CHAPTER 1: SCIENTIFIC ENDEAVOUR

PRACTICES OF SCIENCE

1. Posing questions and defining problems
2. Planning investigations
3. Conducting investigations
4. Evaluating results
5. Communicating findings

2. Planning investigations

Variables

- **Changed** variable – ONE factor that is changed in the experiment
  - It is the variable being investigated.

- **Measured** variable – the factor that is measured / observed in the experiment.
  - It is the data being collected.

- **Controlled** variables – factors that are **kept constant** in the experiment to **ensure a fair experiment**.

*note: variables should be described precisely
e.g. using terms like "volume" or "mass" or "number" instead of "amount"

Hypotheses

- A **hypothesis** is a proposed explanation or prediction
  - It should show a **relationship** between the changed and measured variable.
  - *e.g.* the **greater** the <u>volume of water</u> given to the plant, the **taller** the <u>height of the plant</u>.

3. Conducting investigations

Measurements – measuring with scientific instruments

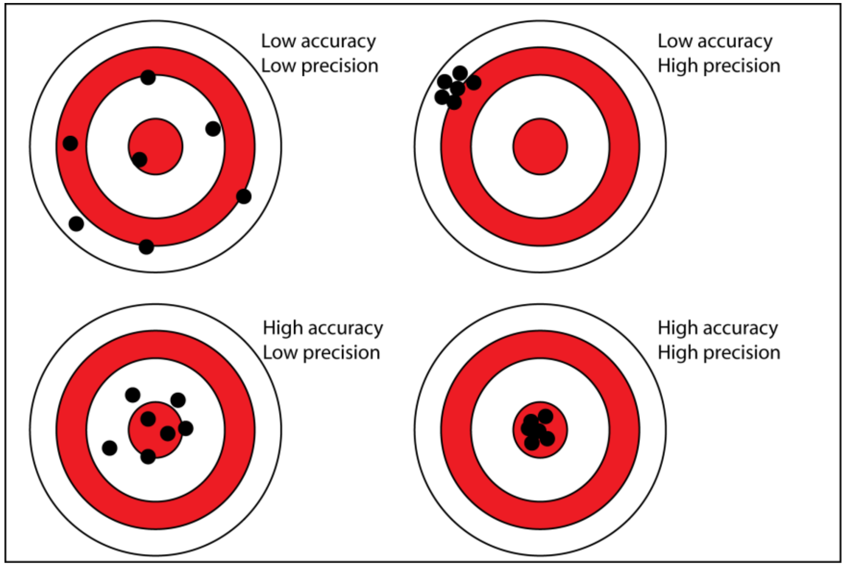
quantity	instrument	SI unit
mass	electronic balance	kilogram (kg)
time	digital stopwatch	second (s)
length	ruler digital calipers (*can be used for diameter and depth*)	metre (m)
temperature	thermometer	Kelvin (K)

* *other common laboratory apparatus are shown in the table in the next page.*

Precision and Accuracy

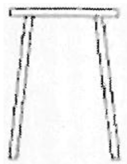
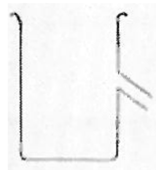
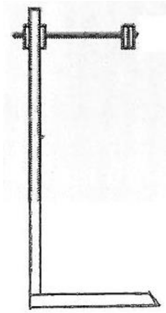
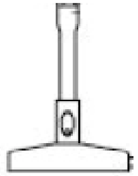
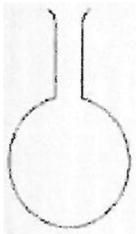
- <u>Accuracy</u>: how **close** the **measured value** is to the **true value** of the measured quantity.

- <u>Precision</u>: how **close measured values** from repeated measurements are **from each other**.



CHAPTER 1: SCIENTIFIC ENDEAVOUR

Measurements – measuring with scientific instruments (laboratory apparatus)

Apparatus	Use	Apparatus	Use	Apparatus	Use	Apparatus	Use
Test tube* 	• For containing or heating **small** amount of substances	Boiling tube* 	• For containing or heating **small** amount of substances	Tripod stand* 	• For supporting apparatus during heating	Displacement can 	• For displaced liquid to flow out through its spout
Beaker* 	• For containing chemicals or collecting liquids	Conical flask* 	• For containing chemicals or collecting liquids • It has a narrow neck to **decrease** the rate of evaporation of liquids.	Retort stand* 	• For supporting apparatus during experiments	Bunsen burner 	• For heating and boiling
Flat bottomed flask (FYI) 	• For containing chemicals when preparing gases if the process requires **no heating** (FYI)	Round-bottomed flask 	• For preparation of gases if the process **requires heating**	Wire gauze* xxxxxxxx	• To support apparatus during heating	Measuring cylinder 	• For measuring a volume of liquid to an accuracy of 0.5 cm^3
Evaporating dish* 	• For evaporating a liquid from a solution	Filter funnel* 	• For separating an **insoluble** solid from a liquid	Pipette 	• For measuring accurately a **<u>fixed</u>** volume of liquid to 1 decimal place (e.g. 25.0 cm^3)	Burette 	For measuring accurately a **<u>variable</u>** volume of liquid to 0.05 cm^3 precision. (e.g. 24.7 cm^3)

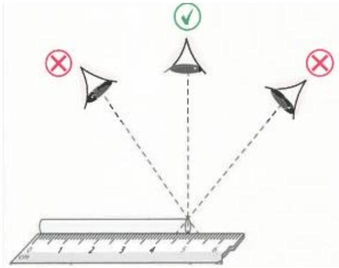
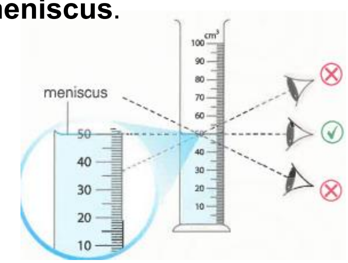
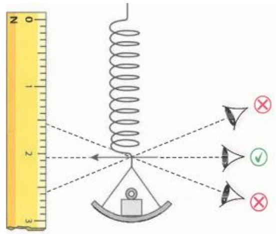
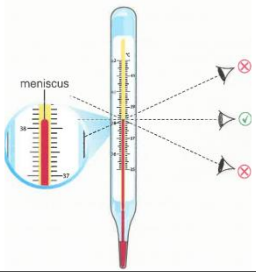
*required to draw

CHAPTER 1: SCIENTIFIC ENDEAVOUR

<u>3. Conducting investigations</u>

Measurements – Errors

1. Zero error: instrument gives a non-zero reading when the measured quantity is zero.
    - G3 Error can be prevented / solved by:
        - Pressing the "tare" button on an electronic instruments (e.g. electronic balance, digital calipers)
2. Parallax error: when markings on an instrument is viewed from the wrong angle.
    - G3 Error can be reduced by:

ruler: position the eye such that the line of sight is **perpendicular** to the **marking** on the ruler. 	measuring cylinder: position the eye so that the line of sight is aligned with **the bottom of the meniscus**. 
spring balance: position the eye such that the line of sight is **perpendicular** to the **marking** on the scale. 	thermometer: position the eye such that the line of sight is level with the **top of the meniscus**. 

<u>3. Conducting investigations</u>

Measurements – Errors

G3 Errors can be classified into two types:

1. Consistent errors
    - Errors that result in readings that are **consistently inaccurate**.
    - *E.g. using an electronic balance that has a zero error of +0.2 g → results will consistently be 0.2 g heavier than the actual mass.*
2. Unpredictable errors
    - Errors that cause imprecise measurements
    - Contributed by unpredictable environmental conditions.

<u>Data</u>

Quantitative data

- Results are in a **numerical** or **measurable** form.
- *e.g. height of a plant (1.0 cm, 2.0 cm, 3.0 cm)*

Qualitative data

- Results are based on the **five senses / observations**
- *e.g. colour of the coconut, smell of the flower*

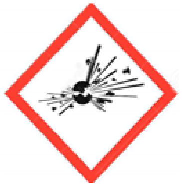
<u>Attitudes of Science</u>

- **Perseverance**: determination and unwillingness to give up even when facing difficulties or failures
- **Curiosity**: a strong desire to learn and seek out information to gain an understanding
- **Open-mindedness**: the willingness to explore different possibilities and ideas, even if it is not the norm
- **Objectivity**: to practice Science in an impartial manner, without influence from personal experiences and beliefs
- **Creativity**: to explore original and unconventional methods or solutions

  Integrity: being honest and upright; practising Science to further knowledge rather than for personal benefit

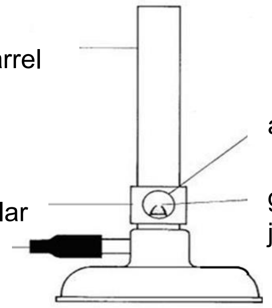
CHAPTER 1: SCIENTIFIC ENDEAVOUR

❑ Hazard symbols

 **Acute Toxicity**	 **Environmental Hazard**	 **Corrosive**
Can cause toxic or harmful effects to body when in contact	Has potential to cause harm to the environment	May cause severe damage on contact with body parts
 **Gases under pressure**	 **Explosives**	 **Flammable**
Stored in pressurized cylinders May explode when heated	May cause fire, explosion	Highly flammable May cause fire or produce poisonous gas when reacted with air, water or chemicals
 **Harmful/Irritant**	 **Carcinogenic**	 **Oxidising Substance**
Can lead to irritation allergic reactions Has harmful health effects Can cause harm to ozone layer	Can cause breathing difficulties Can cause infertility, birth defects, damage to organs or cancer	Releases oxygen easily which can cause fire

❑ Bunsen burner

Parts	Function
Collar	• To **control** the amount of air entering the Bunsen burner by opening or closing the air hole
Air hole	• To allow air to **enter** the Bunsen burner



❑ To light up the Bunsen burner

1. **Close** the air hole.
2. Turn on the gas tap fully.
3. Light the burner.
4. Open the air hole till you see a **2-tone blue flame**.

Luminous flame	Non-luminous flame
Orange colour	Blue colour
Unsteady	Steady
Hot	Very hot

* a non-luminous flame should be used for heating

Safe laboratory practices

1. Do not eat or drink in the laboratory.
2. Long hair should be tied back.
3. Ties should be removed.
4. Safety goggles should be worn when there is risk of injury to eyes.
5. Wash hands before leaving laboratory.
6. Do not play in the laboratory.
7. Report breakages to the teacher immediately. (Do not clean it up by yourself.)
8. Do not ingest chemicals
9. Do not eat or drink in the laboratory.
10. Long hair should be tied back.
11. Ties should be removed.
12. Safety goggles should be worn when there is risk of injury to eyes.
13. Wash hands before leaving laboratory.
14. Do not play in the laboratory.
15. Report breakages to the teacher immediately. (Do not clean it up by yourself.)
16. Do note ingest chemicals

CHAPTER 2: EXPLORING DIVERSITY OF MATTER BY ITS PHYSICAL PROPERTIES

- The **physical properties** of a material are qualities that can be observed and measured without changing its composition.

Physical Property	Explanation	Examples
*Strength	The ability to **support** a heavy load without changing its shape permanently	Steel is used to make bridges.
*Hardness	The resistance to wear and tear, and **scratches**	Diamond is the hardest material in the world and is used to cut stones.
*Flexibility	The ability to **bend** without breaking and **return** to its initial shape and size after bending	Nylon is used to make fishing rods.
Electrical conductivity	A measure of how easily an **electric current** passes through the material	Copper is used for electrical wires as it is a good **conductor of electricity**.
Thermal conductivity	A measure of how easily **heat** flows through the material	Iron is used to make cooking pots as it is a **good conductor of heat**.
Melting point	Temperature at which the material changes from **solid** state to **liquid** state	Most metals have **high** melting point and they exist as **solids**. Non-metals usually have **low** melting points and they exist as **liquids**.
Boiling point	Temperature at which the material changes from **liquid** state to **gaseous** state	Some non-metals have **low** boiling points and they exist as **gases**.
Density	**Mass** of a substance per unit **volume**	Wood is **less dense** than water because it floats on water. Iron is **denser** than water because it sinks in water.

CHAPTER 2: EXPLORING DIVERSITY OF MATTER BY ITS PHYSICAL PROPERTIES

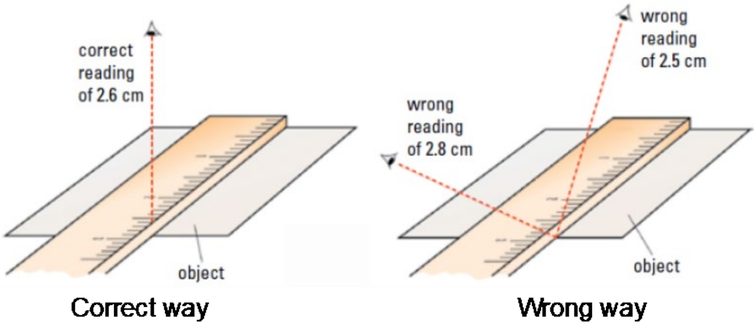
- Five main classes of materials, their physical properties, and uses are as follows:

Material	Physical Properties	Uses
Plastic	• Lightweight • Does not corrode • Low melting point • Can be moulded into shapes • **Poor** conductor of heat and electricity	• Plastic bags • Plastic food containers • Plastic electrical sockets
Glass	• Transparent • Fragile • High melting point • Can be moulded into shapes • **Poor** conductor of heat and electricity	• Window panes
Metal	• Shiny • Can be bent without breaking • Can be moulded into shapes • **Good** conductor of heat and electricity	• Aluminium drink cans • Copper electrical wires • Gold bangles
Ceramic	• Hard but fragile • **High** melting point • Can be moulded into shapes • **Poor** conductor of electricity	• Porcelain plates
Fibre	• Can be spun into threads and woven into fabrics • Able to absorb dyes • **Poor** conductor of heat and electricity	• Clothes

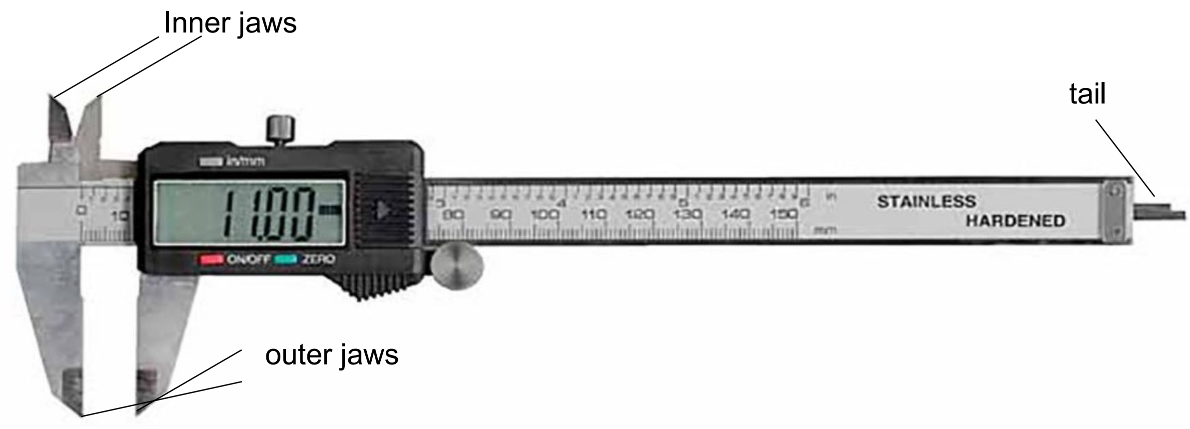
CHAPTER 2: EXPLORING DIVERSITY OF MATTER BY ITS PHYSICAL PROPERTIES

Measurement of Length

- The **SI unit** of length is the **metre (m)**.
  - 1 m = 100 cm = 1000 mm
  - 1 km = 1000 m
- To measure length, we can use **metre rule** (short lengths), **measuring tape** (longer lengths or lengths of curved surfaces) or **digital calipers** (short lengths and diameters of small objects)
- When using a metre rule to measure length, we need to place our eyes **vertically above** the metre rule in order to obtain a correct reading.
- Placing our eyes in the wrong position will lead to a **parallax error**, resulting in an inaccurate reading.



- Metre rule and the measuring tape → can measure lengths accurately up to **0.1 cm**.
- Digital calipers → can measure lengths accurately up to **0.01 cm**.
- The **inner and outer jaws** are used to measure the **internal and external diameters** of an object while its **tail** is used to measure the **depth** of an object.



CHAPTER 2: EXPLORING DIVERSITY OF MATTER BY ITS PHYSICAL PROPERTIES

Determination of Volume

- **Volume** is the amount of space an object occupies.
- The **SI unit** of volume is **cubic metre (m^3)**.
    - 1 m^3 = 1000000 cm^3
    - 1 ml = 1 cm^3

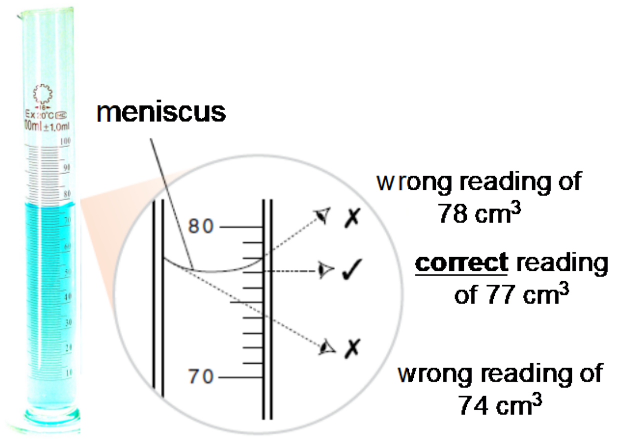
Measuring volume of regular solids

- For **regular** solids, we can use **<u>formulae</u>** to determine the volume. (*r* = radius, *h* = height)

Regular solids	Formula
Sphere	$\frac{4}{3}\pi r^3$
Cylinder	$\pi r^2 h$
Cone	$\frac{1}{3}\pi r^2 h$
Cube	length x breadth x height
Pyramid	$\frac{1}{3}$ x base area x height

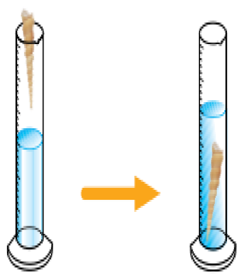
Measuring volume of liquids

- To determine the volume of **liquids**, we need to use a **measuring cylinder**.
- When taking a reading from a measuring cylinder, the eye must be at the same level as the **<u>bottom</u>** of the **meniscus** to help us avoid **parallax errors**.
- For mercury, the reading must be taken at the **top** of the meniscus.



*Measuring volume of irregular solids

- To determine the volume of **irregular** solids, we can fill up a measuring cylinder with a fixed volume of water (e.g. 60 cm^3) and lower the irregular solid into the measuring cylinder.
- The irregular solid will **displace** the water in the measuring cylinder.
- The volume of the irregular solid would be the **difference** in volume readings between the new volume obtained and the original volume of water.



- A **sinker** (with string) can be used to fully submerge irregular solids which floats on water.
- A **displacement can** that is filled with water can also is used to determine the volume of irregular solid if the object is too large to fit into a measuring cylinder.

CHAPTER 2: EXPLORING DIVERSITY OF MATTER BY ITS PHYSICAL PROPERTIES

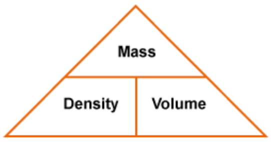
Measurement of Mass

- **Mass** is the amount of matter in an object.
- The **SI unit** of mass is the **kilogram (kg)**.
  - 1 kg = 1000 g
  - 1 g = 1000 mg
  - 1 tonne = 1000 kg
- To measure mass, we need to use the **electronic balance**.

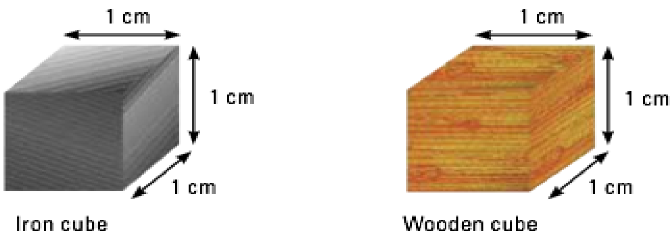
An electronic balance used in laboratories is easy to use and very accurate.

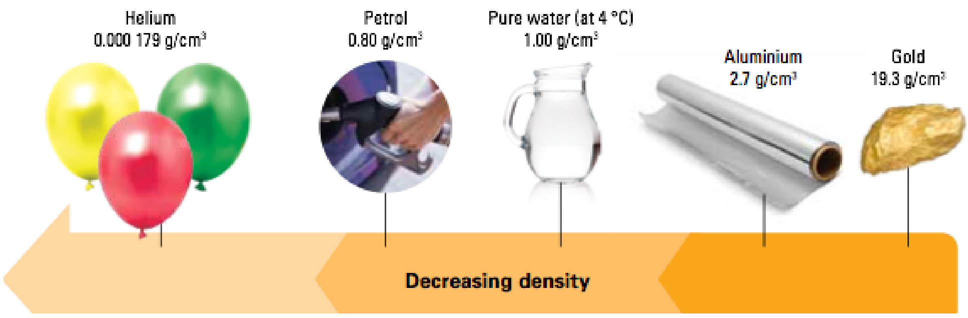
Determination of Density

- The **density** of a substance is the mass of the substance per unit volume.
- Density $= \dfrac{\text{mass}}{\text{volume}}$ $\qquad D = \dfrac{m}{V}$



- The **SI unit** of density is the **kilogram per cubic metre (kg/m^3)**.
- Density can also be expressed in g/cm^3
- For the same mass, the density will be **lower** if the volume of the substance is **higher**.
- For the same volume, the density will be **higher** if the mass of the substance is **higher**.

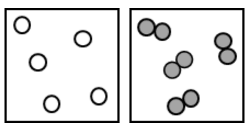
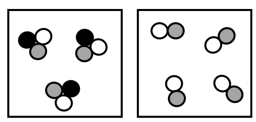
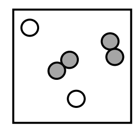
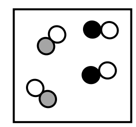
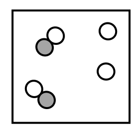




Why do objects float or sink?

- Object **A** will **<u>float</u>** on Liquid **B** if its density is **lesser** than that of Liquid **B**.
- Object **C** will **<u>sink</u>** in Liquid **B** if its density is **higher** than that of Liquid **B**.
- For example:
  - Oil is **less dense** than water. Hence, oil **floats** on water.
  - Helium is **less dense** than air. Hence, modern airships are filled with helium gas so that they can **rise** into the air.
  - The steel hull of a ship is hollow and contains a lot of air. Hence, the density of the ship becomes **less** than the density of seawater, allowing it to **float** on seawater.

CHAPTER 3 - EXPLORING DIVERSITY OF MATTER BY ITS CHEMICAL COMPOSITION

	ELEMENTS	COMPOUND	MIXTURE
Definition	Basic building blocks of matter.	A compound consists of **two or more elements** that are **chemically combined**.	A mixture consists of **two or more** elements and/or compounds that are **NOT chemically combined**.
Composition	Only one element	Two or more elements that are chemically combined	Two or more elements/compounds, not chemically combined.
Proportion of constituents	-	Fixed composition of constituents.	No fixed composition of constituents.
Properties of constituents	-	Has different properties from its constituents.	Has similar properties to its constituents.
Separation of constituents	Cannot be broken down into simpler substances.	Cannot be separated by physical means.	Can be easily separated by physical means
Examples	Oxygen (O_2), iron (Fe), nitrogen (N_2)	Water (H_2O), carbon dioxide (CO_2), sodium chloride (NaC*l*), ammonia (NH_3)	air, salt solution, sea water, fuel, milk, steel, brass, coffee
			 Mixture of elements  Mixture of compounds  Mixture of elements and compounds

The Periodic Table of Elements

Key: proton (atomic) number / atomic symbol / name / relative atomic mass

← metal | non-metal →

	Group 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
period 1								1 H hydrogen 1										2 He helium 4
period 2	3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
period 3	11 Na sodium 23	12 Mg magnesium 24											13 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* chlorine 35.5	18 Ar argon 40
period 4	19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
period 5	37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
period 6	55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 T*l* thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
period 7	87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 F*l* flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

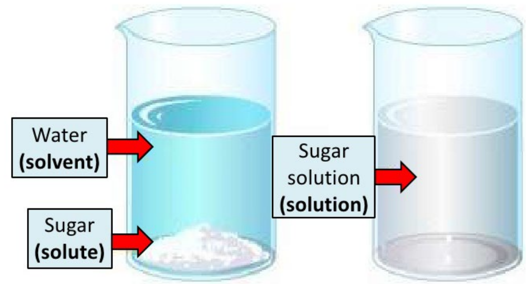
lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

CHAPTER 3 - EXPLORING DIVERSITY OF MATTER BY ITS CHEMICAL COMPOSITION

Solutions and Suspensions

Solutions

- <u>Solution</u>: a **mixture** in which a **solute** dissolves completely in a **solvent**.
- <u>Solute</u>: the **substance that dissolves** in a liquid (the solvent).
- <u>Solvent</u>: the **liquid** in which solutes are dissolved in.



Factors affecting rate of dissolving

1. Size of solute particles
    - The smaller the size of the solute particles, the higher the rate of dissolving
2. Temperature of solvent
    - The higher the temperature of the solvent, the higher the rate of dissolving
3. Rate of stirring
    - The higher the rate of stirring, the higher the rate of dissolving

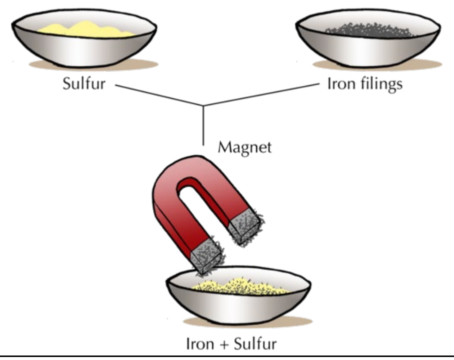
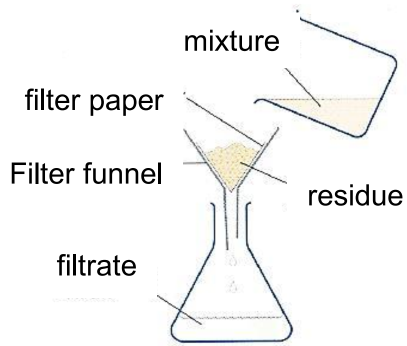
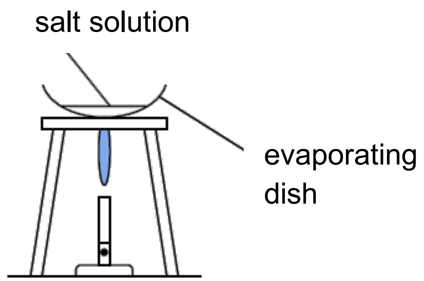
Solubility[G3]: the mass of **solute** that can **dissolve** in a **fixed volume of solvent** at a particular temperature.

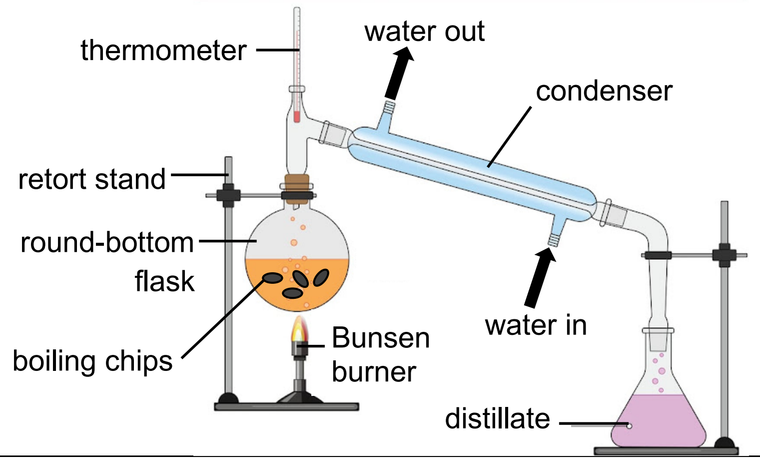
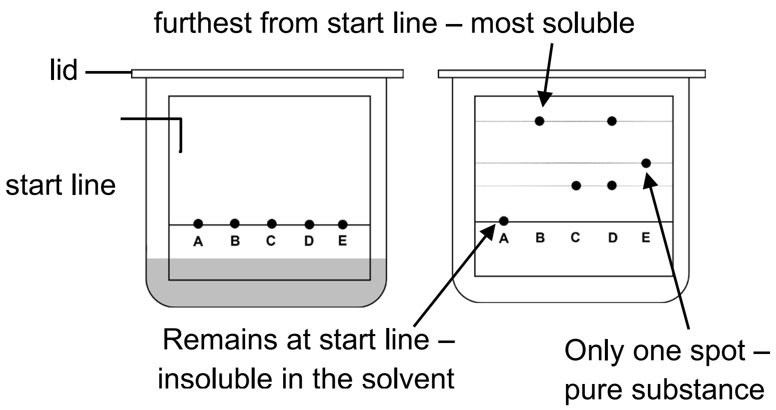
- Factors affecting solubility:
    1. Type of solute
    2. Type of solvent

Suspension: a mixture that contains **insoluble substances** in a solvent.

Solutions	**Suspensions**
• Particles of solute are fully dissolved and cannot be seen.	• Insoluble substances can be seen
• Light can pass through <u>fully</u>	• Light cannot pass through <u>fully</u>
• E.g. salt solution, sugar solution, mineral water, soda water etc.	• E.g. muddy water, waste water, calamine solution etc.

CHAPTER 4: EXPLORING DIVERSITY OF MATTER USING SEPARATION TECHNIQUES

Technique	Magnetic Separation	Filtration	Evaporation to Dryness
Experimental Set-up *(add your own labels)*			
Applications	Recycling of metals from waste, sorting scrap metal	Straining tea, water filtration, filtering of pollutants in airways	Production of salt, production of dried herbs/food
Separates…	Magnetic and non-magnetic materials	Insoluble solid – liquid mixture (e.g. sand and water)	Soluble solid – liquid mixture (e.g. salt solution)
Physical Property…	Magnetic (able to be attracted by magnet) - e.g. Steel, Iron, Nickel, and Cobalt	Size of particles	Boiling point of solvent
Describe the steps to obtain the desired product	1. Place a **magnet** near the mixture of materials. 2. **Magnetic** materials will be attracted by the magnet, leaving behind the **non-magnetic** materials.	1. Pour mixture through filter paper and funnel 2. **Solid** will be collected as the **residue** on the filter paper 3. **Liquid** will be collected as **filtrate** in the beaker/conical flask.	1. Heat the solution until all liquid has **evaporated**. 2. Solid will be left behind as a **residue** .

Technique	**Simple Distillation**	**Paper Chromatography**
Experimental Set-up		
Applications	Making perfumes, producing distilled water, making food colourings and obtaining drinking water from seawater.	Urine drug test, detecting pollutants, identifying colours in dyes
Separates…	Soluble solid – liquid mixture (e.g. seawater)	e.g. food colourings, dyes
Physical Property…	Boiling point of solvent	Different solubilities in the same solvent
Explanation on set-up	- Bulb of thermometer should be placed at the **mouth** of **condenser** to **measure the temperature of vapour entering the condenser / the boiling point of the distillate** - The condenser **provides a cool environment to condense** hot **vapour into liquid**, - Cold water enters the **bottom** of condenser and leaves from **the top to provide a cool environment for maximum condensation.** - Boiling chips: to ensure **smooth boiling**	- Start line is drawn in **pencil** ○ Pen ink is made up of a **mixture of dyes** that will **interfere with the results** - Solvent should be **below the start line** to **prevent** the samples from **dissolving in the solvent before the start of the experiment**. - Most soluble component will travel up the chromatogram **the furthest and fastest.**

Four National Taps of Singapore

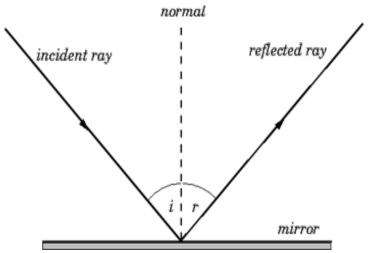
1. Water from local catchments
2. Imported water from Malaysia
3. NEWater
4. Desalination

CHAPTER 5: RAY MODEL OF LIGHT

- ✓ **Luminous** objects give out light to our eyes. Examples: Sun, fire, lamp.
- ✓ **Non-luminous** objects reflect light into our eyes. Examples: Moon, tree, book.

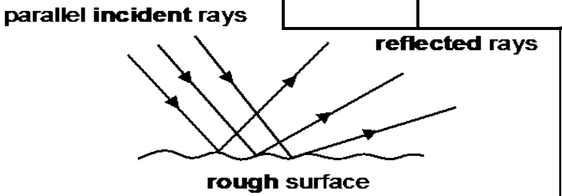
- ✓ A light ray can be represented by drawing a **straight line** with an **arrow**. The arrow indicates the **direction** of the light ray
- ✓ Light travels in straight lines.

	Plane mirror	Convex mirror	Concave mirror
Image formed	Upright, same size	Upright, smaller (diminished)	Upright, bigger (magnified)
Area Seen	Same	Wide field of vision	Narrow field of vision
Uses	Periscope	Rear-view mirror, blind corners	Dentist's mirror, microscope

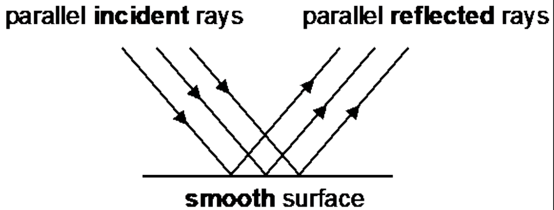


- **Reflection** is the bouncing of light rays off a surface.
- The angle of incidence (*i*) is **equal** to the angle of reflection (*r*).

__Diffuse reflection__:

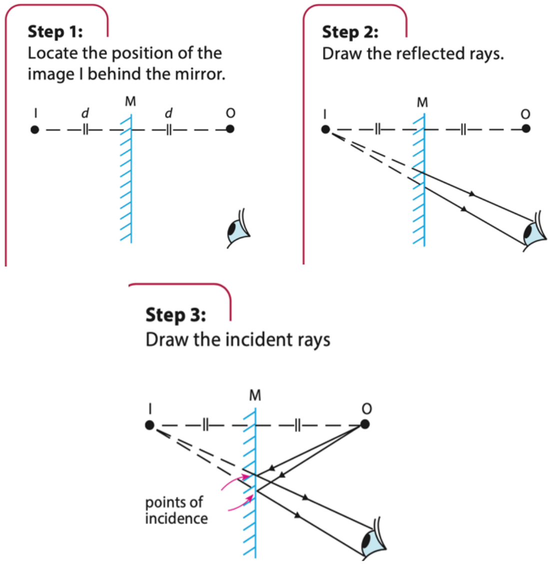


__Regular reflection:__



__Characteristics of an image formed by a mirror__

- The image is **upright**.
- The image is **virtual**.
- The image is **laterally inverted**.
- The image is of the **same size** as the object.
- The **distance** between the **object and the mirror** is the **same** as the distance between the **image and the mirror**.



How to draw ray diagram for reflection of light?

1. Use a ruler to measure the perpendicular distance from object to mirror. Measure the same distance from mirror to image. Locate image. Draw the image in dotted lines.
2. Draw the reflected ray from the image to the eye. Draw an arrow pointing to the eye.
3. Draw the incident ray from the object to the point where light is incident on mirror. Draw an arrow pointing to the mirror.
Note: All rays and images behind mirror are virtual (dotted).

CHAPTER 5: RAY MODEL OF LIGHT

*

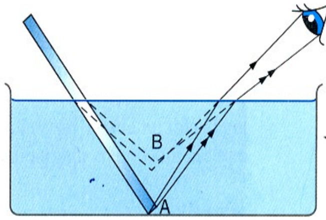
- ✓ Refraction is the <u>**bending**</u> of light as it **changes speed** when it travels from one medium to another of a **different optical density**.
- ✓ **Solids** have the <u>**highest**</u> optical density, followed by liquids and then gases.

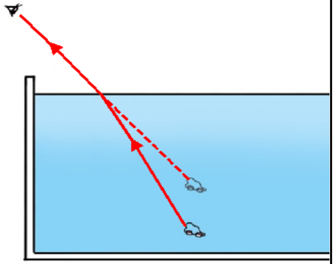
*

- ❑ Light travels from optically **less** dense to optically **denser** medium → speed of light **decreases** → light bends **towards** normal
- ❑ Light travels from optically **denser** to optically **less dense** medium → speed of light **increases** → light bends **away from** normal

*

- ❑ **Refraction** causes a drinking straw to appear **bent**, shifted and magnified.
- ❑ Refraction causes an object to appear <u>**nearer**</u> to the water surface.pp





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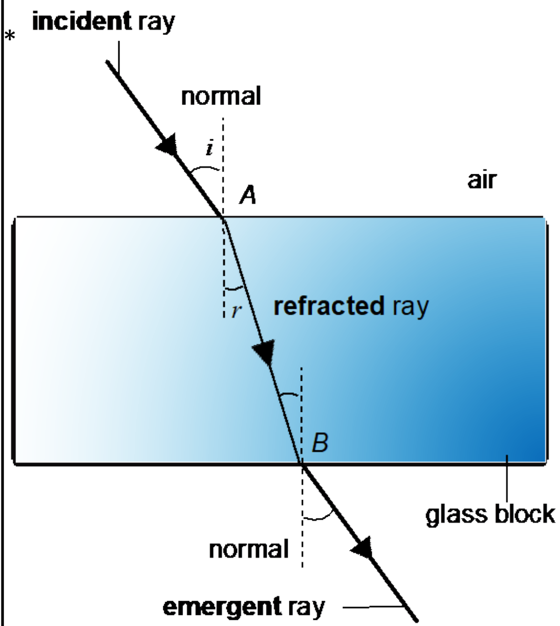
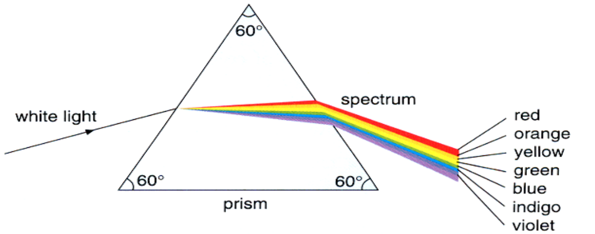


i = angle of incidence
r = angle of refraction

*

- ❑ Dispersion of light: the different colours of white light slow down at different extents and <u>**bend towards**</u> the normal at **different angles** when entering and leaving the prism.



Harmful effects of light:

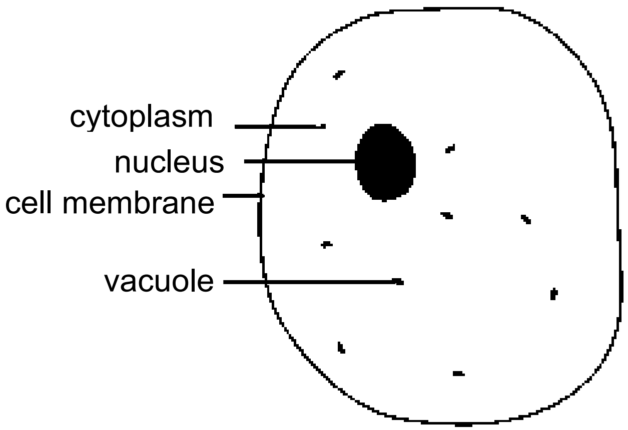
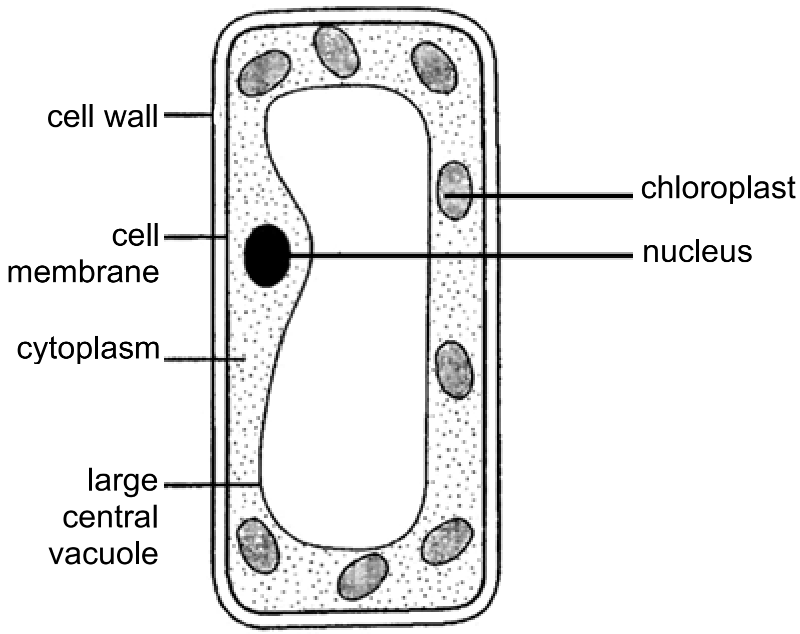
- Light pollution – affects living things on their daily activities such as sleeping, searching for food,
- disorientation of birds
- use a lot of electricity

Electromagnetic (EM) Radiation

Radiation	Application	Harmful effect
Infrared radiation (heat)	Thermal imaging camera	climate change
Visible light	Vision Plant photosynthesis	can cause light pollution
Ultraviolet radiation	produce vitamin D / Sterilisation	can harm eyes and cause skin cancer

CHAPTER 6: MODEL OF CELLS – THE BASIC UNITS OF LIFE

Animal vs Plant Cells

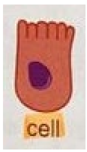
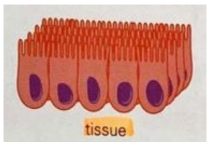
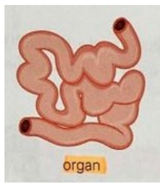
	Typical Animal Cell	Typical plant cell
Drawing		
Presence of cell wall	Cell wall is absent	Cell wall is present
Presence of chloroplast	Chloroplasts are absent	Chloroplasts are present
Vacuoles	Many small vacuoles are present.	One/few large central vacuole

CHAPTER 6: MODEL OF CELLS – THE BASIC UNITS OF LIFE

Functions and characteristics of cell structures

Cell structure	Function	Key characteristics
Cell membrane	Controls the movement of substances into and out of a cell	Partially permeable
Cytoplasm	Site where most chemical reactions take place	-
Nucleus	Controls all activities that occur within the cell	Contains genetic material (DNA) that can be passed down to the next generation
Vacuole	Stores liquids, food and waste materials	-
Cell wall	Protects and supports the cell	Fully permeable
Chloroplast	Allows photosynthesis to take place	Contains chlorophyll

Cellular organisation

	Cell	Tissue	Organ	System	Organism
Description	Basic building block of life.	Cells of the same type form a tissue and perform a specific function	An organ is formed from different tissues that perform a specific functions.	A system is formed many different organs that perform a specific function..	Several different systems make up an organism.
Examples	Intestinal epithelial cell 	Intestinal epithelium (wall) 	Intestine 	Digestive system 	Human 

Division of labour

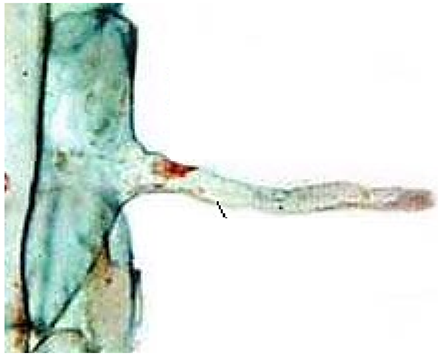
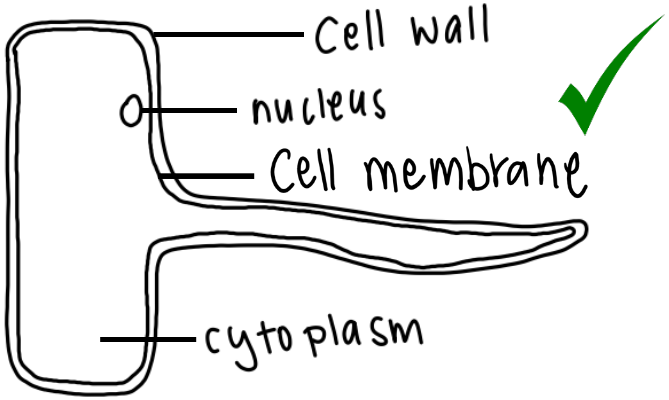
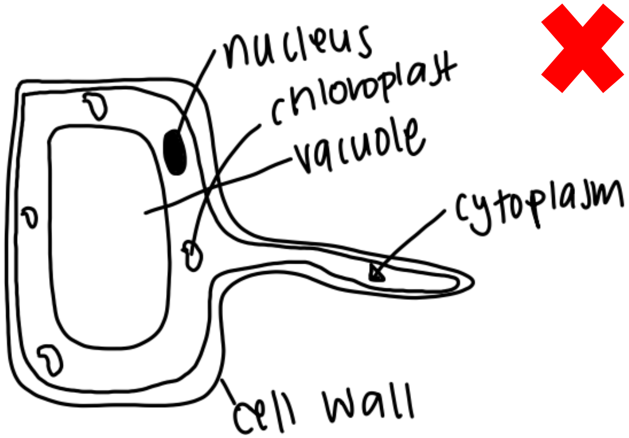
1) In a multicellular organism: different parts of the organism perform various functions in a coordinated way.

2) At a cellular level: different parts of a cell perform different functions in a coordinated way.

⇨ Allows for the organism / cell to function effectively and efficiently

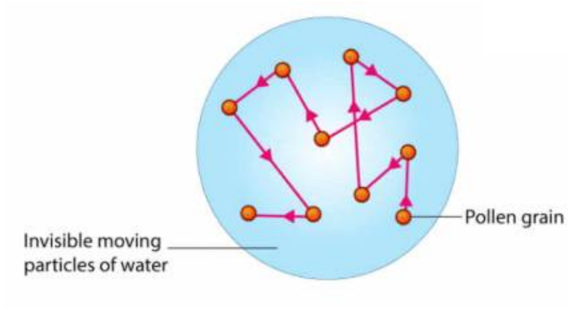
Cell drawing checklist

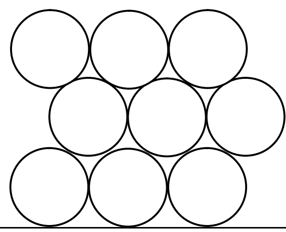
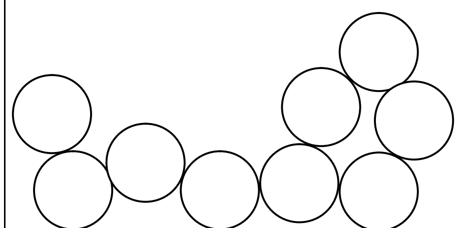
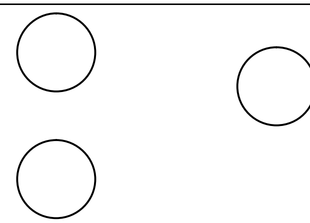
General drawing skills	
Drawing consists of smooth and clean lines	
Drawing is done using a pencil	
Drawing does not have any shading	
Drawing occupies at least half to three quarters of the space provided.	
Drawing does not spill out of the space provided.	
Labels	
Label lines are drawn with a ruler	
Label lines do not have arrowheads	
Label lines cut across as little of the drawing as possible	
Label lines do not intersect	
Label lines are drawn horizontally	
Labels are written next to the label lines	
Accuracy	
Cell structures in the drawing are proportional in size (e.g. thickness of cell wall matches what is shown)	
Shapes of cell structures in the drawing are accurate	
Drawing only contains cell structures that are shown in the micrograph / diagram.	

micrograph	
drawing 1	
drawing 2	

CHAPTER 7: PARTICULATE NATURE OF MATTER

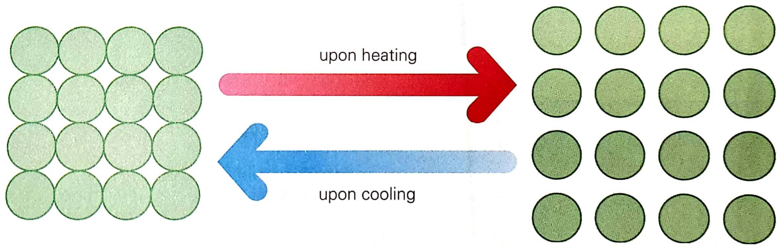
- All matter is made up of small discrete particles in **constant, random motion.**
  - *e.g.* movement of pollen grains in a dish of water: water particles are in constant and random motion, and collide with the pollen grain. This causes pollen grains to move.
  - *e.g.* 'dancing' dust: air particles are in constant and random motion, and collide with the dust. This causes the dust to move.



	SOLIDS	**LIQUIDS**	**GASES**
Arrangement of particles	▪ **Very closely packed** ▪ **Orderly** arrangement	▪ **Closely packed** ▪ **Disorderly** arrangement	▪ **Far apart** ▪ **Disorderly** arrangement
Movement of particles	▪ **Vibrate** and rotate about their fixed positions	▪ Move **randomly** ▪ **Slide past** each other	▪ Move **randomly** and **quickly** in any direction
Forces of attraction between particles	▪ Very strong	▪ Strong	▪ Weak
Diagram			
Physical Properties	▪ Has a definite volume ▪ Has a definite shape ▪ Cannot be compressed	▪ Has a definite volume ▪ Has no definite shape ▪ Cannot be compressed	▪ Has no definite volume ▪ Has no definite shape ▪ Can be compressed

CHAPTER 7: PARTICULATE NATURE OF MATTER

Expansion and Contraction



During cooling:	During heating:
• particles lose energy and vibrate less vigorously • distance between particles decrease • volume of substance decreases • **Contraction** occurs	• particles gain energy and vibrate more vigorously • distance between particles increase • volume of substance increase • **Expansion** occurs

The following **do not change** during expansion and contraction:

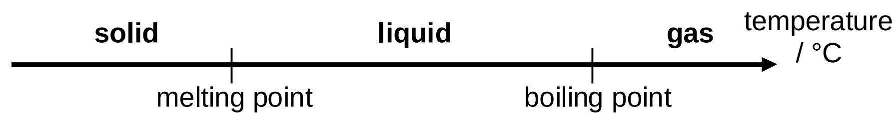
- Size of particles
- Number of particles
- Mass of substance
  ⇨ Mass is conserved
  ⇨

Diffusion

Diffusion is the net movement of particles from a region of higher concentration to a region of lower concentration.

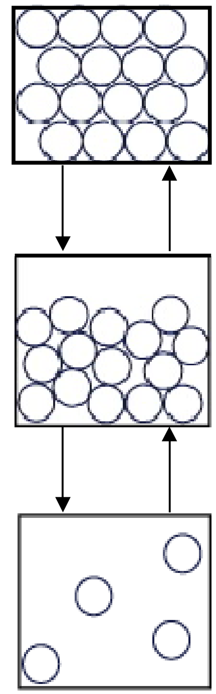
Examples:
- Tea particles diffusing from the tea bag to the surrounding water
- Helium gas particles diffusing out of balloon to the surrounding air
- Perfume particles diffusing and spreading out in a room

* Change of state



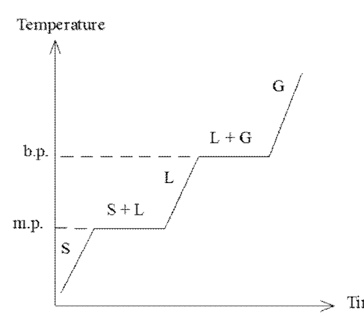
Melting
- Particles gain energy and vibrate faster at fixed positions
- They eventually gain enough energy to overcome the very strong forces of attraction between them, becoming a liquid

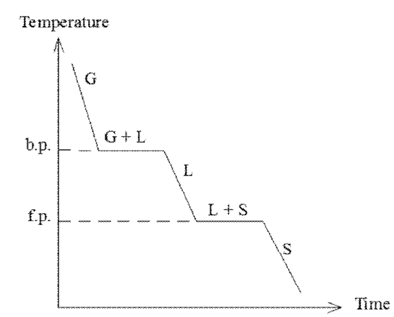
Boiling
- Particles gain energy and move faster and further apart
- They eventually gain enough energy to overcome the strong forces of attraction between them, becoming a gas



Freezing
- Particles lose energy and move slower.
- This causes the particles to be pulled closer to one another by the forces of attraction between them, forming a solid.

Condensation
- Particles lose energy and move slower.
- This causes the particles to be pulled closer to one another by the forces of attraction between them, forming a liquid.



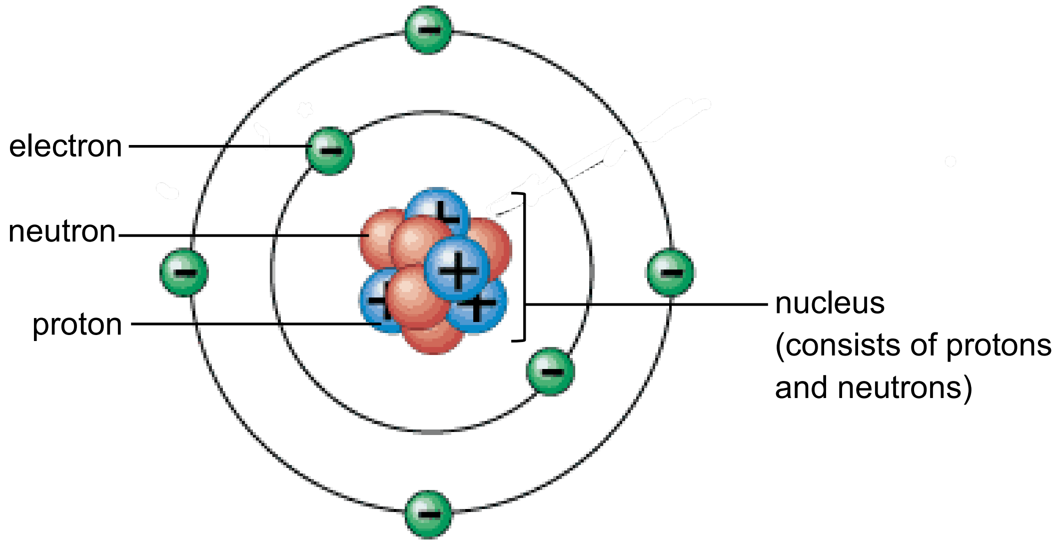


During change of state, temperature remains constant.

CHAPTER 8: MODEL OF MATTER – ATOMS AND MOLECULES

Atoms

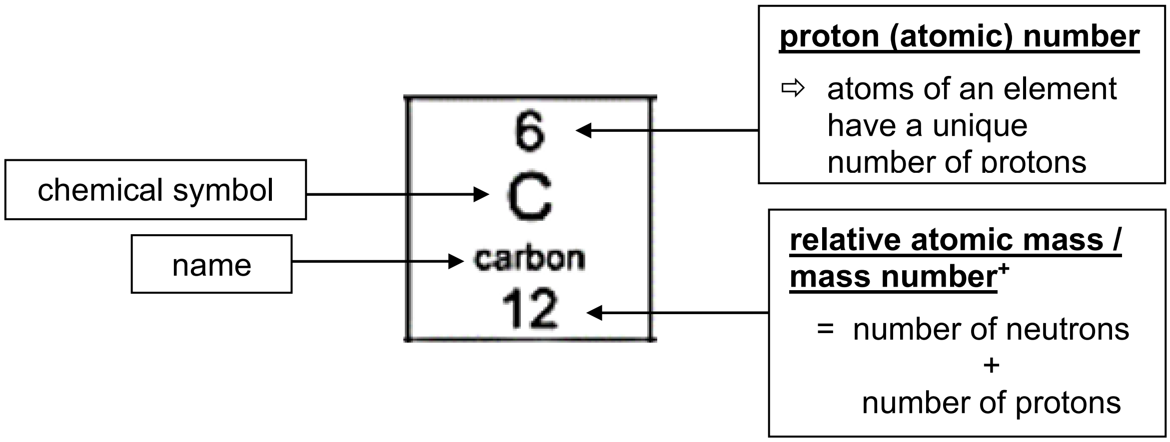
- An atom is the smallest unit of an element.
- It consists of **protons**, **neutrons**, and **electrons**.



	Relative mass	Relative charge	Position
protons	1	+1	Within nucleus
neutrons	1	0	Within nucleus
electrons	$\frac{1}{1840}$	-1	Around nucleus

- Atoms are **electrically neutral** (overall charge = 0)
  - As the **number of protons = number of electrons**.
  - Hence, the **positive charges** are **balanced** with the **negative charges**.

- The Periodic Table provides information about the atom of various elements
.

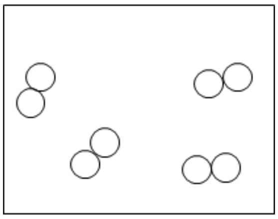
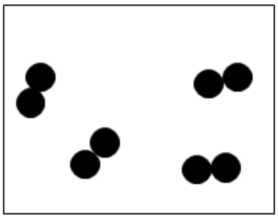
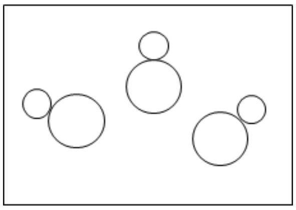
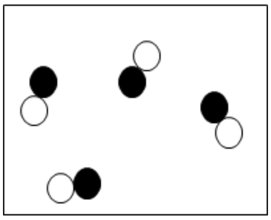


⁺ the mass of an atom is mainly contributed by the mass of the nucleus

CHAPTER 8: MODEL OF MATTER – ATOMS AND MOLECULES

Molecules

A molecule is a group of two or more atoms that are chemically combined.

An **element** is a pure substance that cannot be broken down into any simpler substances by chemical methods.	A **compound** is a substance made up of two or more different elements chemically combined.
Molecules of elements consist of one type of atom only.  	**Molecules of compounds** consist of more than one type of atom.  

Chemical formula

A **chemical formula** of a molecule shows the number and types of atoms contained in it. For example, the chemical formula of water is H_2O. This means that in a molecule of water, there are two hydrogen atoms and one oxygen atom.

- *e.g.* CO_2 → 1 carbon atom, 2 oxygen atom
- *e.*g. NaOH → 1 sodium atom, 1 oxygen atom, 1 hydrogen atom