magnesium oxide) forms a compound.
- If a substance melts or boils over a range of temperatures and its composition is not constant, it is a mixture.
- Iron and sulfur simply stirred together form a mixture, from which the iron can be removed with a magnet. When strongly heated, they react to form the compound iron sulfide, which is dull and non-magnetic.

| Element | Compound | Mixture |
|---|---|---|
| Diamond (carbon), copper, mercury, neon, magnesium, chromium, hydrogen | Carbon dioxide, water/steam, salt, sugar, baking soda, rust (iron oxide), calcium carbonate (chalk, marble), sodium hydroxide | Mineral water, seawater, air, blood, soil, steel, brass, petrol, milk, orange juice |

**TAKE NOTE**

*Common trap: "colourless and odourless gas" or "fixed melting point" does NOT prove a substance is a compound; elements are also pure with fixed melting points. Only breaking down into simpler substances proves it is a compound. Also note: helium is an element, not a compound; the Periodic Table lists only elements, never compounds or mixtures.*

## 3.6 SOLUTIONS AND SUSPENSIONS

Solutions and suspensions are both mixtures.

**DEFINITION**

**Solution:** a solution is a homogeneous mixture in which one substance (the solute) dissolves completely in another substance (the solvent).


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- Elements are **pure substances**, so they have fixed melting and boiling points.
- Some elements aren't natural; a few (e.g. technetium) were first made in labs.

## Chemical Symbols

- A **chemical symbol** is one capital letter, or two letters with only the first one capitalised.

| Element | Symbol | Element | Symbol |
|---|---|---|---|
| Hydrogen | H | Sodium | Na |
| Carbon | C | Magnesium | Mg |
| Nitrogen | N | Chlorine | Cl |
| Oxygen | O | Potassium | K |
| Sulfur | S | Iron | Fe |
| Silver | Ag | Copper | Cu |

**TAKE NOTE** | *The symbol of potassium is K, not P; P is phosphorus. Watch out for symbols that come from Latin names: Na (sodium), K (potassium), Fe (iron), Cu (copper), Ag (silver).*

## Atoms and Molecules

- An atom is the smallest particle of an element.
- A molecule is two or more atoms chemically joined together.
- An **element molecule** contains one element only, e.g. oxygen $O_2$, nitrogen $N_2$, sulfur $S_8$.
- A **compound molecule** contains different elements, e.g. $H_2O$, $CO_2$.
- A single unjoined atom (e.g. argon, Ar) is not a molecule.
- Elements can exist as single atoms (such as helium and copper) or as molecules (such as oxygen), not only as single atoms.

## The Periodic Table

- A **group** is a vertical column; elements in the same group share chemical properties (for example, chlorine and iodine in Group 17).
- A **period** is a horizontal row; from left to right across a period, elements trend metallic → non-metallic.
- **Metals** are on the left and in the centre; **non-metals** are on the right (plus hydrogen).
- **Metalloids**, such as silicon and boron, lie on the zigzag boundary and are part-metal, part-non-metal.
- Commonly tested: chlorine is in Group 17 and Period 3; boron is in Group 13 and Period 2.


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CHAPTER

4

# Exploring Diversity of Matter using Separation Techniques

TOPICAL NOTES


Mixtures are everywhere: seawater, ink, scrap metal. This chapter: separating a mixture's constituents by differences in physical properties, and how Singapore uses these techniques for a sustainable supply of **potable** (drinkable) water.

## 4.1 WHY WE SEPARATE MIXTURES AND HOW TO CHOOSE A TECHNIQUE

Separating mixtures lets us **reduce, reuse, recycle** resources. Examples: potable water, food safety, waste management.

Because the constituents are not chemically combined, they keep their own physical properties. Separation exploits a difference in a physical property between them.

- Choose the technique from the constituents' properties (whether they are magnetic, and their particle size, solubility and boiling point) and from which substance you want to collect.
- The amount of each constituent does NOT determine the technique.
- Other factors to consider are cost, reliability and environmental impact.

Optional for G2

- For example, reverse osmosis gives potable water but is costly, so Singapore can't rely on it alone.

| Separation technique | Physical property used | Type of mixture separated | Example |
|---|---|---|---|
| Magnetic attraction | Magnetism | Magnetic + non-magnetic substances | Iron filings from sulfur |
| Sieving / filtration | Particle size | Insoluble solid + liquid (or solids of different sizes) | Sand from water |
| Evaporation to dryness | Solvent boils away at a lower temperature than the solute | Dissolved (soluble) solid + liquid, to obtain the solid | Salt from salt solution |
| Distillation | Difference in boiling points | Solvent + dissolved solid, or two miscible liquids, to obtain the pure liquid | Pure water from seawater |
| Paper chromatography | Different solubilities in a solvent | Small amounts of substances dissolved to different extents | Dyes in ink |

**TAKE NOTE** | *Separation techniques are physical methods; they only work on mixtures. A compound such as water cannot be separated into hydrogen and oxygen by any of these techniques, because its elements are chemically combined.*

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Enrichment

## Separating Funnel and Decantation

Two extra exam methods:

- **Separating funnel**: used for two immiscible liquids, such as oil and water. They settle into two layers, with the denser liquid (water) below the less dense one (oil). Open the tap to run off the lower layer, then close it as the boundary reaches the tap. The property used is density (with immiscibility).
- **Decantation**: pour off the liquid after the insoluble solid has settled (e.g. water off settled sand). It is quick but less complete than filtration.

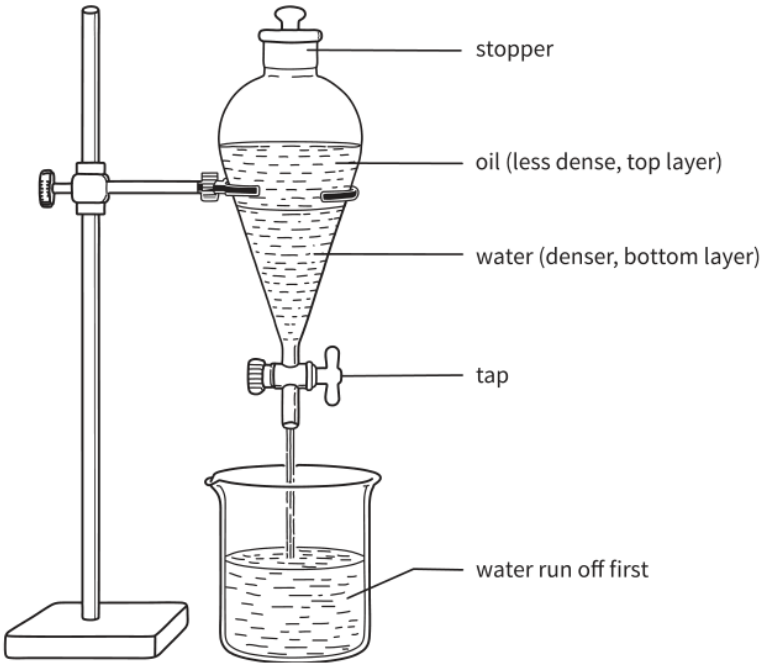


*Figure 4.6: A separating funnel separates immiscible liquids such as oil and water.*

## Other Separation Ideas Seen in Exams

- Gold panning: swirling with water washes away the lighter particles, while the denser, insoluble gold stays in the pan as the residue. It is based on density.
- Steam distillation: steam passed through plant material extracts essential oils (perfumes); the oils evaporate easily, and the vapour is then condensed and collected.
- Electrolysis: water is a compound, not a mixture, so no physical technique can split it. Electricity breaks it into hydrogen and oxygen gas. (Distillation, filtration and magnetic attraction are all wrong answers here.)
- Visking tubing (dialysis): a partially permeable membrane with tiny pores lets small particles (e.g. dissolved ink) through but blocks large ones (e.g. starch); same size-based principle as filtration.

Optional for G2

- Reverse osmosis membranes work the same way.

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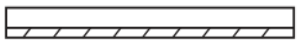
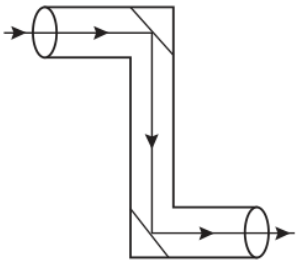
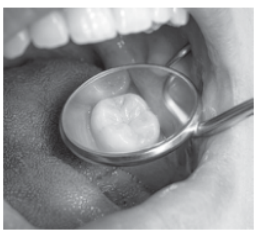
Enrichment

## Field of View: Who Can Be Seen in the Mirror?

Which objects can an observer see in a mirror? **Method**: find each object's image behind the mirror, then draw a line from the image to the eye. The object is visible only if this line crosses the mirror without being blocked by an opaque object; if the line misses the edge of the mirror, the object is not seen.

## 5.4 USES OF MIRRORS: PLANE AND CURVED

Reflecting surfaces can be plane (flat) or curved. A **convex** surface curves outwards (like the back of a spoon), while a **concave** surface curves inwards (like a spoon's bowl, which "caves in").

| Type of mirror | Plane | Convex (curves outwards) | Concave (curves inwards) |
|---|---|---|---|
| **Diagram** |  |  |  |
| **Image characteristics** | Same size, upright, virtual, laterally inverted, same distance behind mirror | Smaller (diminished), upright, virtual | Magnified, upright, virtual when the object is close to the mirror |
| **Function** | Forms an accurate, undistorted image | Gives a wide field of view, many objects seen at once | Magnifies nearby objects; converges light |
| **Applications** | Checking appearance; periscope; lining walls to make interiors appear wider; optician's eye chart  | Blind-corner mirrors at road junctions; security mirrors in shops; rear-view and side mirrors of cars  | Dentist's mirror; cosmetic/ shaving and make-up mirrors; mirror near the base of a microscope (reflects light onto the specimen); car headlights (forms a strong beam); solar cookers (focuses sun rays to a hot spot)  |

**TAKE NOTE**

*Common mix-ups: a dentist's mirror is CONCAVE (magnifies), while road-junction/ security/rear-view mirrors are CONVEX (wide field of view). Spectacles work by REFRACTION (lenses), not reflection, the odd one out in "which uses reflection?" questions. Shared property of plane, convex and concave mirror images of a nearby object: all are virtual and upright.*

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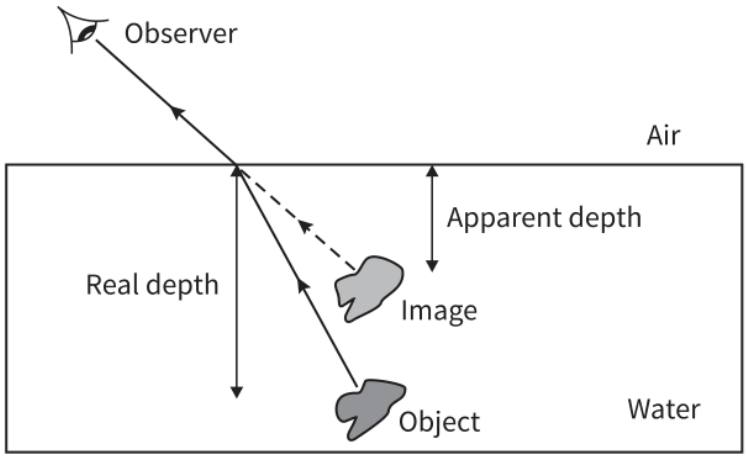


*Figure 5.9: Refraction at the water surface makes the object appear nearer to the surface than it really is.*

**TAKE NOTE** | *The pool-looks-shallow and bent-pencil effects are caused by REFRACTION only, not reflection. Conversely, seeing your face in a puddle is REFLECTION, not refraction. Sort every everyday example into the correct phenomenon before answering.*

Enrichment

## Lenses and the Eye (Refraction Applications)

Refraction, not reflection, is at work in lenses:

- **Magnifying glass** (a convex or converging lens) refracts light so that objects appear larger; a converging lens brings parallel rays to its **focal point**.
- **Spectacles** correct vision by refraction. In **myopia** (short-sightedness) the image forms in front of the retina, so a concave (diverging) lens spreads the rays to move the image back onto the retina.
- Eyes use refraction too: light bends from air into the denser cornea as its speed drops.

Optional for G2

## 5.6 DISPERSION OF WHITE LIGHT

White light isn't one colour, but a spectrum of seven: red, orange, yellow, green, blue, indigo, violet (**ROYGBIV**).

**DEFINITION** | **Dispersion:** the splitting of white light into its component colours.

- Through a glass prism, each colour travels at a different speed, so each is refracted (bent) by a different angle.
- Red bends the least and violet the most. This band of colours is called a **spectrum**.
- **Rainbows**: after rain, sunlight is refracted and dispersed at each raindrop's air–water boundary, so it splits into the seven colours.


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## Inferring Whether a Cell Is a Plant or an Animal Cell

Compare an unknown cell against the two models:

- If it has a **cell wall** or **chloroplasts** and a large central vacuole, it is a **plant** cell.
- If it has no cell wall, no chloroplast and only small vacuoles, it is an **animal** cell.

Some cells are exceptions to the model:

- **Root hair cells** are plant cells but have **no chloroplasts** because they live underground and do not photosynthesise; this shows that a plant cell can still lack chloroplasts.
- **Red blood cells** are animal cells but have **no nucleus**.
- ***Euglena*** has both: it contains chloroplasts (like a plant) yet swims and takes in food (like an animal). It fits neither model neatly, which shows why models sometimes need revising.

Enrichment

## The Bacterial (Prokaryotic) Cell

A bacterial cell (how it differs from typical animal and plant cells):

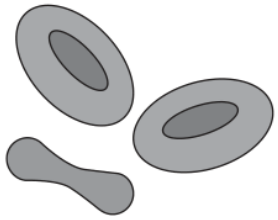
- has a cell wall, cell membrane and cytoplasm;
- has a **flagellum** (whip-like tail) for movement (like a sperm cell's tail);
- has genetic material as a single loose **chromosome**; NO true, membrane-bound nucleus.

Compared with a typical animal cell, a bacterium differs mainly by having a cell wall and no proper nucleus.

# 6.5 SPECIALISED CELLS

In multicellular organisms, not all cells do the same job. Cells become **specialised**, their structure adapted (modified) to carry out one function well.

## Specialised Cells in Animals (Humans)

| Cell | Diagram | Special features | How it helps the function |
|---|---|---|---|
| Red blood cell |  | No nucleus; biconcave (dented disc) shape; contains haemoglobin (red pigment) | No nucleus = more room for haemoglobin; biconcave shape = larger surface area for faster oxygen diffusion; haemoglobin binds and carries oxygen around the body |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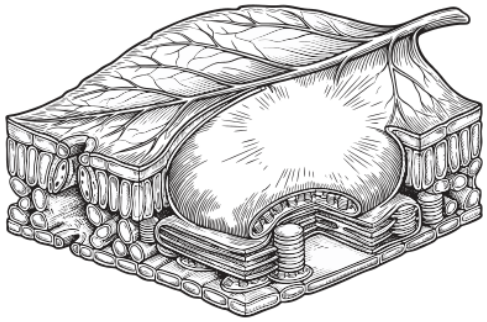
CHAPTER

6

# Model of Cells – The Basic Unit of Life

TOPICAL NOTES



All living things are made of **cells**, the smallest units that carry out life processes. This chapter looks at how microscopes reveal cells; the structures inside typical plant and animal cells and their functions; how to tell plant from animal cells; and how cells are organised into tissues, organs, systems and organisms.

## 6.1 CELLS AND LIVING ORGANISMS

Cells are the basic building blocks of life. Every organism is made of one or more cells, which carry out the activities that keep it alive.

- Cells take in nutrients from food and convert them into energy.
- Cells carry out specialised functions and can reproduce (make more cells).
- Cells are very small, usually 1–100 micrometres (μm) across, so most are only visible under a microscope.

**DEFINITION** | **Cell:** the basic (smallest) unit of life that makes up all living things.

### Unicellular and Multicellular Organisms

Organisms are grouped by how many cells they have.

| Type | Meaning | Examples |
|---|---|---|
| Unicellular | Made of only one cell | Bacteria, Amoeba, Paramecium, diatoms, yeast, some plankton |
| Multicellular | Made of many cells | Animals, plants, fungi (e.g. mushroom, worm, cat, fern, hibiscus) |

**TAKE NOTE** | *The size of an organism does NOT tell you if it is unicellular or multicellular. A tiny organism may still be multicellular, and some single cells are quite large. Judge by the NUMBER of cells, not the size.*

**TAKE NOTE** | *A common exam trap: a unicellular organism (like an Amoeba) still needs a nucleus to control its activities and to reproduce. "Unicellular" does not mean "no nucleus".*

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## GLOSSARY

| Term | Definition |
|---|---|
| **Matter** | anything that has mass and occupies (takes up) space. |
| **Particulate nature of matter** | a model which states that matter is made up of tiny, discrete particles that are in constant and random motion. |
| **Brownian motion** | the constant, random movement of microscopic particles suspended in a liquid or a gas, caused by uneven bombardment (collisions) from the invisible particles of the liquid or gas around them. |
| **Expansion** | the increase in volume of a substance when it is heated, because its particles gain energy and move further apart. |
| **Contraction** | the decrease in volume of a substance when it is cooled, because its particles lose energy and move closer together. |
| **Melting** | the process in which a solid changes into a liquid, without a change in temperature. |
| **Boiling** | the process in which a liquid changes into a gas throughout the liquid, without a change in temperature. |
| **Freezing** | the process in which a liquid changes into a solid, without a change in temperature. |
| **Condensation** | the process in which a gas changes into a liquid. |
| **Sublimation** | the process in which a solid changes directly into a gas without passing through the liquid state. |
| **Vapour deposition** | the process in which a gas changes directly into a solid without passing through the liquid state. |
| **Melting point** | the fixed temperature at which a pure solid changes into a liquid. |
| **Boiling point** | the fixed temperature at which a pure liquid changes into a gas. |
| **Diffusion** | the net movement of particles from a region of higher concentration to a region of lower concentration. |

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- **Heating**: the particles gain (heat) energy and vibrate or move faster, so the distances between them increase, the volume increases and the substance expands.
- **Cooling**: the particles lose energy and vibrate or move less, so the distances between them decrease, the volume decreases and the substance contracts.
- All three states expand and contract in this way. The extent is greatest for a gas, then a liquid, then a solid (gas > liquid > solid), because gas particles move furthest apart while solid particles only vibrate faster in place.

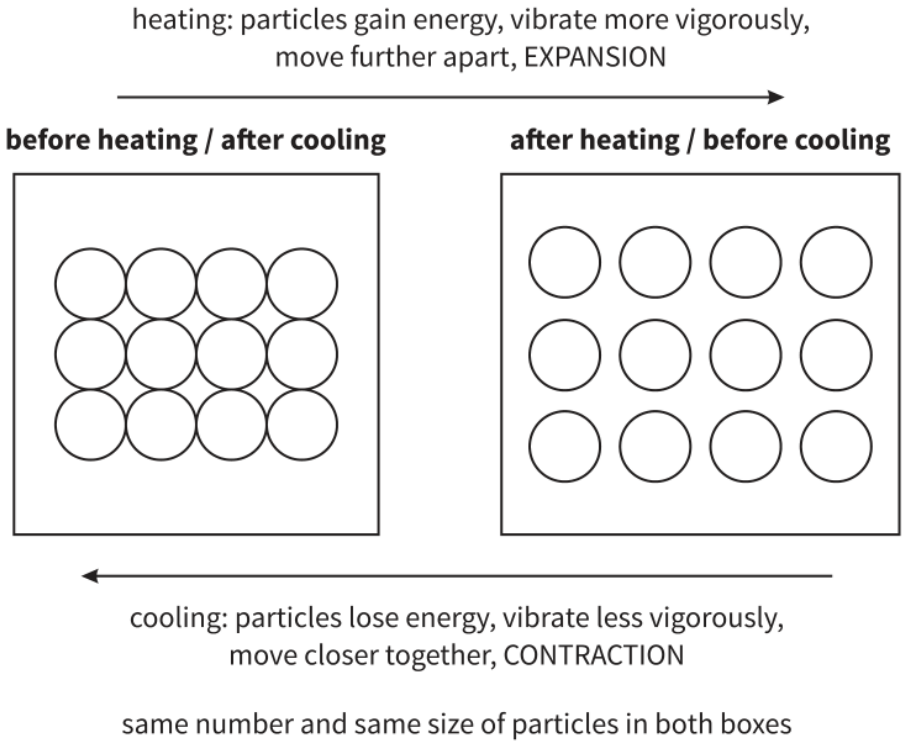


*Figure 7.3: Expansion and contraction, only the distances between particles change.*

**TAKE NOTE**

*Conservation of mass: during expansion and contraction the number and size of the particles do NOT change, so the mass stays the same. Because volume changes while mass is constant, density = mass ÷ volume DECREASES on expansion and INCREASES on contraction. Wrong options to reject: "the particles increase in size / in number / become lighter / melt and join together".*

Enrichment

## Expansion and Contraction in Everyday Life

These applications are frequently tested. Always answer with "particles gain or lose energy, move faster or slower, and move further apart or closer together":

- Balloon in hot sun or bottle in hot water: the trapped air particles gain energy and move faster and further apart, so the gas expands and the balloon inflates. No new particles enter.
- Loosening a tight metal cap with warm water: the metal expands more than the glass, so the cap loosens.


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| Substance | Formula | Elements (types) | Atoms per molecule |
|---|---|---|---|
| Hydrogen | $H_2$ | 1 (hydrogen) | 2 |
| Water | $H_2O$ | 2 (hydrogen, oxygen) | 2 + 1 = 3 |
| Carbon dioxide | $CO_2$ | 2 (carbon, oxygen) | 1 + 2 = 3 |
| Ammonia | $NH_3$ | 2 (nitrogen, hydrogen) | 1 + 3 = 4 |
| Sulfuric acid | $H_2SO_4$ | 3 (hydrogen, sulfur, oxygen) | 2 + 1 + 4 = 7 |
| Aluminium oxide | $Al_2O_3$ | 2 (aluminium, oxygen) | 2 + 3 = 5 |

- A formula with only one type of element ($H_2$, $O_2$, $S_8$) shows an element, while one with two or more (CO, $H_2O$) shows a compound.
- A subscript applies only to the symbol before it, so $NH_3$ has 3 hydrogens and 4 atoms in total.

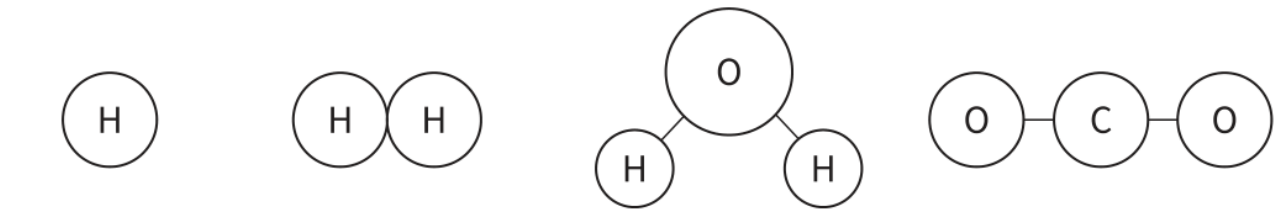
**TAKE NOTE**

*Brackets multiply everything inside them. $Ca(OH)_2$ = 1 Ca + 2 O + 2 H = 5 atoms, 3 elements. $(NH_4)_3PO_4$ = 3 N + 12 H + 1 P + 4 O. Also, for MORE THAN ONE molecule, multiply the whole count: 2 molecules of $H_2SO_4$ contain 7 × 2 = 14 atoms.*

## Molecular Diagrams

Molecules can be drawn as labelled or shaded circles, where touching circles represent atoms that are chemically joined.

- An atom of an element is shown as one circle (e.g. labelled H).
- A molecule of an element is shown as identical circles joined (e.g. H–H for $H_2$).
- A molecule of a compound is shown as different circles joined (e.g. two H on one O for $H_2O$; N with three H for $NH_3$; O–C–O for $CO_2$).




hydrogen atom | hydrogen molecule $H_2$ (molecule of an element) | water molecule $H_2O$ (molecule of a compound) | carbon dioxide $CO_2$ (molecule of a compound)

*Figure 8.6: Representing atoms and molecules with labelled circles.*

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## Number of Neutrons Can Vary

- An atom's neutrons need not equal its protons.
- Same-element atoms can differ in neutrons (e.g. carbon with 6, 7 or 8).
- Some have zero neutrons; common hydrogen has 1 proton, 1 electron and 0 neutrons.

Optional for G2

## Models of the Atom

Atoms cannot be seen, so scientists use **models**, simplified and revised as new evidence appears.

- **Dalton's billiard ball model** (1800s): the atom is a solid, hard, indivisible ball.
- **Thomson's plum pudding model** (early 1900s): the atom is a sphere of positive charge with electrons scattered inside, like plums in pudding.
- **Present (planetary) model**: electrons orbit a small central nucleus, like planets round the sun. The atom is mostly empty space; if it were the size of a football stadium, the nucleus would be only a marble at the centre.
- Both older models are now inaccurate: they cannot explain many atomic properties. Science is constantly revised: ideas change with new evidence.

**TAKE NOTE**

*A tested comparison: similarity between the plum pudding model and the present model; both contain electrons (negative charges). Differences: (1) in the plum pudding model the positive charge is spread throughout the atom, but in the present model it is concentrated in a small central nucleus; (2) in the plum pudding model electrons are scattered randomly, but in the present model electrons move in shells around the nucleus.*

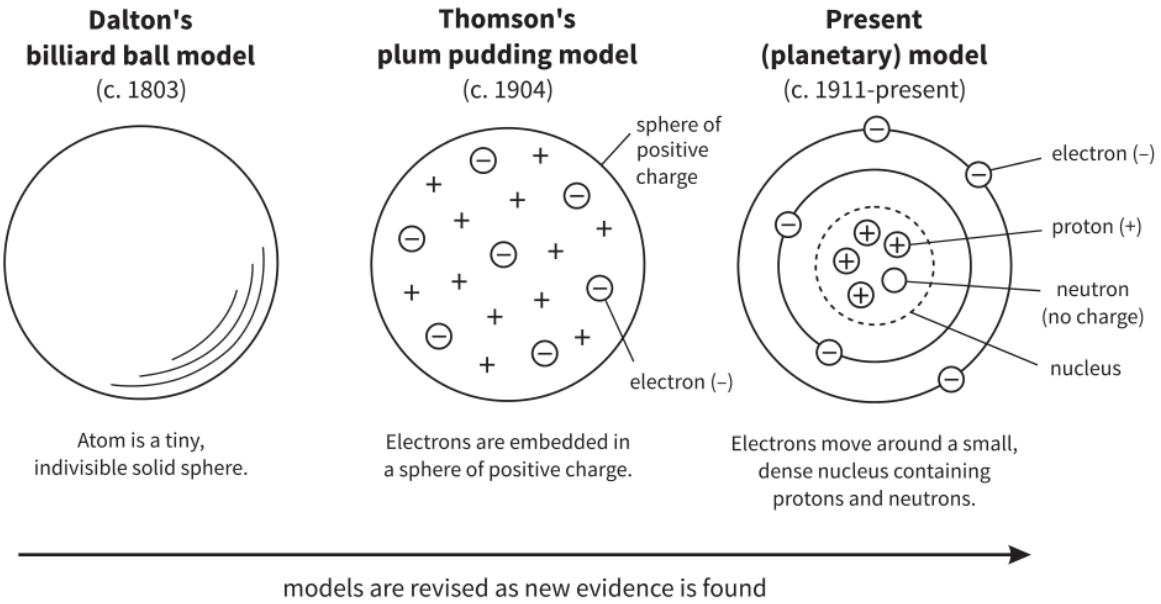


*Figure 8.3: Atomic models have been constructed, justified and revised over time.*


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**15** A student investigates how the temperature of a beaker of water changes with time as it is heated. The diagrams show the readings on his stopwatch as the water reaches different temperatures.


time at 20 °C


time at 80 °C


time at 100 °C

What is the time taken for the temperature to rise from 80 °C to 100 °C?

(A) 1 min 54 s

(B) 2 min 06 s

(C) 3 min 46 s

(D) 5 min 40 s ( )

**16** Three students each weighed a 20.0 g mass three times using different electronic balances. Their readings are shown in the table.

| student | mass / g | | | |
|---|---|---|---|---|
| | reading 1 | reading 2 | reading 3 | average reading |
| 1 | 19.5 | 20.4 | 19.8 | 19.9 |
| 2 | 23.2 | 23.1 | 23.2 | 23.2 |
| 3 | 20.6 | 20.0 | 20.3 | 20.3 |

| | most accurate readings | most precise readings |
|---|---|---|
| (A) | 1 | 2 |
| (B) | 1 | 3 |
| (C) | 2 | 1 |
| (D) | 2 | 3 |

( )

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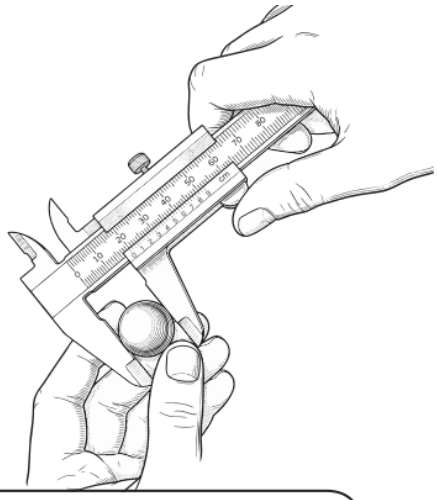
CHAPTER

# 2

# Exploring Diversity of Matter by Its Physical Properties



TEST

**TEST SUMMARY**

| Section A | Section B | Total |
|---|---|---|
| _____ / 20 | _____ / 23 | _____ / 43 |

## SECTION A MULTIPLE CHOICE QUESTIONS

There are twenty questions in this section. Answer ALL questions. For each question, there are four possible answers, A, B, C and D. Choose the one you consider correct and record your choice in the brackets provided.

**1** Which statements are true about metals?

1 They are good conductor of heat.

2 They are poor conductors of electricity.

3 They can be easily moulded into shapes.

4 They cannot be bent without breaking.

(A) 1 and 2 only

(B) 1 and 3 only

(C) 3 and 4 only

(D) 1, 2, 3 and 4 ( )

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**2** (a) Solubility is the ability of a solute to dissolve in a solvent

Figure 3.6 shows how temperature affects the solubility of solids A, B and C in water.

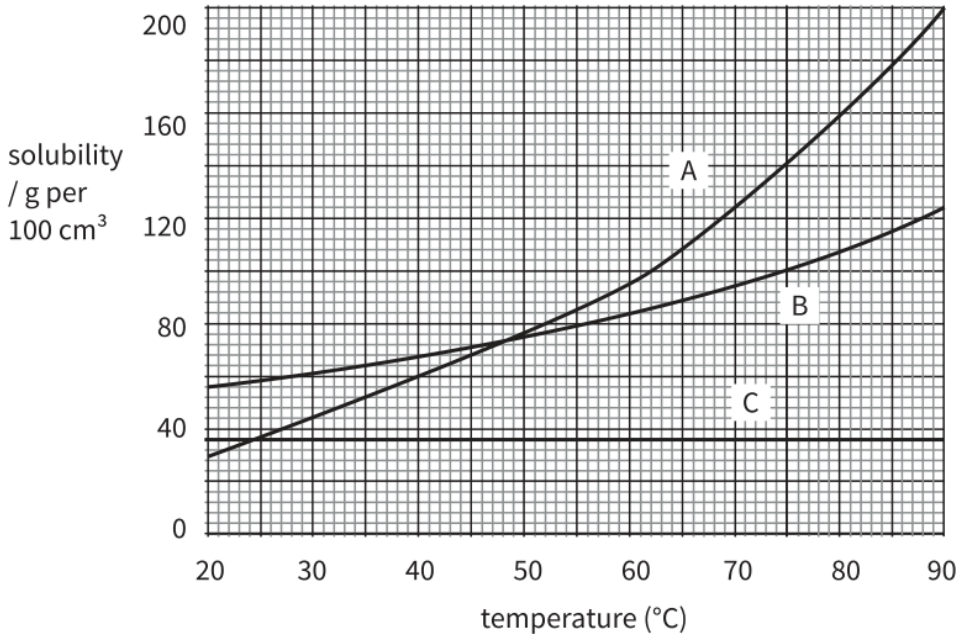


*Figure 3.6*

(i) State the solubility of B at 65 °C.

_____ [1]

(ii) State the temperature at which A and C has the same solubilities.

_____ [1]

(iii) Describe two ways to increase the rate of dissolving of the solids in water.

1 _____

_____

2 _____

_____ [2]

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WORKSHEET 1



**14** Which of the following correctly shows the applications of each separation technique?

| | distillation | evaporation | filtration |
|---|---|---|---|
| (A) | breathing | obtaining pure water | making perfumes |
| (B) | obtaining drinking water | making perfumes | breathing |
| (C) | obtaining pure water | obtaining salt from seawater | obtaining drinking water |
| (D) | obtaining salt from seawater | obtaining drinking water | obtaining pure water |

(  )

**15** A student wants to separate a mixture of iron powder, salt, water and sand.

1 chromatography

2 filtration

3 magnetic separation

4 evaporation

What is the correct sequence of steps the student can take to obtain the iron powder, salt and sand separately?

(A) 1 → 2 → 3

(B) 2 → 1 → 4

(C) 3 → 2 → 4

(D) 3 → 4 → 2 (  )

**16** A mixture contains salt, strips of aluminium foil and iron filings.

In what order should the separation techniques be carried out to obtain each substance separately?

*first* ⟶ *last*

(A) dissolving, filtration, evaporation, chromatography

(B) magnetic attraction, dissolving, filtration, evaporation

(C) filtration, dissolving, evaporation, magnetic attraction

(D) filtration, evaporation, magnetic attraction, chromatography (  )



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CHAPTER

# 5 Ray Model of Light

TEST

## TEST SUMMARY

| Section A | Section B | Total |
|---|---|---|
| _____ / 20 | _____ / 26 | _____ / 46 |

## SECTION A MULTIPLE CHOICE QUESTIONS

There are twenty questions in this section. Answer ALL questions. For each question, there are four possible answers, A, B, C and D. Choose the one you consider correct and record your choice in the brackets provided.

**1** Which statements about light are correct?

1 light can be reflected off surfaces

2 light cannot travel through vacuum

3 light travels at $3 \times 10^8$ cm/s

4 light travels in straight lines

(A) 1 and 2 only

(B) 1 and 4 only

(C) 2 and 3 only

(D) 2 and 4 only ( )

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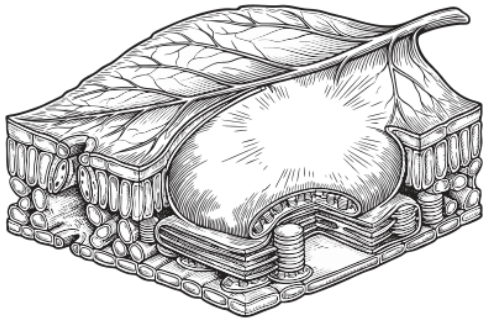
CHAPTER

# 6

# Model of Cells – The Basic Unit of Life



TEST

**TEST SUMMARY**

| Section A | Section B | Total |
|---|---|---|
| _____ / 20 | _____ / 37 | _____ / 57 |

## SECTION A MULTIPLE CHOICE QUESTIONS

There are twenty questions in this section. Answer ALL questions. For each question, there are four possible answers, A, B, C and D. Choose the one you consider correct and record your choice in the brackets provided.

**1** Optional for G2

Which statements about division of labour are correct?

1 Division of labour occurs only in multicellular organisms.

2 Division of labour requires different types of cells to have different functions.

3 Division of labour allows organisms to carry out tasks efficiently.

4 Division of labour ensures organisms look different from other organisms.

(A) 1 and 2 only

(B) 2 and 3 only

(C) 1, 2 and 3 only

(D) 1, 2, 3 and 4 ( )

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**5** The melting points and boiling points of three substances, X, Y and Z, are shown. The physical state of each substance at 25 °C is also indicated.

| substance | physical state at 25 °C | melting point / °C | boiling point / °C |
|---|---|---|---|
| X | gas | –56 | A |
| Y | solid | 78 | 152 |
| Z | liquid | B | 88 |

*Table 7.7*

(a) Using the information in the table, circle the correct options for the two statements.

The value of A is less than 25 °C / more than 25 °C.

The value of B is less than 25 °C / more than 25 °C. [1]

(b) When substance Y is heated from 25 °C to 50 °C, the density of Y decreases.

Explain, using ideas from Particulate Nature of Matter, why the density of Y decreases when heated.

_____

_____

_____ [2]

(c) Draw the arrangement of particles in substance Y at 25 °C.

[1]

Optional for G2

(d) Describe the changes to the movement and arrangement of the particles in substance Y as substance Y is heated from 140 °C to 160 °C.

movement _____

_____

arrangement _____

_____ [2]

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**19** Enrichment

An element R is found directly below element Q in the Periodic Table. Which statements about elements Q and R are true?

1 They have similar chemical properties.

2 They have the same number of electron shells.

3 They have the same number of electrons in their outermost electron shell.

(A) 1 and 2

(B) 1, 2 and 3

(C) 1 and 3

(D) 2 and 3 ( )

**20** Enrichment

The table shows the number of protons, neutrons and electrons in two atoms X and Y.

| atom | protons | neutrons | electrons |
|---|---|---|---|
| X | 6 | 6 | 6 |
| Y | 7 | 6 | 7 |

A researcher writes the following statements about the atoms.

1 X and Y are atoms of the same element.

2 X and Y are electrically neutral.

3 X and Y have the same chemical symbol.

4 X and Y have the same mass number.

Which statements are correct?

(A) 1, 2 and 3

(B) 1, 3 and 4

(C) 2 only

(D) 2 and 4 ( )

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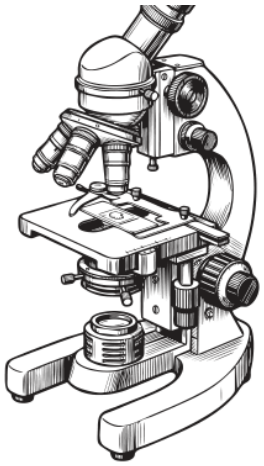
CHAPTER

# 1

# The Scientific Endeavour

TEST



## TEST SUMMARY

| Section A | Section B | Total |
|---|---|---|
| _____ / 20 | _____ / 32 | _____ / 52 |

## SECTION A MULTIPLE CHOICE QUESTIONS

There are twenty questions in this section. Answer ALL questions. For each question, there are four possible answers, A, B, C and D. Choose the one you consider correct and record your choice in the brackets provided.

**1** Which SI unit is **incorrectly** matched to its respective physical quantity?

| | length | mass | time |
|---|---|---|---|
| (A) | centimetre | gram | minute |
| (B) | centimetre | gram | second |
| (C) | metre | kilogram | minute |
| (D) | metre | kilogram | second |

(  )

**2** Which of the following is not an important value that makes a good scientist?

(A) grit
(B) perseverance
(C) resilience
(D) stubbornness

(  )

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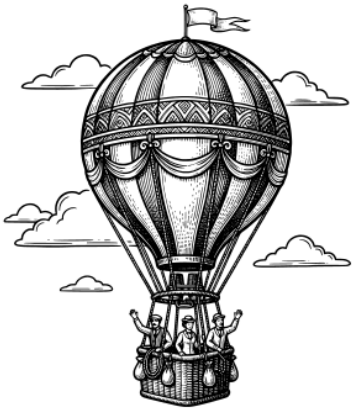
CHAPTER 7

# Model of Matter – The Particulate Nature of Matter

TEST



## TEST SUMMARY

| Section A | Section B | Total |
|---|---|---|
| _____ / 20 | _____ / 29 | _____ / 49 |

## SECTION A MULTIPLE CHOICE QUESTIONS

There are twenty questions in this section. Answer ALL questions. For each question, there are four possible answers, A, B, C and D. Choose the one you consider correct and record your choice in the brackets provided.

**1** Optional for G2

Which changes of state involve the gaining of heat?

$$\text{Solid} \underset{3}{\overset{1}{\rightleftharpoons}} \text{Liquid} \underset{4}{\overset{2}{\rightleftharpoons}} \text{Gas}$$

(A) 1 and 2
(B) 1 and 4
(C) 2 and 3
(D) 3 and 4 ( )

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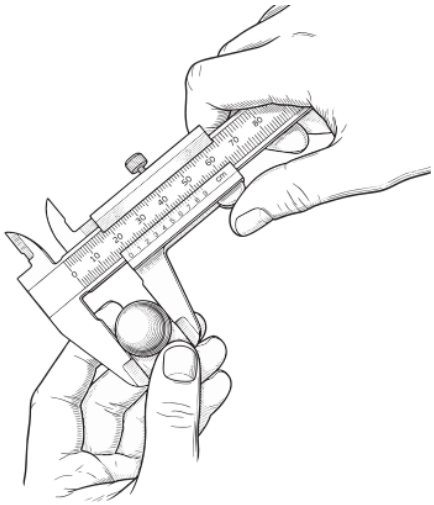
CHAPTER

# 2

# Exploring Diversity of Matter by Its Physical Properties

WORKSHEET 2



## SECTION A MULTIPLE CHOICE QUESTIONS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| D | D | D | B | A | C | A | A | C | B |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| B | B | D | B | A | D | D | D | D | B |

## SECTION A – Detailed Explanations

**1 D** **The correct answer is D because part D is the depth probe (the thin rod that extends from the end of the caliper's beam), which can be inserted straight down into the test tube to measure its internal depth directly.**

**A** is incorrect because part A is the upper (inside) jaws, used to measure internal diameters, not depth.

**B** is incorrect because part B is the lower (outside) jaws, used to measure external widths or diameters of objects.

**C** is incorrect because part C is the main scale/beam, which displays graduated markings and is not inserted into an object to measure depth.

**2 D** **The correct answer is D because block Y sinks in liquid Z, so block Y is denser than liquid Z, while block X floats in liquid Z, so block X is less dense than liquid Z. Liquid Z is therefore denser than block X but less dense than block Y.**

**A** is incorrect because block X floats and block Y sinks, so block X is less dense than block Y, not denser.

**B** is incorrect because block X floats on liquid Z, so block X is less dense than liquid Z, not denser.

**C** is incorrect because block X floats on liquid Z, so liquid Z is denser than block X, not less dense.

**3 D** **The correct answer is D because in the SI (International System of Units), the base unit for mass is the kilogram (kg) and the base unit for volume is the cubic metre ($m^3$).**

**A** is incorrect because grams (g) is not the SI unit for mass and $cm^3$ is not the SI unit for volume.

**B** is incorrect because grams (g) is not the SI unit for mass, even though $m^3$ is correct for volume.

**C** is incorrect because $cm^3$ is not the SI unit for volume, even though kg is correct for mass.

**4 B** **The correct answer is B because sodium is a metal, and metals have free electrons that can move easily through the material, allowing heat to be conducted very quickly, giving metals a high thermal conductivity.**

**A** is incorrect because glass is a non-metal solid that does not have free electrons, so it is a poor conductor of heat.

**C** is incorrect because chlorine is a non-metal gas, and gases are very poor conductors of heat as their particles are far apart.

**D** is incorrect because ceramics are non-metal materials that do not have free electrons, so they conduct heat poorly and are often used as insulators.

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CHAPTER

# 4

# Exploring Diversity of Matter using Separation Techniques

WORKSHEET 2


## SECTION A MULTIPLE CHOICE QUESTIONS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| D | D | C | D | B | A | C | C | D | C |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| C | D | C | C | B | D | B | C | C | C |

## SECTION A – Detailed Explanations

1 **D** **The correct answer is D because filtration separates an insoluble solid from a liquid by passing the mixture through filter paper; glass pieces do not dissolve in water, so they are trapped by the filter paper while the water passes through.**

**A** is incorrect because chromatography separates different dissolved substances (such as different coloured dyes) from one another, not a single solid dissolved in water like sugar and water, which would be separated by evaporation.

**B** is incorrect because distillation separates liquids with different boiling points or a dissolved solid from its solvent; steel and sand are both solids, so distillation cannot be used here.

**C** is incorrect because evaporation is used to separate a dissolved solid from a liquid solvent, not two liquids; alcohol and petroleum are two liquids with different boiling points and should be separated by distillation.

2 **D** **The correct answer is D because steel is magnetic and sand is non-magnetic, so a magnet will attract the steel and pull it away from the sand, separating the mixture.**

**A** is incorrect because neither copper nor sulfur is magnetic, so a magnet cannot attract either component.

**B** is incorrect because both iron and steel are magnetic, so a magnet would attract both components and cannot separate them from each other.

**C** is incorrect because neither sand nor pepper is magnetic, so a magnet cannot attract either component.

3 **C** **The correct answer is C because the white residue is the solid that did not dissolve and stayed on the filter paper, which must be white and insoluble – that is R. The blue filtrate is the solution that passed through the filter paper, meaning a blue solid dissolved in the water – that is Q (blue, soluble). So the mixture contained Q and R.**

**A** is incorrect because P is insoluble, so neither P nor R would dissolve; the filtrate would be colourless water, not blue.

**B** is incorrect because P is insoluble and blue, so P would remain as the residue on the filter paper, giving a blue residue, not a white one.

**D** is incorrect because both Q and S are soluble, so both would dissolve completely and no residue would be left on the filter paper.

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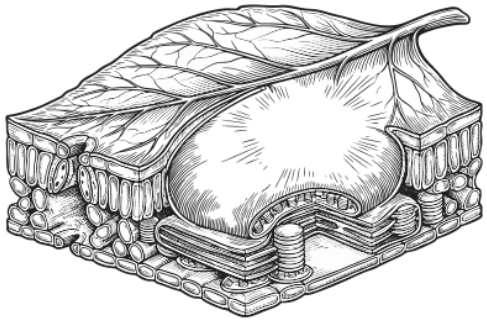
CHAPTER

# 6

# Model of Cells – The Basic Unit of Life

WORKSHEET 1



## SECTION A MULTIPLE CHOICE QUESTIONS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| A | A | D | B | C | A | B | B | C | D |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| B | A | B | C | A | B | B | A | D | D |

## SECTION A – Detailed Explanations

**1 A** **The correct answer is A because the correct order of organisation from simplest to most complex is cells → tissues → organs → systems; cells are the basic unit of life, groups of similar cells form tissues, groups of tissues form organs, and groups of organs working together form a system.**

**B** is incorrect because it places organs before tissues, but tissues are simpler than organs.

**C** is incorrect because it lists systems as the simplest, when systems are actually the most complex level.

**D** is incorrect because it places tissues as the simplest and cells in the middle, but cells are the simplest unit, not tissues.

**2 A** **The correct answer is A because blood is a tissue (a group of similar cells working together), not an organ; an organ is made up of different tissues working together to carry out a function.**

**B** is incorrect because a leaf is an organ made up of different tissues such as the epidermis and mesophyll tissue.

**C** is incorrect because a root is an organ made up of different tissues that work together to absorb water and minerals.

**D** is incorrect because the stomach is an organ made up of different tissues such as muscle tissue and lining tissue that work together to digest food.

**3 D** **The correct answer is D because the cell membrane is selectively permeable, meaning it allows only some substances to pass through in both directions – some substances can enter the cell and some substances can leave the cell.**

**A** is incorrect because it only mentions substances entering the cell, leaving out the fact that substances can also leave.

**B** is incorrect because it only mentions substances leaving the cell, leaving out the fact that substances can also enter.

**C** is incorrect because the cell membrane does not allow all substances to pass through freely; it controls which substances can enter and leave.

**4 B** **The correct answer is B because the cell membrane is a partially permeable layer that surrounds the cell and controls what substances can enter and leave the cell.**

**A** is incorrect because photosynthesis takes place in the chloroplast, not the cell membrane.

**C** is incorrect because energy is released in the mitochondria, not the cell membrane.

**D** is incorrect because chemical reactions take place in the cytoplasm, not the cell membrane.

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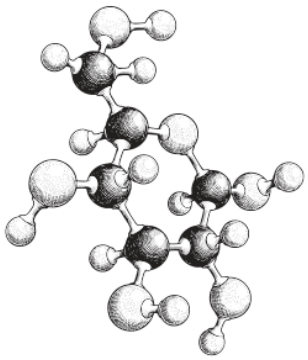
CHAPTER

# 8

# Model of Matter - Atoms and Molecules

TEST



## SECTION A MULTIPLE CHOICE QUESTIONS

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|
| C | C | D | B | B | D | B | B | B | C |

| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| A | A | B | B | D | C | A | D | C | C |

## SECTION A – Detailed Explanations

1 C **The correct answer is C because a neutron carries no electrical charge, so its relative charge is 0.**

**A** is the electron's relative charge, which is −1.

**B** is the electron's relative mass, which is very small (about 1/1840) and is usually described as negligible rather than exactly 0. Only C, the relative charge of the neutron, has a value of exactly 0.

**D** is the proton's relative charge, which is +1.

2 C **The correct answer is C because electrons are negatively charged and neutrons have no charge, so saying both are positively charged is incorrect.**

**A** is incorrect because a neutral atom always has an equal number of protons and electrons, making it electrically neutral.

**B** is incorrect because in the simple atomic model taught at this level, electrons are described as moving around the nucleus in fixed shells or orbits.

**D** is incorrect because protons and neutrons are indeed densely packed together in the nucleus at the centre of the atom.

3 D **The correct answer is D because the element with 12 protons is magnesium, which is a metal; it has 10 electrons, meaning it has lost 2 electrons (12 – 10 = 2), giving it a charge of 2+, so it is a positive ion.**

**A** is incorrect because a metal atom must have equal numbers of protons and electrons (both 12), but here there are only 10 electrons.

**B** is incorrect because a negative ion has more electrons than protons, but here there are fewer electrons (10) than protons (12).

**C** is incorrect because 12 protons identifies the element as magnesium, which is a metal, not a non-metal.

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- Physical saddle-stitched booklets delivered to your home

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