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nature of science
the swonky parts
<u>CONPTT Grid</u>
Consistent
When observations/ experiments are repeated under the same conditions, the results are reasonably the same.
Observable
The phenomenon or evidence can be observed by human senses or an extension of those senses. (eg microscope)
Natural
A natural cause or naturally occurring mechanism is used to explain how or why an event happens.
Predictable
Accurate predictions are based on ***only*** natural causes, not on presupposed or assumed information.
Testable
Controlled experiments can be designed to test the natural cause of the event or phenomenon.
Tentative
Explanations of the cause of the phenomenon are subjected to change when new (*legit)* evidence occurs.

<u>Scientific Method</u>
Observation
Question
Hypothesis
Experiment
Analysis
Communication

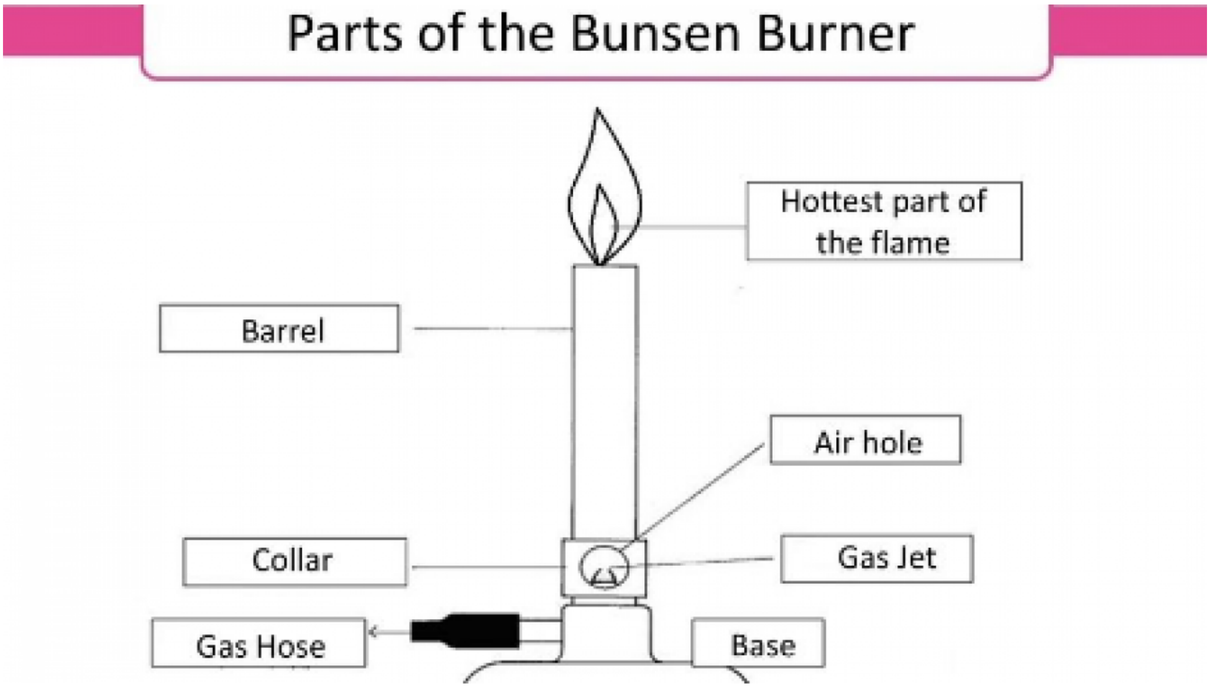
the not so swonky parts

Safety rules-

Safety rule	Reason
Wear your own safety googles when using chemicals or when heating.	Protects eyes from harmful fumes and chemicals or liquid that may accidentally pour from a test tube during heating.
Do not put solid waste nor pour concentrated chemicals into the sink.	This is to prevent corroding the sink and the chemicals from reacting with one another while in the sink. To also prevent clogging up of sink (solid waste)
Do not close all doors and windows when using the laboratory.	Good ventilation will prevent the accumulation of fumes of gases (from chemical reactions or gas supply) which may make us feel unwell.

Do not taste any chemicals.	To avoid consuming dangerous chemicals that may be harmful.

Bunsen burner



Closed airhole- luminous flame
Open air hole- non-luminous flame
Luminous flame
-Unsteady
-Visible
-Yellow coloured flame

Non- luminous flame
-Steady
-Not visible
-Blue coloured flame

Leave workstation for a few minutes while having Bunsen burner on-
Turn flame from non-luminous flame to luminous by closing air hole

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physical properties
Metal- malleable, good electrical conductivity, good thermal conductivity
Ceramic- hard, brittle, high melting point
Glass- transparent, brittle, poor electrical conductivity
Plastic- do not corrode/ non-biodegradable, poor electrical conductivity, poor thermal conductivity
Fibre- elastic, poor electrical conductivity, poor thermal conductivity

A **physical** property is any property that can be observed or measured.

A **physical quantity** can be quantified by measurement and is made up of a numerical magnitude and a unit.

base physical quantities	**SI base units**
length	metre (m)
mass	kilogram (kg)
time	second (s)

(*these are the common ones 👀*)

prefix	how much it represents
mega (M)	10^6
kilo (k)	10^3
centi (c)	10^{-2}
milli (m)	10^{-3}

Uncertainty of a reading
Half of smallest division: e.g. thermometer, measuring cylinder (also precision)

Density= mass/volume

average density= total mass/ total volume

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chemical composition

Elements

- pure substances that cannot be broken down further into simpler substances using chemical processes
- contains only one type of atom
- metals from periodic table grp 1-3
- metalloids
- non-metals from grp 5-8
- pure so melt and boil at fixed temp

Compounds

- are made of two or more types of atoms chemically combined together
- has a fixed proportion of each element by mass
- formed from elements by chemical change
- pure so melt and boil at fixed temp
- properties are different from elements
- can be separated by chemical methods tho so yay:)

Mixtures

- Solutions
- are mixtures of two or more substances homogeneously mixed, usually dissolved.
- Formed by dissolving solute into solvent

- Suspension
- are mixtures that have some solid or liquid that is insoluble in liquid or gas
- heterogeneous mixtures
- insoluble particles prevent light from passing through; will settle to bottom after some time

- have a variable proportion of each element
- melt and boil over a range of temperatures
- properties are similar to the combination of elements/compounds found in mixture
- can be separated using separation techniques

	Solubility	Rate of Dissolving
What is it?	the maximum mass of a solute that can dissolve in a fixed volume of solvent at a certain temperature	the mass of a solute that can dissolve in a fixed volume of solvent in a fixed amount of time
Affecting factors	- Nature of solvent - Nature of solute - Temperature	- Temperature - Size of solute particles - Rate of mixing

basically solubility is against temp, rate of dissolving is against time

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separation techniques

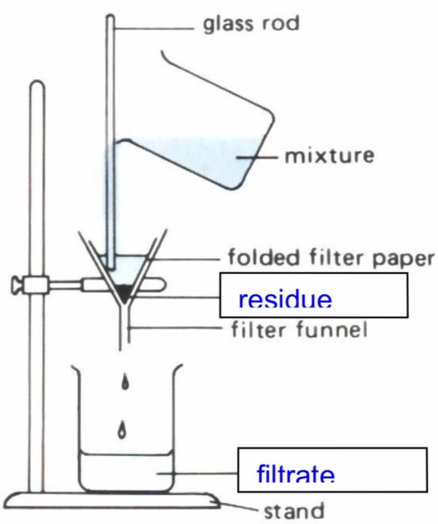
Magnetic attraction

- Basis of separation: magnetic or non-magnetic material
- Substances in the world can be magnetic (can be attracted by magnets) or non-magnetic. Iron and steel (which contains iron) are both magnetic.
- A magnet can be used to separate a magnetic material from a non-magnetic material.
- Technique does not work for separating mixtures where more than one substance is magnetic
- Daily application: Garbage separation

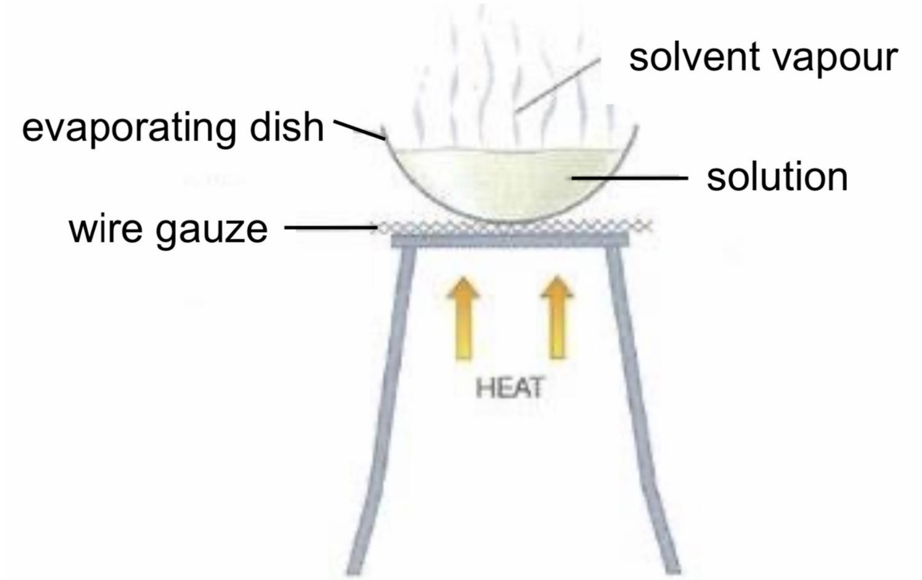
a pic bc why not

Filtration

- Basis of separation: solubility (liquid and insoluble solid mixture)
- Cannot be used for liquid and soluble solid mixtures
- A solid that is not soluble in a liquid can be separated from it by the process of filtration

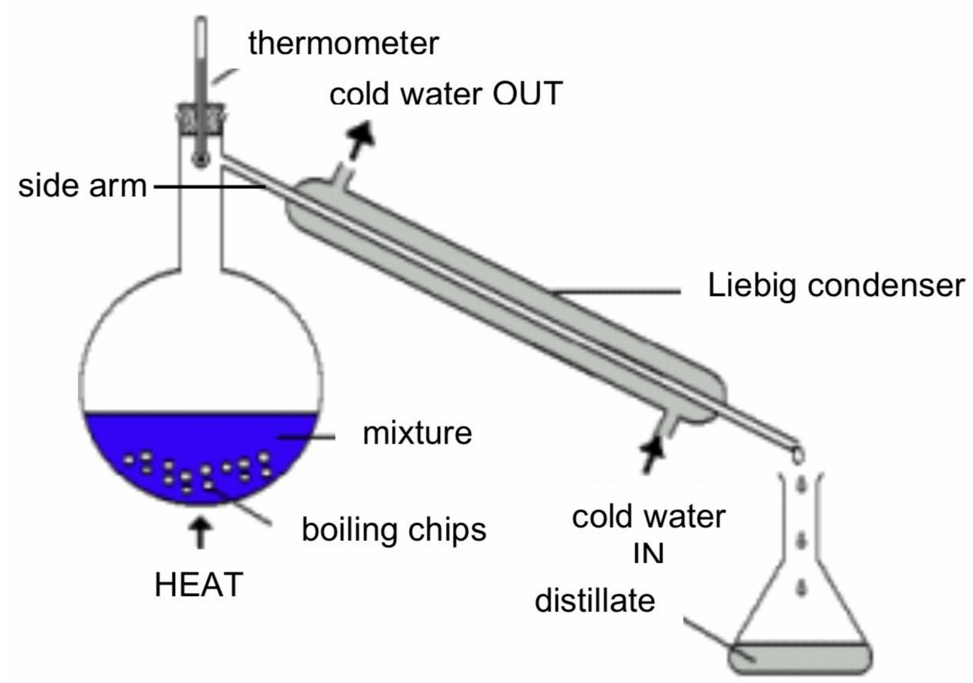


more pics bc why not

Evaporation
- Basis of separation: boiling point (solutions)
- A solid that dissolves in a solvent to form a solution cannot be separated by evaporation. The solvent has to be evaporated away before the solute can be recovered as an undissolved solid.
- Technique cannot be used for insoluble solid in liquid solvent/ soluble solid in liquid solvent that decomposes under high heat.
- 

Distillation
- Basis of separation: boiling points that are far apart
- A solvent can be separated from the original solution by distillation.
- The distillate (liquid that is collected) that is collected has the lower boiling point and is usually the solvent.

- Technique cannot be used for miscible liquid mixtures whose boiling points are very close to each other

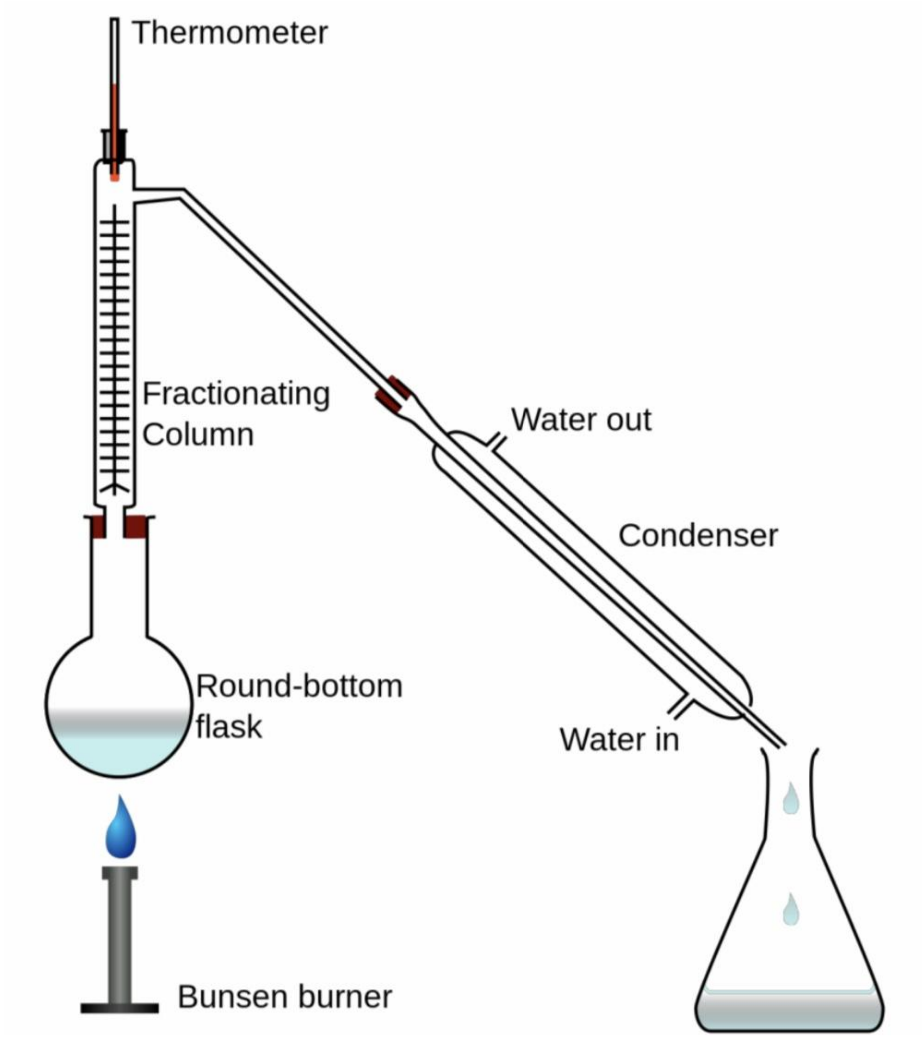


- Boiling chips are added to ensure smooth boiling.
- The component with the lower boiling point will turn into vapour and rise upwards.
- The thermometer's bulb must be beside the side arm to ensure that the boiling point of the substance being measured is distilled.
- The vapour will then enter the condenser.
- The condenser must slope downwards so that the liquid condenses inside and runs downwards into the conical flask.
- In the condenser, cold running water enters from the bottom so that the water jacket will be completely filled with water for more efficient cooling.

Fractional Distillation

- Basis of separation: boiling points of liquids (in miscible liquid mixtures) that are different but very close to each other
- Miscible liquids can be separated as they will boil at different temperatures and can be collected accordingly.
- The first distillate (liquid that is collected) is the liquid with the lowest boiling point.

- Daily application: Oil refining

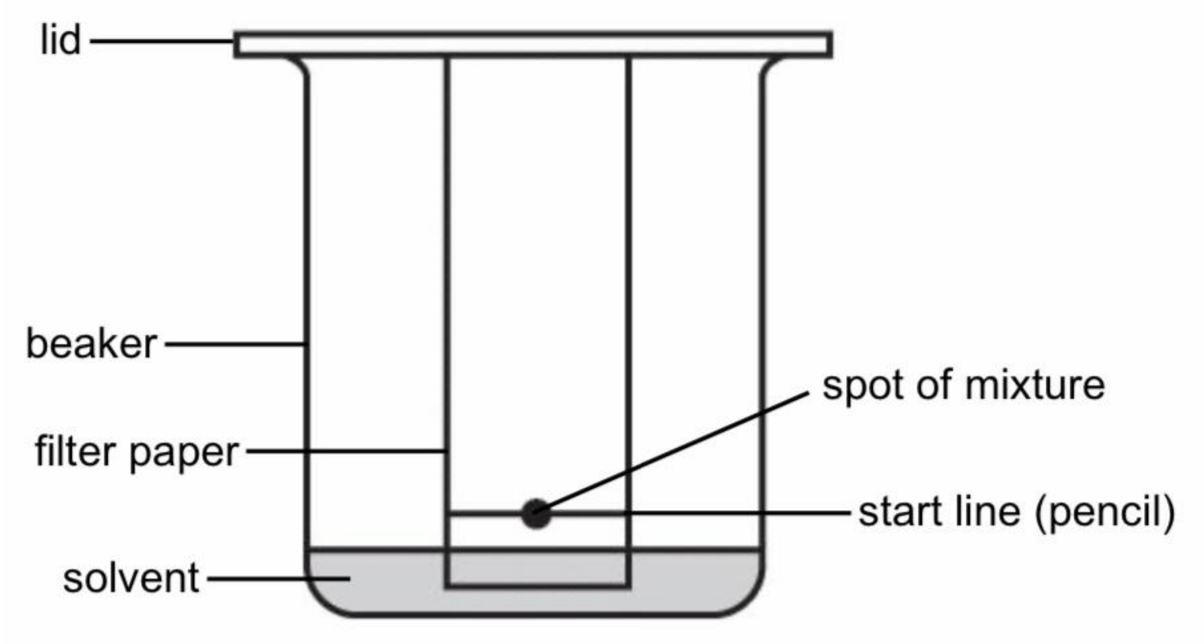


- A fractionating column has many glass beads to provide a larger surface area for vapour to condense on.
- The liquid with the lowest boiling point will boil and distill over first.
- Other liquids with higher boiling points that happen to form vapour will be condensed in the fractionating column and fall back down.
- When all of the first liquid has been distilled, heating continues to the next boiling point, until the next liquid distills over.

Chromatography

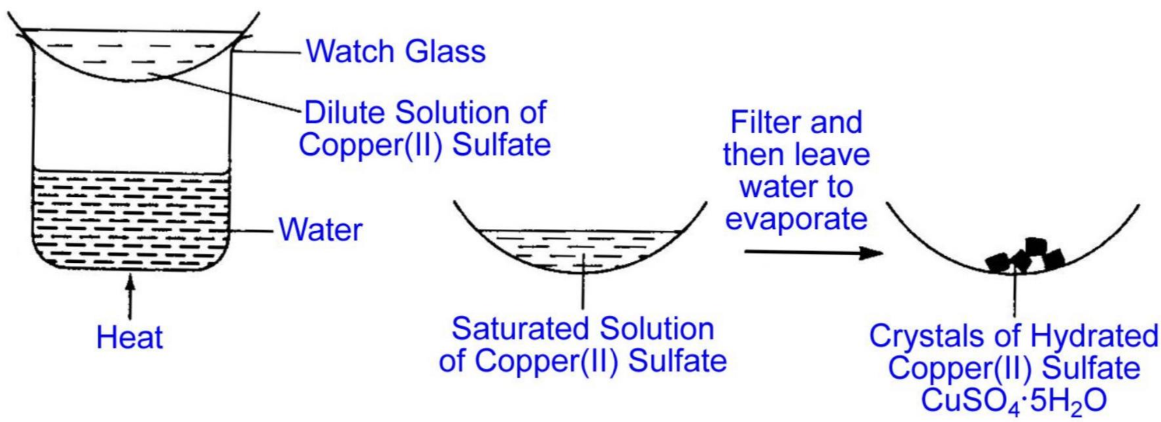
- Basis of separation: solubility in solvents (solutes with different solubilities)
- A mixture can have its components separated based on the solubility of the solutes in the chosen solvent.

R_f value= *distance travelled by component **A** from start line / distance travelled by solvent from start* line



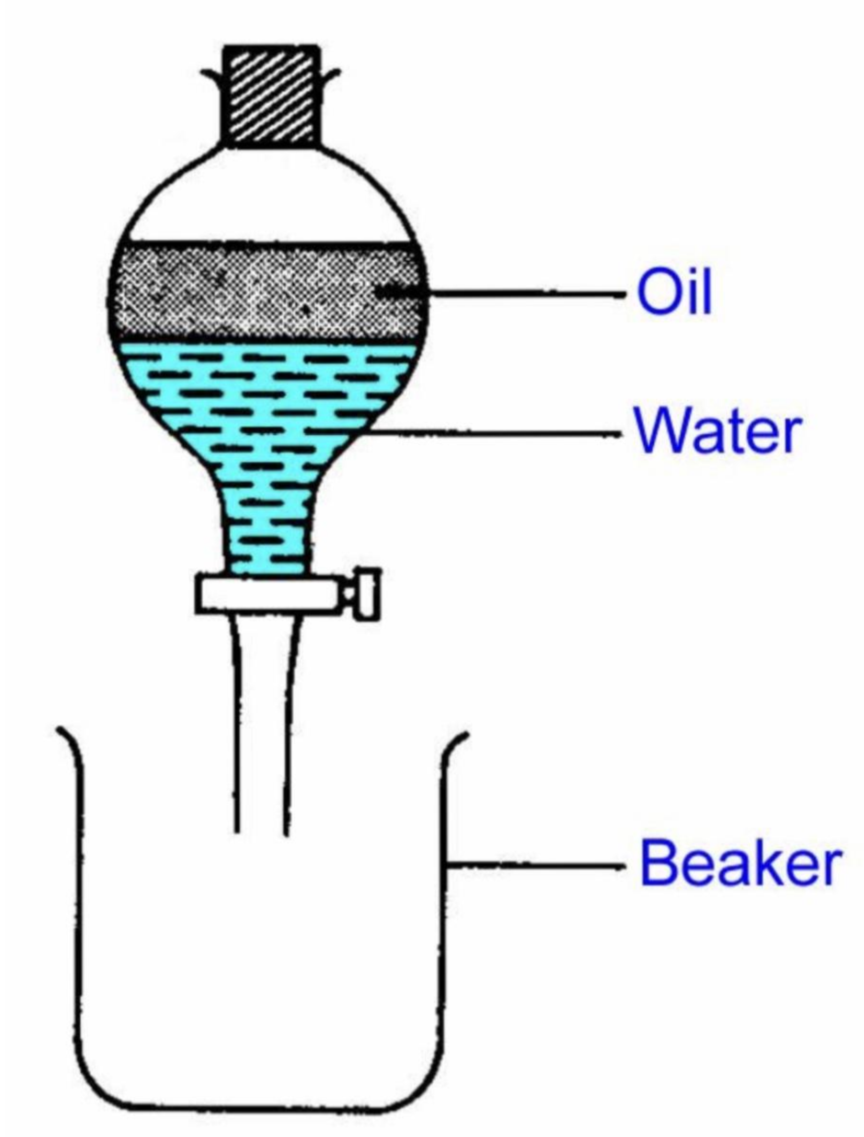
- The starting level of the solvent must be lower than the start line drawn, because the solvent is absorbed upwards by capillary action.
- The start line is drawn in pencil as it is made of graphite and will not dissolve in the solvent.
- The components will move along with the solvent as it moves up the paper. The more soluble ones will move further up with the solvent.

Crystallisation
- Basis of separation: Boiling point (solutions)
- Requires soluble solid in liquid solvent
- If soluble solid decomposes under high heat, can only use crystallisation.



Separation funnel
- Basis of separation: immiscible liquids

- Does not work for miscible liquids (duh!)



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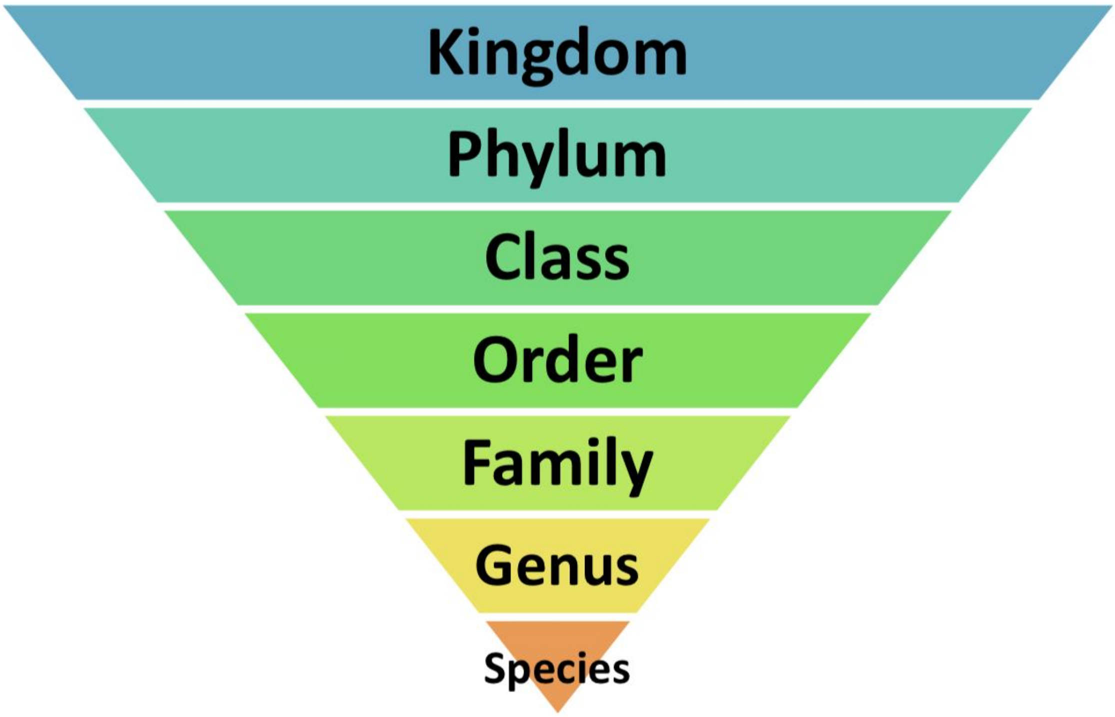
diversity of living things



Keep **P**onds **C**lean **O**r **F**rogs **G**et **S**ick

How do we name organisms?
- Every known organism is given a two-part scientific name, consisting of two Latin words written in italics or underlined. This system is called “binomial nomenclature”. The first part is the genus name while the second part is the species name. For example, scientific name of the tiger is *Panthera tigeris*/ Panthera tigeris.
- These names are important because they allow people throughout the world to communicate clearly about organisms with a standard name.

Dichotomous keys
- Two types- word or chart
- A dichotomous key involves a series of steps. At each step, there are two contrasting choices.
- After it is constructed, it can be used to identify and classify organisms.

Examples:

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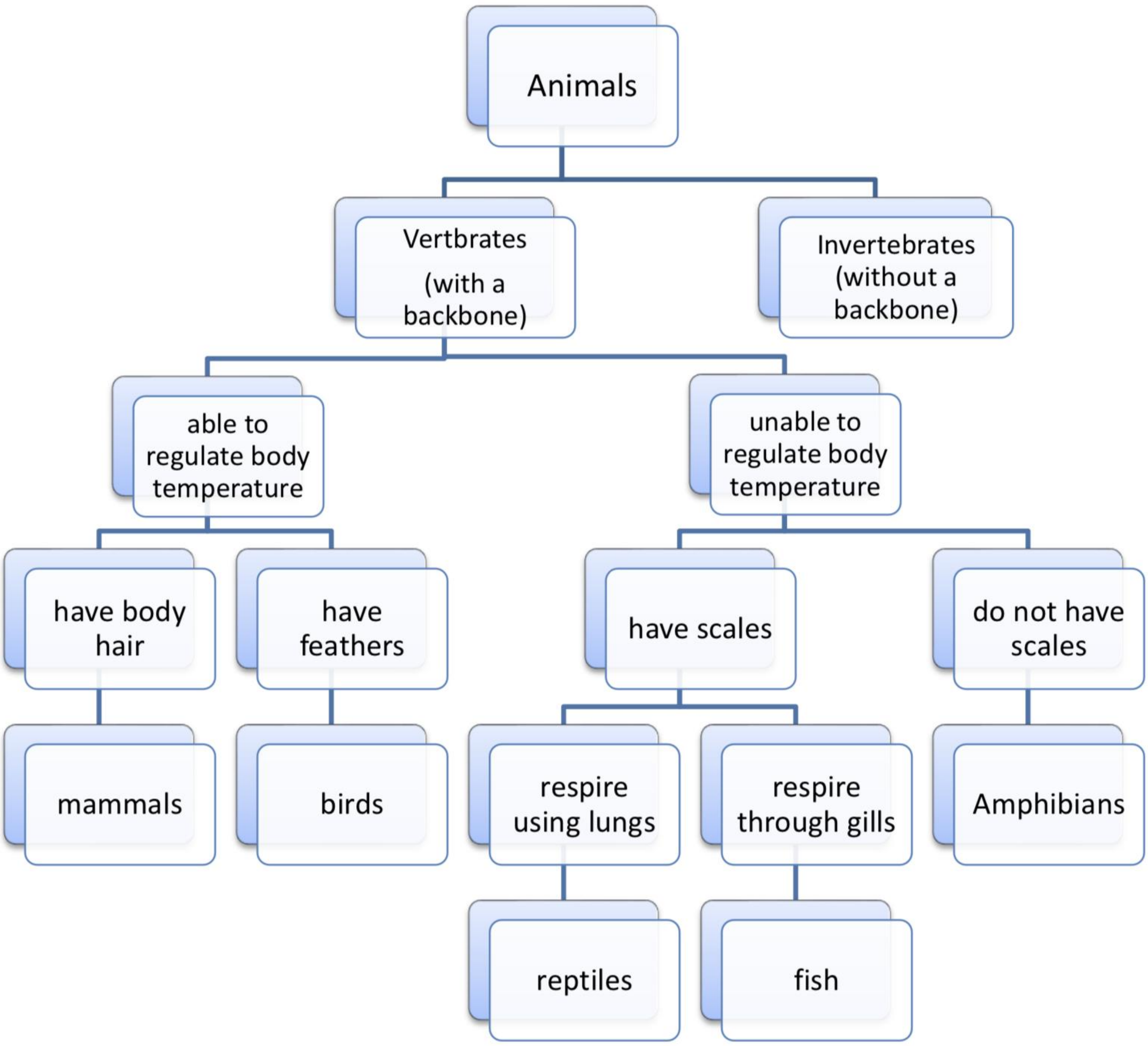

(the chart one)

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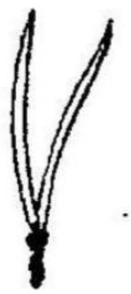
Use the dichotomous key provided to identify the leaves below.

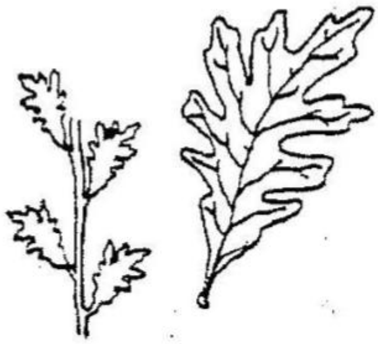
White pine

Maple

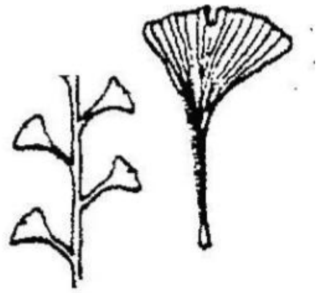
Elm



Jackpine



White oak



Gingko

1.	a.	Trees with leaves modified as needles	Go to step 2
	b.	Trees with broad bladed leaves	Go to step 3
2.	a.	Two needles in a bundle	*Jack pine*
	b.	Five needles in a bundle	*White pine*
3.	a.	Leaves opposite	*Maple*
	b.	Leaves alternate	Go to 4
4.	a.	Leaves shaped like a fan	*Gingko*
	b.	Leaves do not shape like a fan	Go to 5
5.	a.	Leaf blade oval, toothed but not lobed	*Elm*
	b.	Leaf blade with rounded lobes	*White oak*

(the word one)

this diversity thing be like a yes-

Threats to Biodiversity

Diseases

Can kill organisms and cause them to become endangered if disease spread

Excessive hunting

Hunting for food/medicine

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Due to overfishing+ overhunting, many animals endangered and may soon become extinct
Invasion of alien species 👽
Alien species may introduce diseases that may harm native species, be a direct predator of native species, or compete with native species for resources
Changes to/ Loss of habitat
Deforestation

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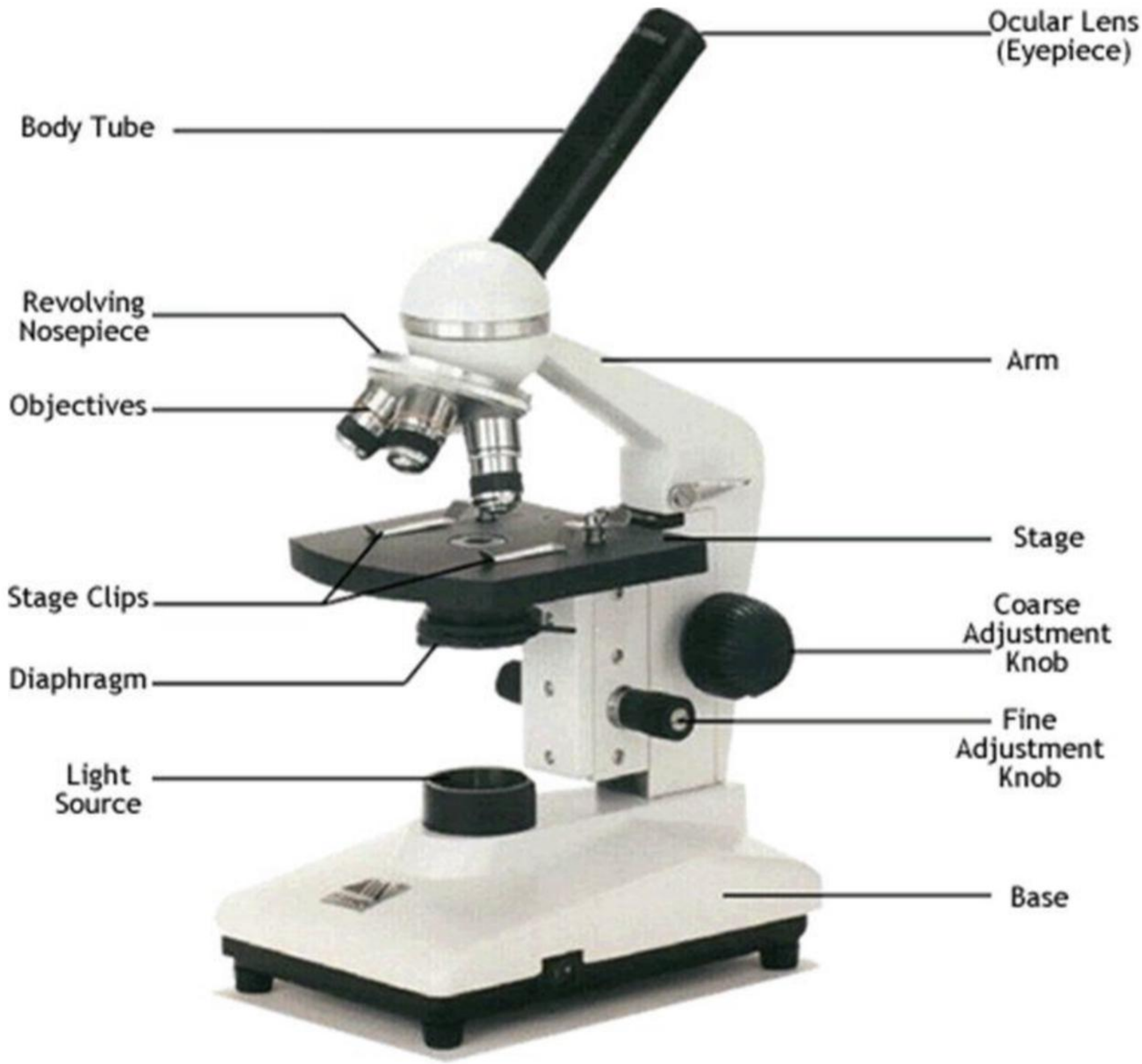
model of cells

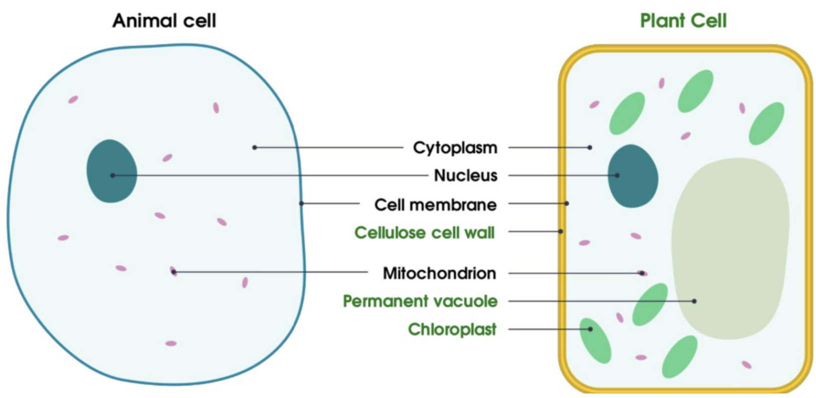
Microscope things



(Source:http://images.slideplayer.com/17/5286332/slides/slide_23.jpg)

Fig. 3.2

Cell parts



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Cell functions

Part	Properties/ Characteristics	Function
Cell surface membrane (plasma membrane)	It is selectively permeable (not partially!!) very thin	A selectively permeable membrane to allow substances to pass through.
cellulose cell wall	Made of cellulose fibres that criss-cross over each other Fully permeable	To support structure of cell To prevent cell from bursting
Cytoplasm	It contains largely water dissolved with different types of substances such as proteins, carbohydrates and lipids It contains specialised structures called organelles with specific functions.	It is where chemical activities in the cell take place.
Nucleus	Contains DNA (deoxyribonucleic acid)	Controls cell activities like cell growth and repair Contains genetic information of cell
vacuole	It is a fluid-filled space in a cell surrounded by a single membrane. An animal cell has many small vacuoles. A plant cell has one large temporarily vacuole. Fluid in plant cell is called cell sap.	Animal cells: Temporarily stores nutrients and water Plant cells: store cell sap containing water, glucose, dissolved mineral salts etc.
Mitochondrion (plural: mitochondria)	Question: Which cell would likely to contain large numbers of mitochondria? Smooth/Skeletal/Cardiac muscles	It is where cellular respiration takes place. During cellular respiration, nutrients are broken down (oxidised) to release energy Energy released is used by cell for cell activities, e.g. growth and repair
Chloroplast	Contains many green pigments called chlorophyll that absorbs light energy	It is where photosynthesis occurs. During photosynthesis, light energy is absorbed by chlorophyll. The light energy is then used to convert carbon dioxide and water into

		glucose for the plant. Oxygen is produced in the process.

Cells: The basic unit of an organism
Simple tissues: Made up of one type of cell to perform a certain function.
Complex tissues: Made up of more than one type of cell to perform a certain function.

Tissue: Cells with similar structures grouped together to perform a shared function.

Organs: Different types of tissues that work together to perform a function
Organ systems: Different organs working together for a common purpose. In a living organism, a group of systems come together to make up the body of the living organism.

Division of labour is the breakdown of workload into smaller and more specific tasks for maximum efficiency.
In a multicellular organism, although different cells / tissues/ organs/ systems perform different functions, they work together to ensure that the whole organism function efficiently and effectively.
Similarly, in a unicellular organism, the different organelles or structures work together to ensure that the different functions are carried out effectively.

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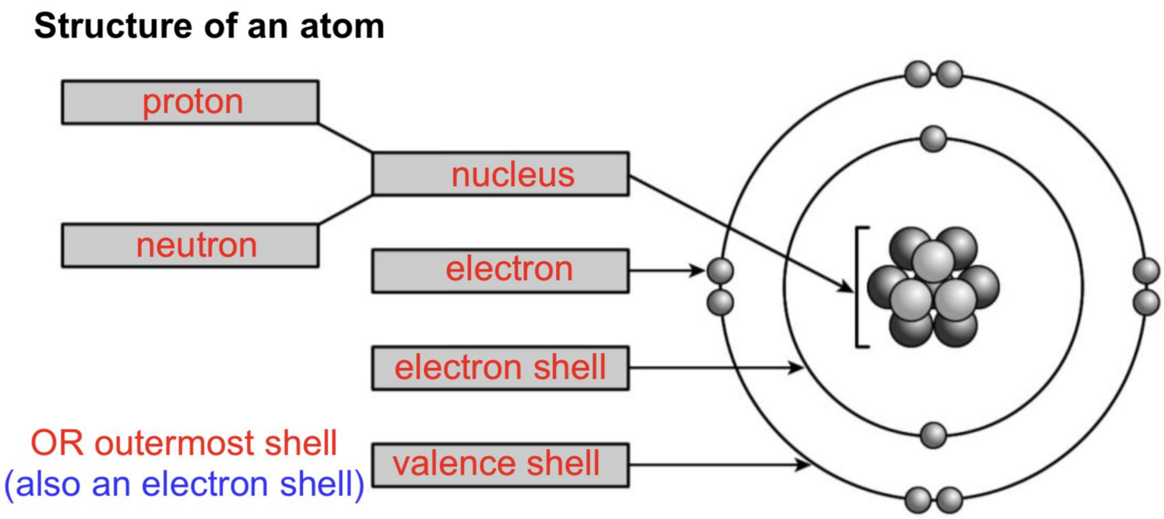
atomic structure



Sub-atomic particle	Location in atom	Relative charge	Relative mass (in a.m.u)
Proton	In nucleus	+1	1
Neutron	In nucleus	0	1
Electron	In electron shell / Orbiting around nucleus	-1	1/1840 or 1/1836

glossary

Atomic number: Number of protons in the nucleus of an atom
Mass number: Total number of neutrons and protons in the nucleus of an atom
Valence electrons: Electrons in the valence shell (or outermost shell)
Isotopes: Atoms which have the same number of protons but different number of neutrons
Positive ion (Cation): An atom that has lost at least one electron
Negative ion (Anion): An atom that has gained at least one electron

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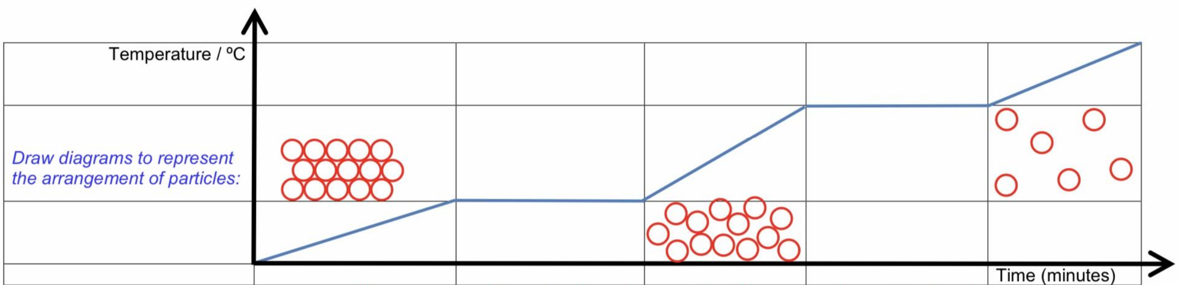
the particulate nature of matter

What the particulate model says about matter	Experimental evidence
All matter is made of tiny particles.	Particles are small and cannot be seen with a microscope.
Particles are in constant and random motion.	1. Brownian motion: observed under a light (optical) microscope e.g. pollen grains in water; e.g. smoke particles in air 2. Diffusion: e.g. drop of ink (dye) in water; e.g. perfume sprayed in a room
There are spaces in between the particles.	1. 50 cm^3 of alcohol mixed with 50 cm^3 of water: • Total volume of this mixture is less than 3 100 cm. 2. A gas can be compressed.
Particles move at different speeds in different states of matter.	Gaseous state of matter occurs at a higher temperature than liquid and solid states ➔ particles in the gaseous state have much higher kinetic energies and move at higher speeds than in liquid and solid states.

2. Heating curve of a substance



State of substance	**solid**	mixture of solid and liquid states	**liquid**	mixture of liquid and gaseous states	**gas**
Name of Process	heating	**melting**	heating	**boiling**	
Change in temperature *-link to change in kinetic energy*	rise in temperature	constant temperature	rise in temperature	constant temperature	rise in temperature
1. Arrangement of particles *-affects shape & compressibility*	Particles are closely packed in an orderly manner		Particles are **less** closely packed than in a solid; arrange in a disorderly manner		Particles are very far apart and disorderly
2. Motion of particles (movement)	Particles vibrate about fixed positions		Particles move freely throughout, sliding over each other		Particles move rapidly (at high speeds) in random directions
3. Kinetic energy of particles (speed)	Particles vibrate with low kinetic energy	*changes from one state to anther*	Particles move at **higher** kinetic energy than in a solid	*changes from one state to anther*	Particles move with **very** high kinetic energy
4. Attractive forces between particles *- affects volume*	**very strong** attractive forces between particles		strong attractive forces (weaker than in a solid)		**very weak** attractive forces

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transport system

	Transport System in Plants	Transport System in Humans
Parts of the system	Vascular Tissues - Xylem (made of dead cells) - Phloem (made of living cells, transports mainly sugars between different parts of plant) In roots, stems and leaves (basically like one long continuous tube)	• heart • Blood vessels (Veins, Arteries, Capillaries) • Blood
Substances being transported	Water, mineral salts and sugars	Nutrients (e.g. glucose, amino acids), oxygen, waste substances (carbon dioxide, urea)
Function of different parts of system	Root • Absorption of water and mineral salts • Diffusion in root hair cells *The absorbed mineral salts move from one cell to the next cell by diffusion until they reach the xylem of the root.*	Heart The heart is a muscular pump. It's pumping action from muscle contractions keep the blood circulating around the body quickly and continuously.
	In stems and leaves: • Transport of water and mineral salts *Water molecules and mineral salts will move from the xylem of the root into the xylem of the stem, and then to different parts of the plant e.g. leaves via the xylem.* • Diffusion of oxygen from the leaves to the surrounding air *In the presence of light energy, photosynthesis occurs in the leaves to produce oxygen. Hence, there will be higher concentration of oxygen in the leaves compared to the surrounding air.*	Blood vessels: • Arteries Sends blood from heart to rest of body • Veins Carry blood from body back to heart • Capillaries Have walls which are one cell thick *Exceptions*: • Pulmonary artery Carries deoxygenated blood from heart to lungs • Pulmonary veins Carries oxygenated blood from lungs to heart
		Blood: • Plasma

	• Diffusion of carbon dioxide from surrounding air to the leaves *In the presence of light energy, carbon dioxide is required for photosynthesis in the leaves.* *Hence, there will be lower concentration of carbon dioxide in the leaves compared to surrounding air.* • Diffusion of water vapour from the leaves to the surrounding air *Water will (naturally) evaporate from the internal cells of leaf to form water vapour. Hence, there will be higher concentration of water vapour in the leaves compared to surrounding air.*	Contains mainly water as solvent for many substances to be carried along bloodstream Also to carry nutrients, waste materials for disposal and hormones and antibodies • Red blood cells Transport oxygen from lungs to all parts of body • White Blood Cells Fight infections of viruses and bacteria • Platelets Help to initiate blood clots when there is damage to blood vessels *Why?* To prevent bacteria or viruses from entering the bloodstream and to prevent excessive blood loss

Adaptations of the Red Blood Cell

Physical characteristics	How the adaptation relates to its function
Biconcave in shape	Increases *surface area to volume ratio*, hence greater diffusion *rate* of oxygen and carbon dioxide.
Presence of haemoglobin molecules	Allows the red blood cell to transport oxygen molecules.
No nucleus / Enucleated	Allows the red blood cell to carry more haemoglobin molecules to bind to more oxygen molecules.
Elastic cell surface membrane	Allows red blood cell to squeeze through blood capillaries that are smaller than its diameter.

nice note to self in a few years' time: does not cover osmosis, and major parts of heart

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light

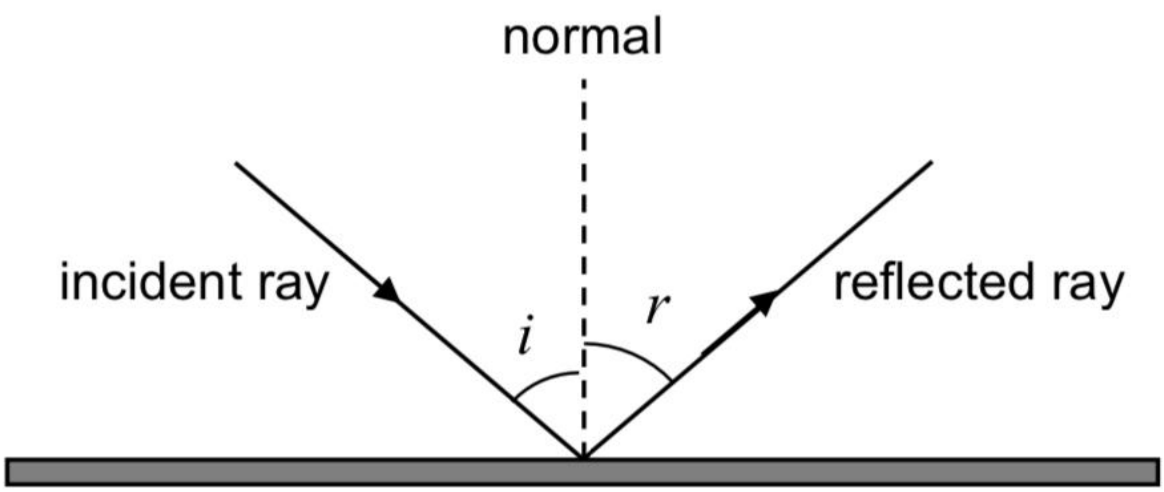
basic fact sheet

- travels at 3.0×10^8 m/s in vacuum/ air
- travels in straight lines

Reflection

- We are able to see an object only when light rays coming from it enter our eyes.
- Objects that give off their own light are luminous.
- Those that do not give off light are non-luminous.
- Non-luminous objects are seen when they reflect light.

Reflection is formed when light rays bounce off a surface.
When a light ray (the incident ray) hits a reflective material at an angle (the angle of incidence i), it bounces off as the reflected ray at an angle called the angle of reflection r.



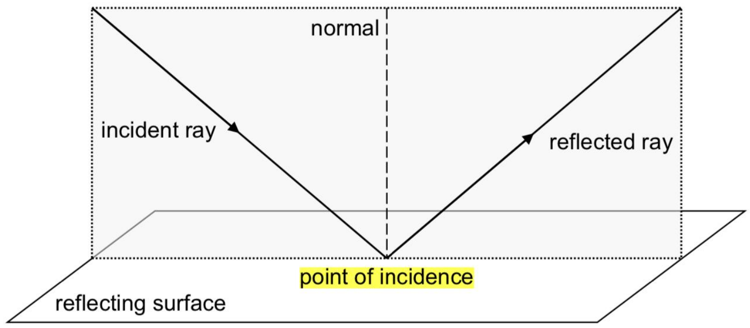
the nice swonky definitions

Normal: a line perpendicular to the reflecting surface
Angle of incidence: angle between the normal and the incident ray
Angle of reflection: angle between the normal and the reflected ray

REMEMBER: Laws of Reflection

1. The angle of incidence is equal to the angle of reflection.
   angle i = angle r

2. The incident ray, reflected ray and the normal at the point of incidence all lie in the same plane.



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Regular reflection
On a smooth surface such as the surface of a mirror, regular reflection takes place.
A parallel beam of light stays parallel after regular reflection.

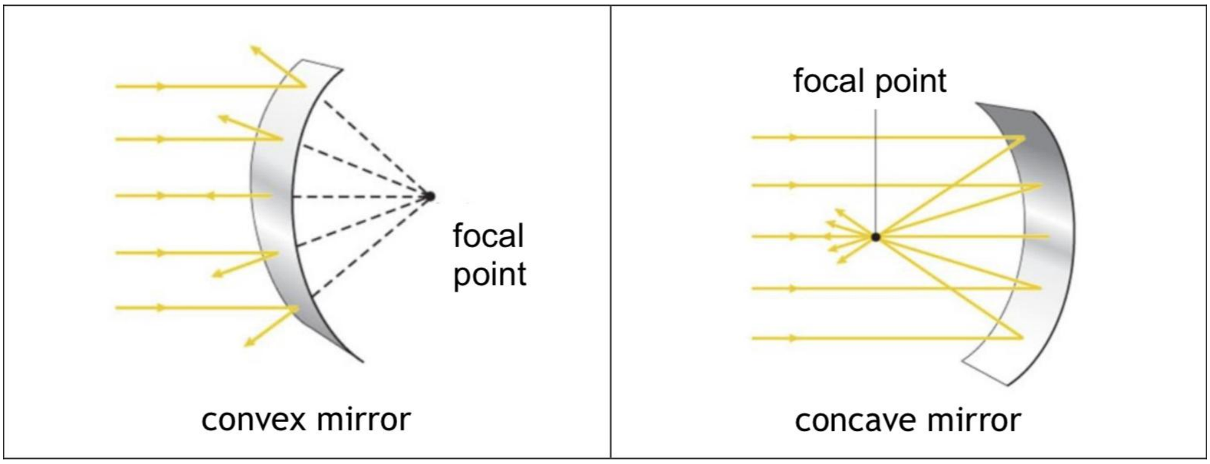
Diffused reflection
On a rough surface such as the surface of a sheet of paper, irregular reflection takes place.
A parallel beam of light is reflected as individual rays reflected in different directions.

Question: Do the laws of reflection still hold in the case of diffused reflection?
Yes, it obeys the laws. Even though the incident rays are parallel, the normal for each incident ray when it hits the surface (point of incidence), is different. By the laws of reflection, the reflected rays will not be parallel.

Characteristics of plane mirror images upright
1. The image is upright.
2. The image is the same size as the object.
3. The image is virtual.
4. The image is laterally inverted.
(The right of the image corresponds to the left of the object and vice versa)
5. Object distance from the mirror is equal to the image distance from the mirror.

Convex Mirrors
• A convex mirror is a mirror that curves outwards.
• Parallel light rays spread apart after reflecting from the mirror as if they came from a focal point behind it.
• Images formed by a convex mirror are virtual and appears smaller than they are (diminished). More objects can be seen in a convex mirror than the same sized plane mirror.

Concave Mirrors
• A concave mirror is a mirror that curves inward.
• Parallel rays bounce off the curved surface of a concave mirror and converge at a focal point.
• Images formed by a concave mirror are virtual and magnified if the objects are sufficiently close to the mirror.



Colours

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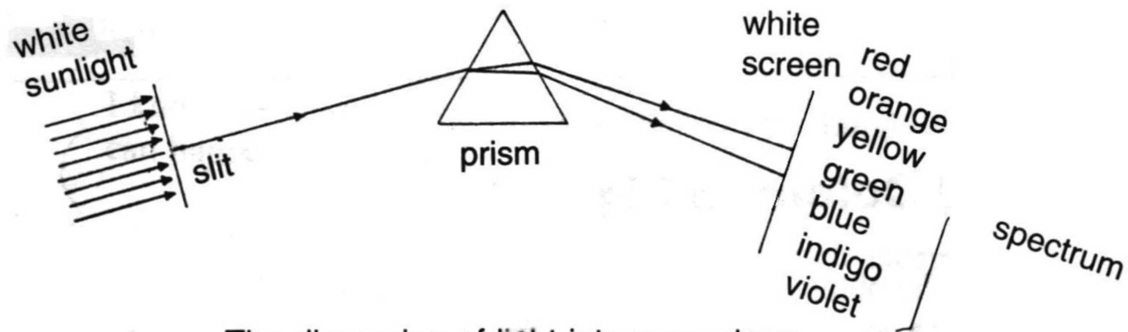
Daylight (or white light) is a mixture of different colours called a spectrum
• When a beam of white light passes through a glass prism, the light splits up and disperses into a spectrum.
• The splitting of white light into its component colour is called dispersion.
• The prism bends or refracts each of the colour in white light by a different angle.
• Red rays travel the fastest through the prism and bend the least.
• Violet rays travel the slowest through the prism and bend the most.



The dispersion of light into a spectrum