Chpt 2 – Physical Properties of Matter *in 2 Pages*

CONCEPT FIRST — Your Physics Tuition Specialist

Focus 1: Physical Quantities

Physical Quantities

- A physical quantity consists of a numerical magnitude and **unit** (e.g. 25 **ms^{-1}**).
- A physical quantity of an object can be measured directly with a measuring instrument.
- There are 7 Base Quantities:

Base Quantity	Name of SI Unit	SI Unit
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Current	ampere	A
Amount of Substance	mole	mol

Prefixes for SI Units

Name	Factor	Symbol
giga	10^9	G
mega	10^6	*M*
kilo	10^3	*k*
deci	10^{-1}	*d*
centi	10^{-2}	*c*
milli	10^{-3}	*m*
micro	10^{-6}	*μ*
nano	10^{-9}	n

E.g. 3215 **k**g = 3125 x **10^3** g = 3125000 g or 3.125 x **10^6** g
700 **n**m = 700 x **10^{-9}** m = 0.000000700 m or 7.00 x **10^7** m
0.000032 s = 32 x **10^{-6}** s = 32 **μ**s

Conversion of Units

(a) kg and g

kg ⟶ (x 10^3) g ; g ⟶ (÷ 10^3) kg

E.g. 2.1 kg = 2100 g

(b) mg and g

mg ⟶ (÷ 10^3) g ; g ⟶ (x 10^3) mg

E.g. 25 g = 25000 mg

(c) ms^{-1} and kmh^{-1}

ms^{-1} ⟶ (x 3.6) kmh^{-1} ; kmh^{-1} ⟶ (÷ 3.6) ms^{-1}

E.g. 20 ms^{-1} = 72 kmh^{-1}

(d) gcm^{-3} and kgm^{-3}

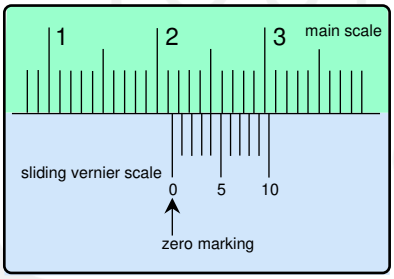
gcm^{-3} ⟶ (x 10^3) kgm^{-3} ; kgm^{-3} ⟶ (÷ 10^3) gcm^{-3}

E.g. 7900 kgm^{-3} = 7.9 gcm^{-3}

Measurement of Physical Quantities

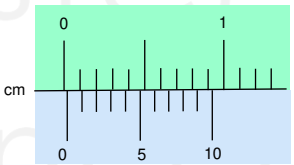
	Length	Mass	Volume	Time	Temperature
SI unit	metre (m)	kilogram (kg)	cubic metre (m^3)	seconds (s)	Kelvin (K)
Measuring instruments	measuring tape, metre rule, vernier calipers	beam balance or an electronic balance.	Liquid: beaker, measuring cylinder, pipette, burette, and volumetric flask. Gas: gas syringe	analogue stopwatch and digital stopwatch.	thermometer
Other common units	centimetre (cm), millimetres (mm)	grams (g), tonne	cubic centimetres (cm^3), millilitres (mℓ), litres (ℓ)	minutes, hours, years	degree Celsius (°C) and degree Fahrenheit (°F)

Vernier Calipers



How to Read
Main scale reading is **2.1** cm. The **4**th marking on the sliding vernier scale is aligned with the marking on the main scale. Therefore, reading is **2.1 + 0.04 = 2.14** cm

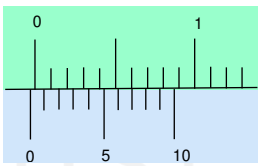
Positive Zero Error:



Zero error = +0.02 cm

Corrected Reading
= L - (+0.02)

Negative Zero Error:



Zero error = -0.03 cm
(read from the 10, leftward)

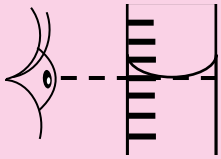
Corrected Reading
= L - (-0.02)

Volume of Regular Solids

Cuboid	Cylinder	Sphere
Volume of cuboid = lwh	Volume of cylinder = $\pi r^2 h$	Volume of sphere = $\frac{4}{3}\pi r^3$

Parallax Error

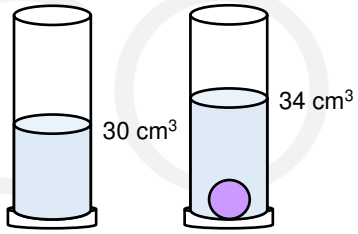
To avoid parallax error, position eye at the same level as the bottom of the meniscus and ensure that there are no air bubbles in the liquid.



Volume of Irregular Solids

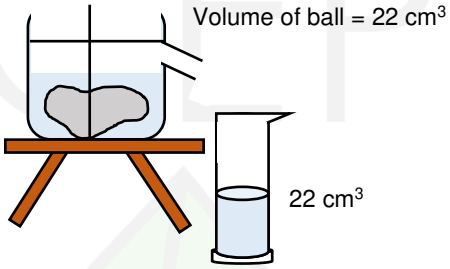
- For the volume of irregular solids, we would have to take the difference between the total volume of the object and water and the volume of the object.

1



Volume of ball = 34 – 30
= 4 cm^3

2 Displacement can method:
the solid must be bigger than the diameter of the measuring cylinder



Focus 2: Science in the Laboratory

Classification of Matter and Physical Properties

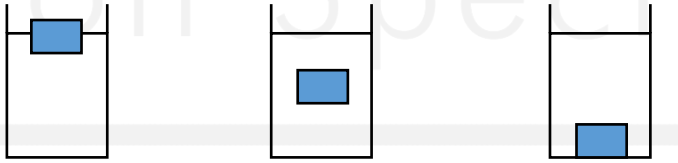
- A physical property is intrinsic to an object and can also be measured but not directly with a measuring instrument.
- A physical property that can be measured with a numerical magnitude and unit is a physical quantity.
- An example of a physical property but not a physical quantity is colour.

Material	Examples	Physical Properties
Plastic	• Plastic bags • Plastic food containers • Plastic electrical socket	• Flexible • Low density • Strong • Poor conductor of heat and electricity
Glass	• Glass window panes	• Not flexible • High density • Poor conductor of heat and electricity
Metal	• Aluminium drink cans • Copper electrical wires • Gold jewelry	• Hard • Good conductor of heat and electricity • Can be bent without breaking

Density

- The density of a substance is its mass per unit volume.
- SI unit: **kilogram per cubic metre (kg/m^3)**
- Other common units : gram per cubic centimetre (g cm^{-3})
- Different materials have different densities – A material would float on a liquid of a greater density and a material would sink in a liquid of a lower density.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$



Float
($\rho_{solid} < \rho_{liquid}$)

Suspended
($\rho_{solid} \approx \rho_{liquid}$)

Sink
($\rho_{solid} > \rho_{liquid}$)

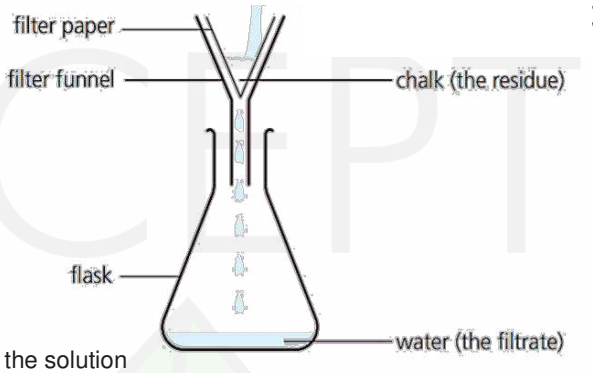
Focus 1: Separating mixtures

Methods of Separation in a Mixture

1. Magnetic Attraction

- Magnetic attraction is used to separate magnetic substances from non-magnetic substances
- Can only be used when one solid is a magnetic material while the other is a non-magnetic material
  - Magnetic materials: zinc, iron, nickel, and cobalt

2. Filtration



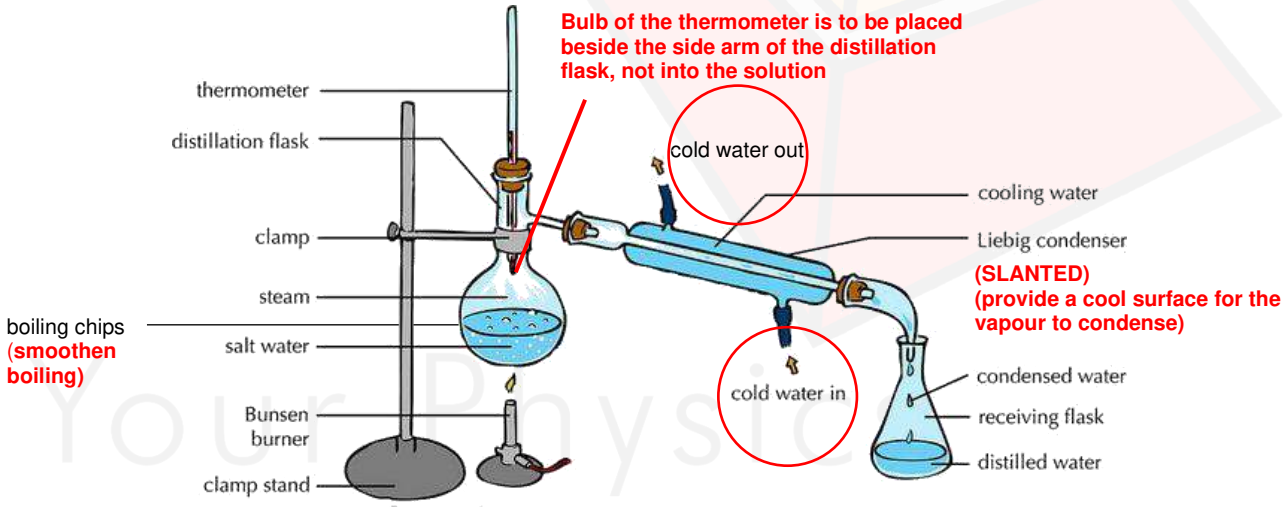
- Separate insoluble solids from liquids
- Mixture of substances with Different Particle Sizes
- Insoluble solid particles on the filter paper are called **residue** while liquid that passes through the filter paper into the beaker is called the **filtrate**

3. Evaporation

- Separating solute from solution to obtain a **solid**
- The **solute** is usually a **solid**, while the **solvent** is a **liquid**.
- The solute must not decompose on strong heating to evaporate the solution
  - Upon heating, the solvent changes from liquid to gas at a much lower temperature than the solute, leaving behind the solute as the residue

4. Distillation

- Separate solution from solute to obtain **a pure liquid**
- During the experiment, **boiling** and **condensation** are involved in this method
- At the end of the experiment, pure liquid would be obtained as a distillate, and the solid residue would be left behind in the boiling flask



5. Chromatography

- Chromatography helps to separate small samples of liquids or dissolved substances.

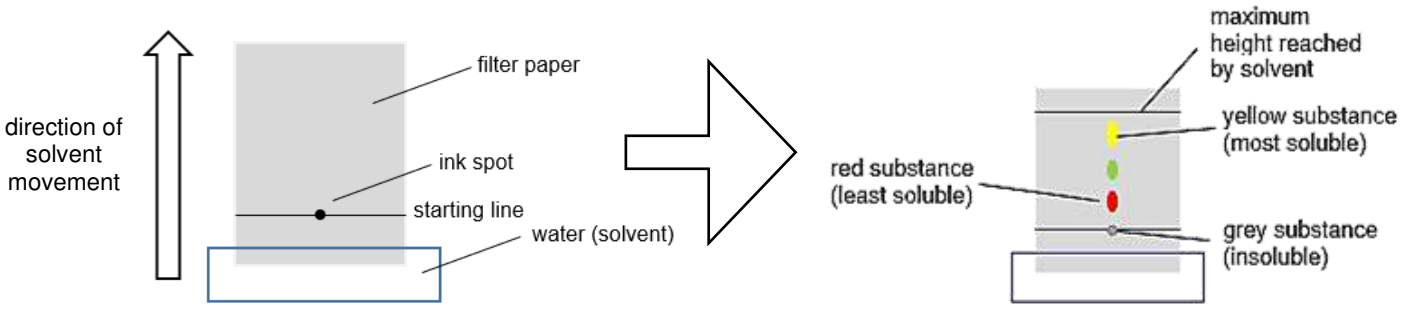
Paper Chromatography

- Used to separate and identify coloured components in dyes or inks.

<u>Factors that affect the movement of each component in the mixture</u>

- **Solubility** of the component in the solvent
  - The more soluble the component is in the solvent, the easier the component moves with the solvent. i.e., travels longer distances from the starting point

- Substances that are **insoluble** remain at the starting point
- Starting line is drawn in pencil as it does not dissolve in most solvents, and hence does not interfere with separation results



Advantages of using Chromatography

- Easy to handle and requires only small amounts of samples
- Commonly used to identify substances in small samples

Uses of Chromatography

1. Identify different dyes used in food
2. Food and beverage industries to test for purity of dyes used
3. Used in forensic science to help in criminal investigations and detect drug abusers

Focus 2: Applications of Separation Techniques

Obtaining Portable Water in Singapore

1. Rainwater from Local Catchment and Imported Water

- Rainwater is chemically treated, filtered, disinfections and supplied as **tap water**

2. NEWater (Reclaimed water)

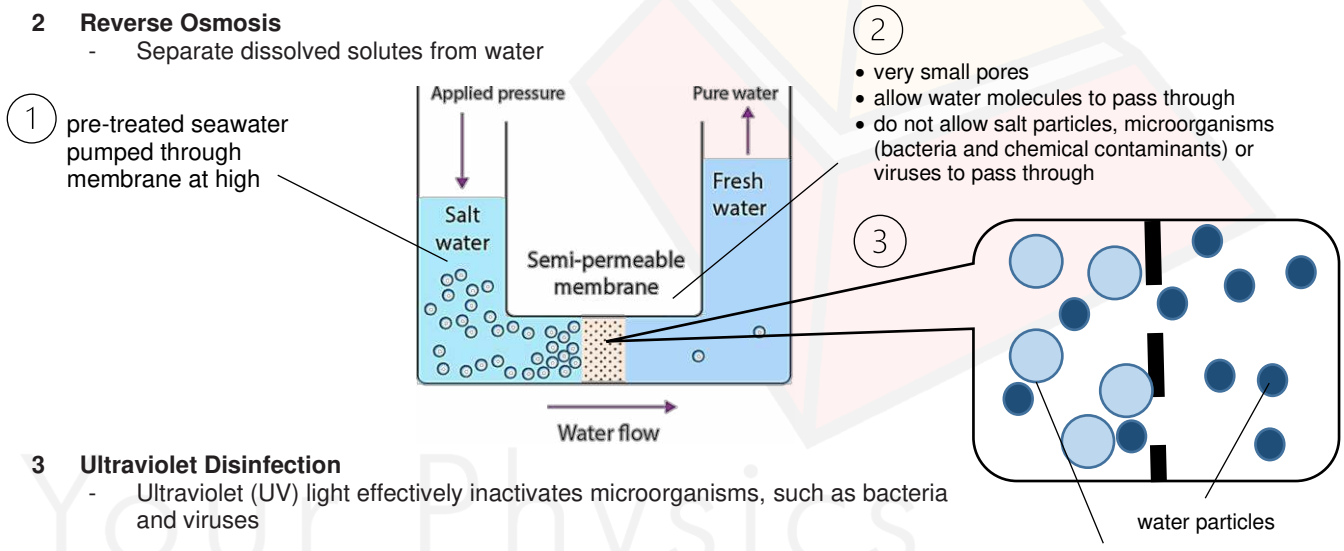
- Ultra-pure, clean, high-grade recycled water (from homes and industries) is collected in sewers and treated in conventional advanced wastewater treatment plants that are called reclamation plants in Singapore to produce NEWater.

1 Microfiltration

- Physically removing suspended solids from water, usually through a membrane (physical filtration)
- Removes bacteria, but not dissolved contaminants

2 Reverse Osmosis

- Separate dissolved solutes from water



3 Ultraviolet Disinfection

- Ultraviolet (UV) light effectively inactivates microorganisms, such as bacteria and viruses

3. Desalinated Water

- Obtaining potable water from seawater ⇨ a process through which the salt content in the product water is greatly reduced
- **Heat** is required during distillation: large volume of seawater translates into large amount of fuel needed ⇨ Distillation consumes extreme amount of energy ⇨ Unsustainable
- **Reverse Osmosis** is used in Singapore's desalination processes (refer above)

4. Water Conservation

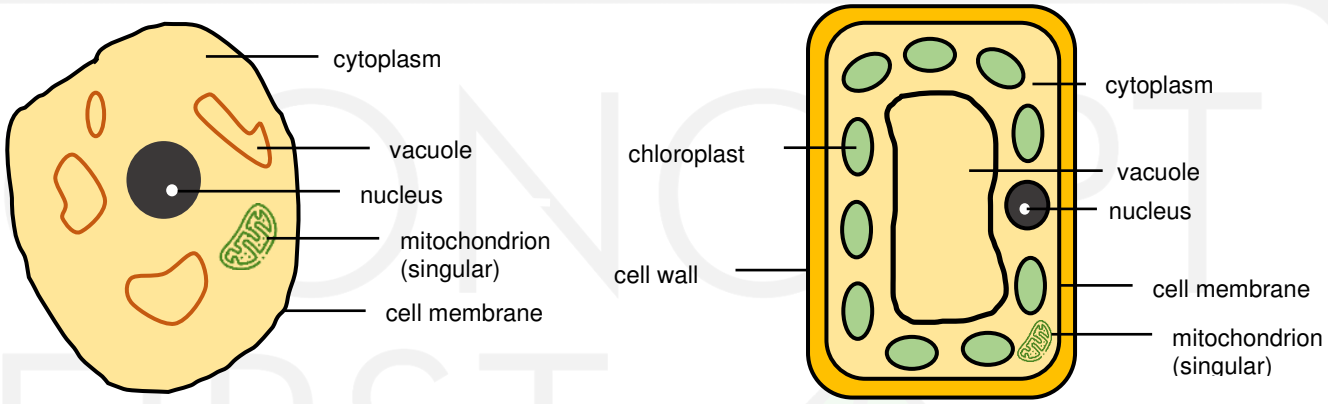
- We should practice responsibility and vigilance in conserving our scarce water to ensure we have an adequate supply of water in the future
- Examples of conservation:

1 Use water-efficient washing machine and wash on full load
2 Always turn taps off tightly so they do not drip
3 Do not run the water continuously while washing dishes
4 Use half-flush on the toilet bowl
5 Wash car with pail instead of hose
6 Water plants with water from washing vegetables

Focus 1: Cells and its Functions

Animal and Plant Cells

- Cells are the basic building blocks of life
- Plants and animals are made up of many cells, where they are known as **multicellular organisms**



Part of Cell	Function
Nucleus	• Controls all activities on the cell • Contains Deoxyribose Nucleic Acid (DNA) enclosed in a nuclear membrane • Responsible for cell division • Keeps the cell alive ; required for self repair
Cytoplasm	• Jelly-like substance • Most cellular activities take place here
Cell membrane	• Partially permeable membrane • Controls substances entering and leaving the cell • Thin and flexible which allows the cell to change its shape
Vacuole	• Only one large central vacuole • Filled with cell sap which helps to store water and mineral salts
Cell wall	• Thick layer made of cellulose which is a rigid substance that helps to maintain the shape of the cell • Supports and protects the cell • Fully Permeable membrane
Chloroplast	• Food producer of the cell stored as glucose • Contain green pigment called chlorophyll • Undergoes photosynthesis when it captures and trap light energy
Mitochondria (plural)	• Double membraned organelle • Releases energy from sugar

Specialised cells

Specialised animal cells

1. Red blood cells
   - Shaped like a biconcave disc with greater surface area to volume ratio for further diffusion of oxygen in and out of cell.
   - The absence of a nucleus allows for more space to carry haemoglobin so that more oxygen can be transported.
   - Haemoglobin binds temporarily to oxygen.
   - Elastic cell membrane to squeeze through narrow blood capillaries.

2. White blood cells
   - Produce antibodies

3. Nerve cell
   - Transmit nerve impulses from one place to another

Specialised plant cells

1. Root hair cells
   - Has long narrow protrusion to increases surface area to volume ratio for efficient absorption of water and mineral salts from the soil
   - Thin wall for easy absorption
   - No chloroplast as it is not exposed to sunlight

2. Xylem
   - Consist of dead cells that transports water and mineral salts from the roots to the stem to the leaves
   - Walls thickened with lignin to provide strength and support for the plant

3. Guard cells
   - Control the size of stoma where exchange of gases occurs
   - Found on surface of leaves

Differences Between Animal and Plant Cells

Animal Cell	Plant Cell
Does not have a cell wall	Has a cell wall
Does not have chloroplasts	May have chloroplasts
Has numerous small vacuoles	Has one or two large vacuoles in the middle of the cell
Can be larger than an animal cell	Can be larger than an animal cell

Focus 2: Division of Labour

- Organisms such as bacteria are unicellular, only consisting of one cell.
- Other organisms such as mushroom and cat are multicellular, consisting of many similar cells or more than one type of cell.
- The size of the organism does not indicate whether it is unicellular or multicellular.

- In a multicellular organism, cells are organised in a manner that allows them to work together for the organism to survive.