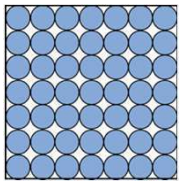
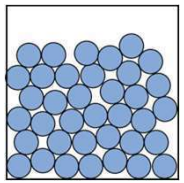
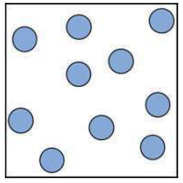
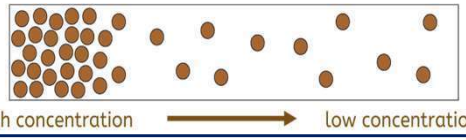
Particles, substances and mixtures

The particle model of matter

	Solid	Liquid	Gas
Diagram			
Arrangement	ordered and all touching	random and all touching	random and not touching
Movement	vibrate in fixed positions	move and slide over each other	move around quickly in random directions
Attraction between particles	strong	weak	very weak

Diffusion

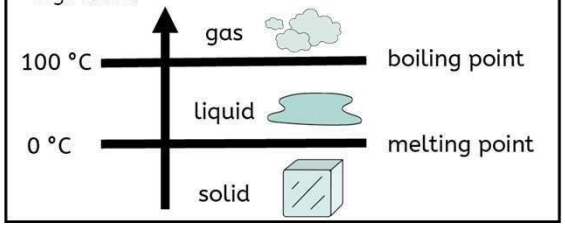
Diffusion is the random movement of particles from an area of high concentration to an area of low concentration. Particles of substances in the liquid and gas states can diffuse because their particles can move freely.



Melting and boiling points

melting point: the temperature at which a substance changes from a solid to a liquid

boiling point: the temperature at which a substance changes from a liquid to a gas, e.g. water



Explaining the properties of solids

Property	Reason
Fixed shape and cannot flow	Strong forces of attraction between the particles keep them in fixed positions.
Cannot be compressed (squashed)	Particles are all touching and have no space to move into.

Explaining the properties of liquids

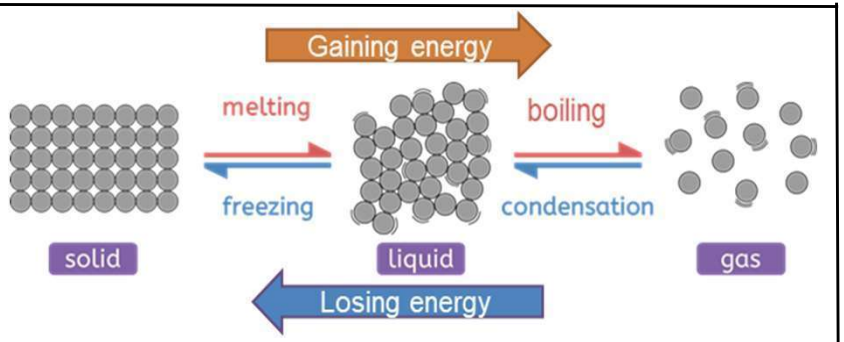
Property	Reason
Takes shape of container and can flow	Weak forces of attraction between the particles, so they can move around each other.
Cannot be compressed (squashed)	Particles are all touching and have no space to move into.

Explaining the properties of gases

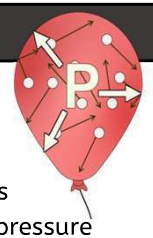
Property	Reason
Takes shape of container and can flow	Very weak forces of attraction between the particles, allowing them to move and spread out.
Can be compressed (squashed)	Particles are not touching and have space to move into.

Change of state

A change of state is a physical change because no new substances are made, and the change is reversible. Only the amount of energy the particles have changes, which affects the arrangement and movement of the particles. Temperature stays constant during a change of state.



Gas pressure

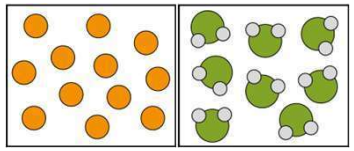


When gas particles collide with the walls of their container, this creates a constant force on the walls of the container. This causes pressure. The faster the particles move, the higher the gas pressure. The gas pressure inside containers can be increased by adding more particles or increasing the temperature. The more frequent the collisions, the higher the gas pressure.

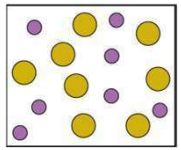
Particles, substances and mixtures

Pure substances and mixtures

A **pure substance** is one that contains only one substance, e.g. pure iron contains only iron particles. A **mixture** contains two or more substances that are not joined together and can be physically separated.



pure substances
(one type of particle)



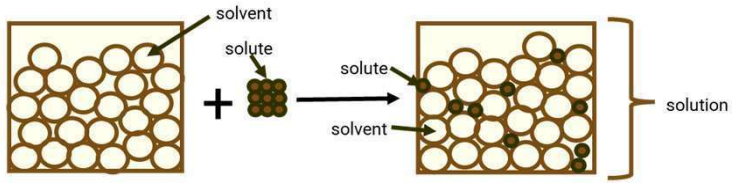
mixture

Solutions and solubility

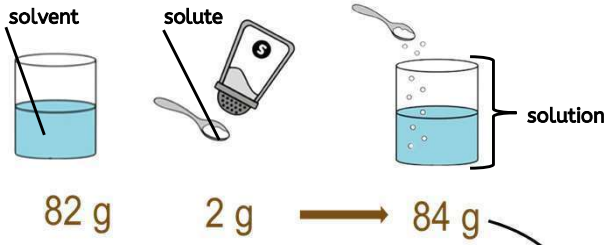
A **solute** can be dissolved in a **solvent**. The mixture created is called a **solution**. When no more solute can dissolve in the solution, it is a **saturated** solution. If a solid dissolves in a solvent, it is **soluble**. If it does not dissolve in a solvent, it is **insoluble**. **Solubility** is a measure of how much solute can dissolve in a solvent. The higher the temperature of the solvent, the greater the mass of the solute that can be dissolved.

Solubility is different for different solutes. The solubility of a solute will change depending on the solvent used.

During **dissolving**, the solute particles are separated and fit between the solvent particles to make a solution.



mixture



Conservation of mass

When a solution is formed, **the mass of the solvent + the mass of the solute = the mass of the solution.**

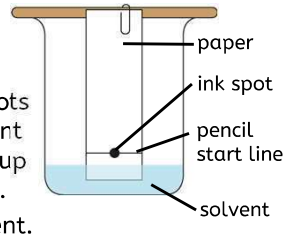
Mass remains constant because the number of particles is the same before dissolving as it is after.

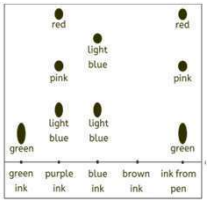
Separating mixtures

We can separate mixtures in different ways depending on their properties:

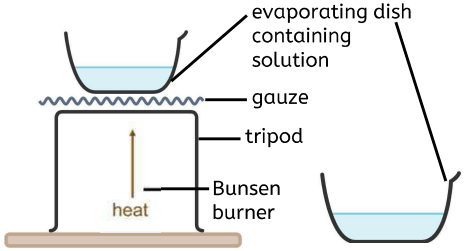
Chromatography is a separation technique that separates mixtures containing more than one solute based on their solubilities in a solvent. It works because some of the coloured substances dissolve better than others, so they travel further up the paper. A pencil line is drawn, and spots of ink or dye are placed on it. There is a container of solvent (e.g. water or ethanol). As the solvent continues to travel up the paper, the different coloured substances spread apart.

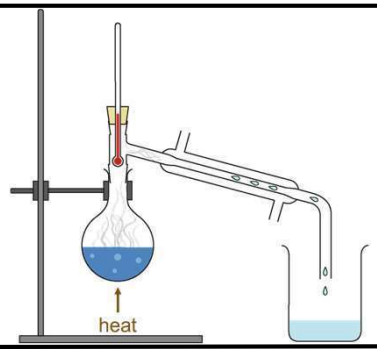
A **chromatogram**, the results of chromatography experiment.





Evaporation and **crystallisation** can be used to separate a soluble solid from a solution. For example, copper sulphate is soluble in water – its crystals dissolve in water to form a copper sulphate solution. During evaporation, the water evaporates away, leaving solid copper sulphate crystals behind. Crystallisation produces larger solid crystals.

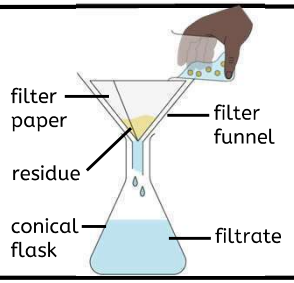




Distillation is a separation technique used to separate a mixture of liquids. The basis for separation in distillation is the difference in the boiling points of the components. For example, water can be separated from an ink and water solution because water has a much lower boiling point than ink. When the solution is heated, water evaporates. It is then cooled and condensed into a separate container. The ink does not evaporate, so it stays behind.

Filtration can be used to separate a liquid from an insoluble solid. The filter paper used in filtration is 'selectively permeable', meaning that it has holes in it that allow the movement of only some substances through whilst preventing the movement of others. The insoluble solid is unable to pass through the small holes of the filter paper. When a mixture of sand and water is filtered:

- The sand stays behind in the filter paper (it becomes the **residue**).
- The water passes through the filter paper (it becomes the **filtrate**).

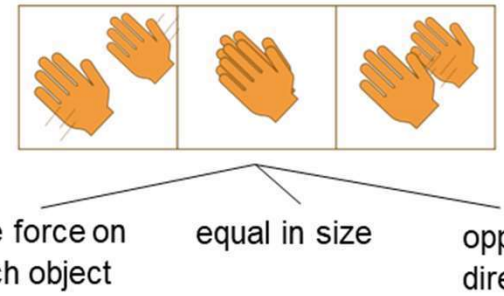


7.02: Fundamentals in physics

Forces and their interactions

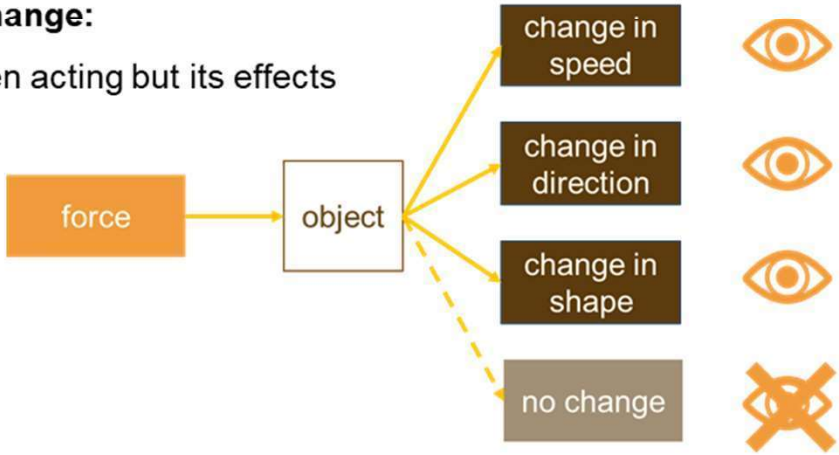
Interaction:

When two objects influence each other and cause a pair of forces to arise.



Forces can cause change:

A force cannot be seen acting but its effects often can.



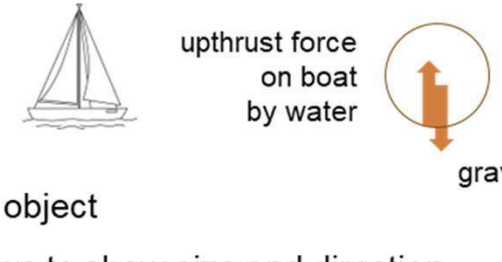
Forces can be contact or non-contact:

Contact forces arise between two touching objects.

Non-contact forces can act between two objects at a distance.

contact	thrust, friction, air resistance, water resistance, normal contact, upthrust
non-contact	gravity force, magnetic force

Free-body force diagrams



One object

Arrows to show size and direction of forces

Labelled forces:

- What kind of force is acting?
- What is the force acting on?
- What exerts the force?

Deforming forces

Two pushing forces cause compression: the object contracts.

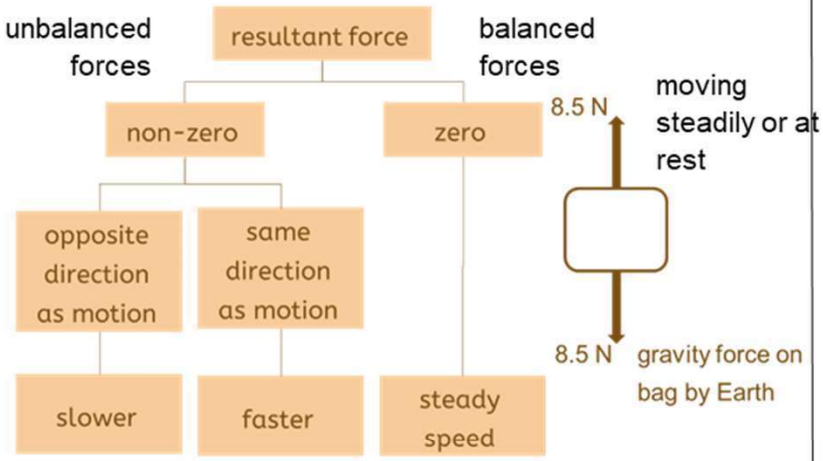
Two pulling forces cause tension: the object extends.

7.02: Fundamentals in physics

Combining forces

More than one force acting:

- Their effects are combined
- As if a single force is acting: the resultant force

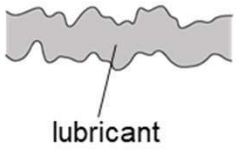


Friction force

- **What?** One of three frictional forces. They act to resist motion.
- **Where?** Acts between solid surfaces, along the surfaces.
- **When?** An object is sliding or trying to. When starting to slide, the applied force must be larger than the limiting friction: so, an unbalanced force acts.
- **How?** Opposite direction to the motion, or the applied force.
- **Why?** Surfaces are uneven, so the 'catching' between them must be overcome.

	Useful	Nuisance
Walking	✓	
Machines		✓
Driving	✓	
Wear and tear		✓


catching;



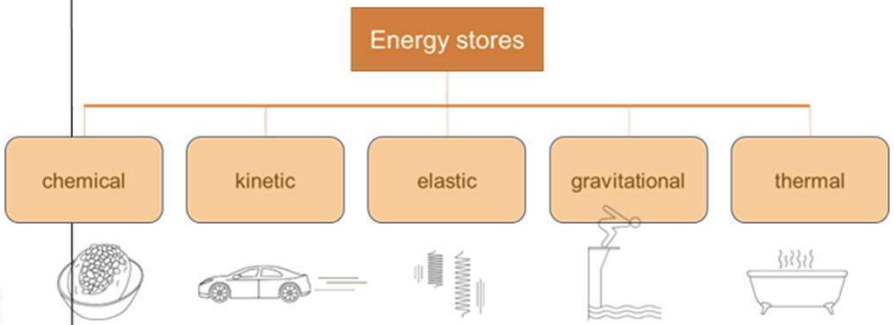
surfaces parted: no catching

Energy stores and pathways

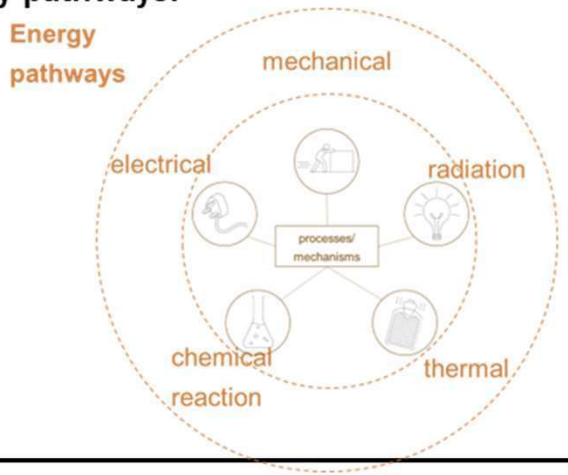
What energy does:

- Flows between objects in a system
- Stays the same when it transfers
- Cannot be used up

Energy is transferred between stores:



Energy is transferred because of processes, by pathways:

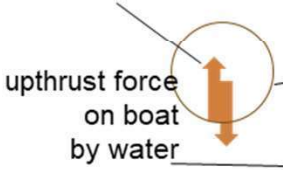


7.02: Fundamentals in physics

Modelling forces

Forces are modelled because:

- forces cannot be seen acting
- there are many forces acting at a time
- their size and direction have important effects on situations, so need to be shown.



Investigating forces

Scientific methods:

- With or without hypothesis
- Manipulating variables or not

Statement to answer an enquiry question.

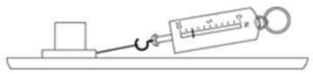
comparative term — Smoother surfaces cause less friction to act on objects sliding over them. — present tense

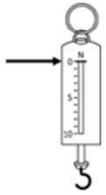
the effect which can be tested

'group' being tested (IV)

Planning to collect high-quality data:

- Measuring with skill
- Preparing the data table
- Repeatable data





Check force-meter is on zero with no force.

headings describe variable

IV

Surface	Force to start sliding (N)		
	1	2	3
Glass	1.4	1.5	1.7
Metal	1.5	1.6	1.7
Polished wood	2.0	2.3	2.2
Plastic	2.9	3.0	2.9
Paper	4.5	3.8	4.0

DV in columns

repeated

Peer review: ★★★

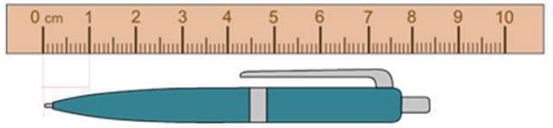
Peers (people of a similar level of knowledge) test the results for quality.

- Repeatability: Same group, same results
- Reproducibility: Different group, same results

Observing by measurement

Using a scale

- set of lines at equal increments
- Labelled with numbers and units



Measuring instruments

- Include rulers, balances, clocks and thermometers.
- Force is measured using a force-meter.

Quantities: and their units

Base quantities: length (m), mass (kg), time (s) and temperature (K).

Derived quantities include force (N).

Cells and organisation

The seven common processes of living organisms

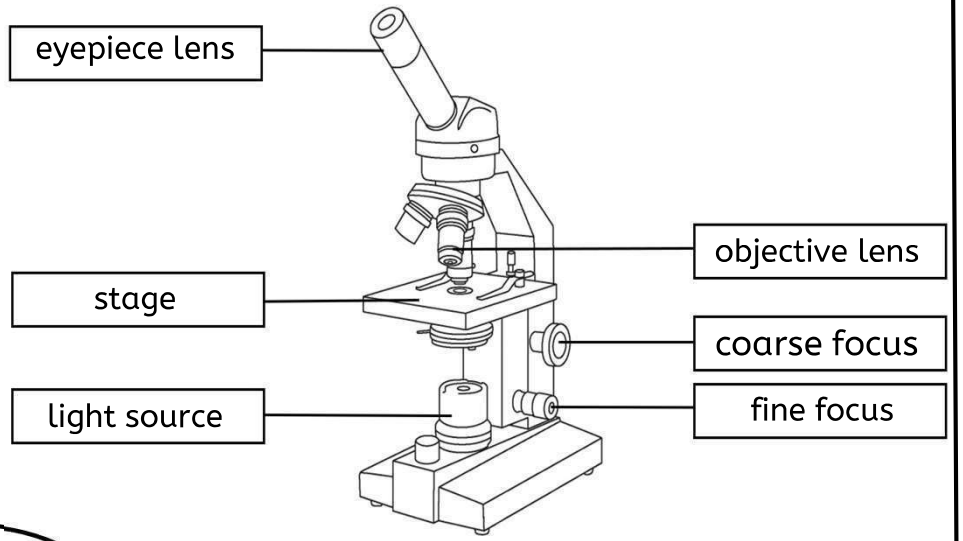
Process	Definition
Movement	Moving itself or its parts to change position or location.
Reproduction	Producing offspring of the same kind.
Sensitivity	Sensing and responding to changes in their surroundings.
Growth	Increasing in size and repairing parts that are damaged.
Respiration	Using oxygen and glucose (a sugar) to provide energy.
Excretion	Removal of waste substances that are no longer needed.
Nutrition	Using food or other nutrients like water to stay alive.

Levels or organisation

cell → tissue → organ → organ system

cell	The smallest living building block of organisms.
tissue	A group of similar cells that work together to perform a specific function.
organ	A structure made up of different types of tissues that work together to carry out a specific function.
organ system	A group of organs that work together to perform a common function.

The parts of the microscope



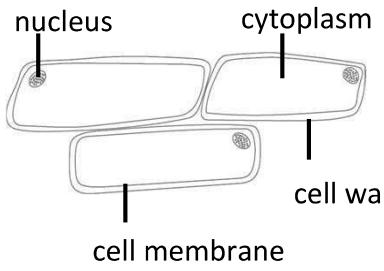
Total magnification = eyepiece x objective

Using a microscope

1. Turn the **objective lens** to the **lowest magnification**.
2. Secure the slide on the **stage** using the clips.
3. Move the **stage** up to the **objective lens** by turning the **coarse focus**.
4. Look down the **eyepiece lens** and move the stage away by turning the **coarse focus**.
5. To make the image sharper and clearer, turn the **fine focus.**
6. Rotate the **objective lens** to get a higher magnification.

Rules for scientific drawings of cells

Drawing of onion cells



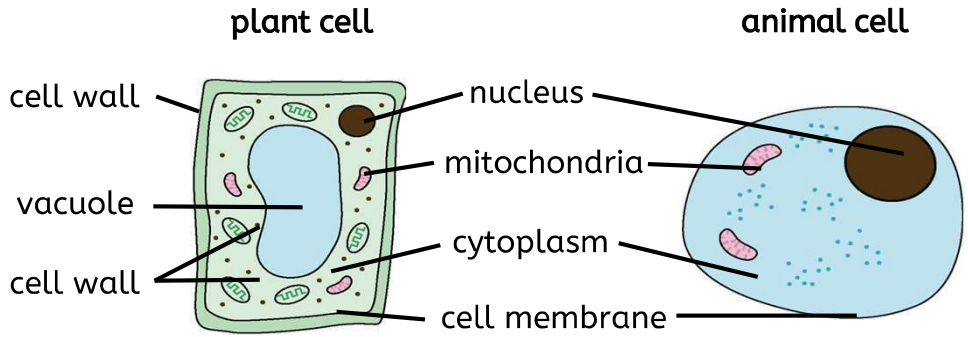
10 x 40 = x400

- smooth continuous lines
- large, with the same proportions
- stippling
- a few cells
- title and label
- total magnification

Cells and organisation

Cell organelles and their functions

nucleus	Contains the genome which controls the cell's activities.
cytoplasm	Where the chemical reactions of the cell take place.
mitochondria	Where energy is released in respiration.
cell membrane	Controls which substances enter or leave the cell.
vacuole	Stores a watery sap.
cell wall	Strengthen and support the cell.
chloroplasts	Where light is trapped for photosynthesis to happen.



Cells are three dimensional (3D).

The rate of diffusion

The rate of diffusion means how fast diffusion happens. Three factors that can affect the rate of diffusion are **temperature**, the **concentration** of particles and **surface area**.

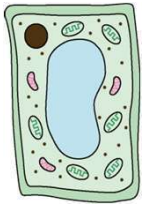
- The higher the temperature, the faster the rate of diffusion.
- The bigger the difference in the concentration of particles, the faster the rate of diffusion.
- The larger the surface area, the faster the rate of diffusion.

Needs of plants and animals for survival

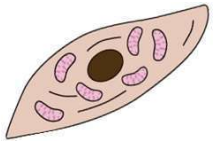
- Plants need oxygen, water, light, carbon dioxide, minerals, a suitable temperature, and space to grow.
- Animals, including humans, need water, oxygen, nutrients and the right temperature to survive.
- Plants and animals need these to keep all the cells that make them up alive and functioning properly.

Oxygen and **glucose** (a sugar) are needed for **respiration** to take place in cells, to provide energy to keep cells alive. These useful substances enter the cell by **diffusion.** Waste products of respiration are carbon dioxide and water. Waste products leave the cell by diffusion and need to be removed from cells to keep them alive.

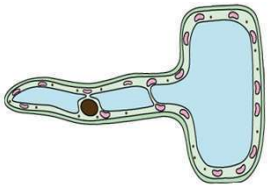
Specialised cells are adapted to carry out a specific function



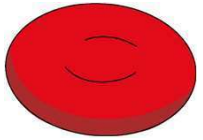
<u>Palisade cell</u>
Lots of chloroplasts that absorb light for photosynthesis. **Column shape** to pack more in the leaf.



<u>Muscle cell</u>
Lots of mitochondria to release energy for contraction.



<u>Root hair cell</u>
A long cell membrane that provides a large surface area to absorb more water and minerals.



<u>Red blood cell</u>
No nucleus for space to carry more oxygen.