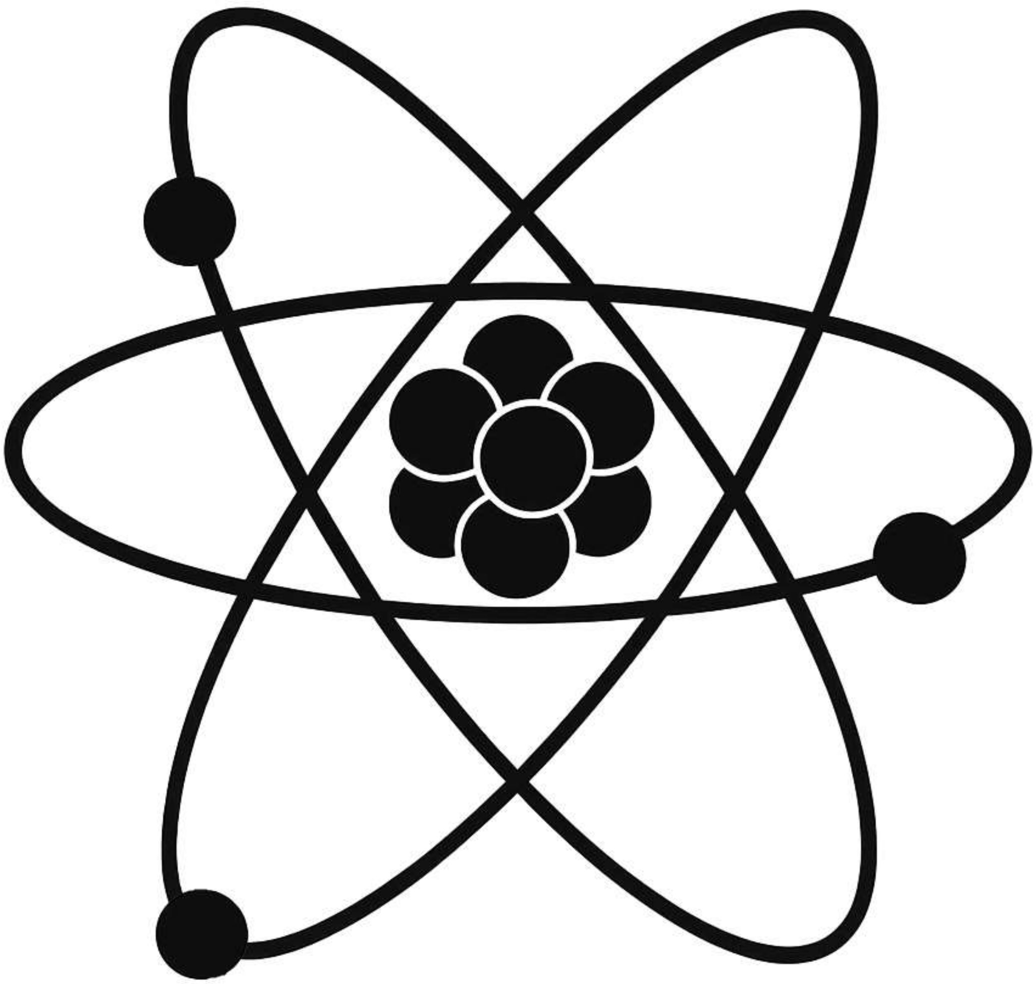
0625 IGCSE Physics
Summary Sheet
Assessment Test Prep



Prepared by:
The ReviseRoom Educator Team

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Thermal Physics

Kinetic Particle Model of Matter

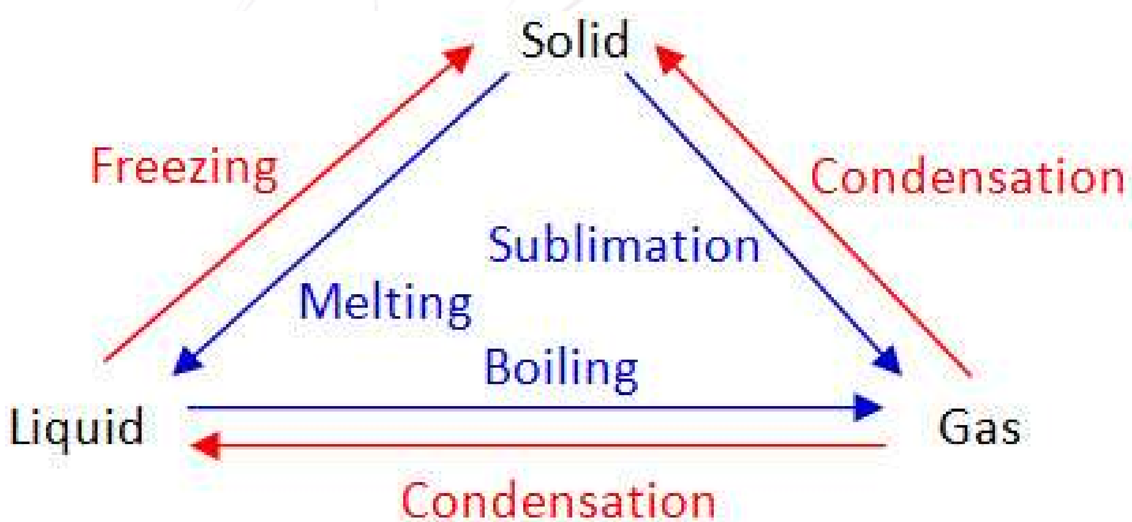
Key Assumptions:

- All matter is made of tiny, constantly moving particles.
- Particles have kinetic energy (energy of motion).
- The strength of forces between particles varies with state (strongest in solids, weakest in gases).
- Temperature affects particle speed (higher temp = faster movement).

Properties of Solids, Liquids, and Gases

Properties	Solids	Liquids	Gases
Arrangement	Tightly packed, fixed patter	Close/touching each other but can slide past each other	Random arrangement, far apart
Movement	Vibrate in fixed positions	Move/slide around each other	Move freely rapidly
Shape	Fixed shape	Take container's shape	Fills entire container
Forces	Very strong	Moderate (can break & reform)	Very weak (negligible)
Volume	Fixed volume	Fixed volume	Expands to fill space
Compressibility	Almost incompressible	Slightly compressible	Highly compressible
Density	High	High (but less than solids)	Very low

Change of states



Evaporating, Boiling, and Melting

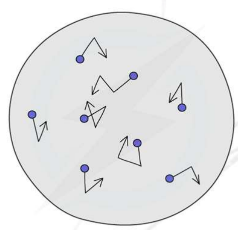
Evaporation	Boiling	Melting
Process of converting liquid into gas / vapor	Process of converting liquid into gas / vapor at boiling point	Process of converting solid into liquid
Occurs at any temperature	Occurs only at boiling point	Occurs only at melting point
Only at liquid surface	Anywhere within the liquid	At the surface
No bubbles formed	Bubbles formed	No bubbles formed
Opposite process is condensation by cooling	Opposite process is condensation by cooling	Opposite process is freezing by cooling

Absolute Zero

Lowest possible temperature where the particles have the least energy (-273°C / 0 K)

Brownian Motion

- Random collisions between the microscopic particles in a suspension and the particles of the gas or liquid
  - Pollen grains suspended in water show random / zig zag movement – due to random bombardment of fast-moving water molecules in all directions



Effect of pressure and temperature on gas

Pressure – caused by the forces exerted by particles colliding with surfaces, creating a force per unit area

Pressure is directly proportional to temperature (constant volume)

$$P \propto T$$

Pressure is inversely proportional to volume (constant temperature)

$$P \propto \frac{1}{V}$$

General Equation

$$pV = \text{constant}$$

$$p_1V_1 = p_2V_2$$

Converting between Kelvin and degrees Celsius

T (in K) = θ (in °C) + 273

Specific Heat Capacity

A rise in an object's temperature increases its internal energy (potential energy + kinetic energy)

Specific heat capacity (c) – the amount of **thermal energy (J)** required to raise the temperature of **1 kg** of a substance by **1°C** (or 1 K)

$$E = mc\Delta T$$

Key Concepts:

1. **High Specific Heat Capacity** → Substance absorbs **lots of energy** for a small temp change (e.g., water: **4200 J/kg°C**).
2. **Low Specific Heat Capacity** → Substance heats up/cools down **quickly** (e.g., metals like copper: **385 J/kg°C**).

Thermal Properties and Temperature

Thermal expansion

When temperature increases:

Solid	Liquid	Gas
Molecules vibrate faster – expand slightly	Molecules move around faster – expand	Molecules move around more rapidly – expands by a large amount

Thermal Energy Transfers

Method	How it works	Medium Required?
Conduction	Heat transfer through a solid by vibrating particles	Requires a solid (best in metals)
Conduction in metals	• Lattice vibrations transfer energy to neighbouring particles • Delocalised / free electrons carry energy through the metal	
Convection	• Heat transfer in fluids (liquids/gases) due to density changes—hot rises, cold sinks • Convection currents occur	Requires a fluid (liquid/gas)
Radiation	Heat transfer via infrared waves	No medium required

Factors affecting radiation

1. Temperature – the hotter an object, the more radiation it emits
2. Surface area – the larger the surface area of an object, the more radiation it emits

Best absorbers – dull black surfaces

Best emitters – dull black surfaces

Worst absorbers – shiny white surfaces

Worst emitters – shiny white surfaces

Chapter 1 – Boring Measurement Stuff

All The SI Units and Physical Quantities

Physical Quantity	SI Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Area	square metre	m^2
Volume	cubic metre	m^3
Density	kilogram per cubic metre	kg/m^3
Speed	metre per second	m/s

Measuring Instruments

Instrument	Typical Use / Measurement Range	Precision
Metre rule	Lengths ~1 mm to 1 m (e.g. 10–100 cm)	±0.1 cm (1 mm)
Vernier caliper	Small lengths & diameters (e.g. 2.3 cm)	±0.01 cm (0.1 mm)
Micrometer screw gauge	Very small lengths (e.g. 0.25 cm)	±0.001 cm (0.01 mm)
Measuring cylinder	Volumes of liquids (~10 mL to 1 L)	±1 mL (varies)
Electronic balance	Mass (solids/liquids)	±0.01 g or better
Stopwatch	Time (reactions, motions)	±0.01 s or ±0.1 s
Thermometer	Temperature	±0.5°C (typical)

Unit Conversions

Quantity	From	To	Conversion
Length	1 km	1000 m	× 1000
	1 m	100 cm	× 100
	1 cm	10 mm	× 10
Mass	1 tonne	1000 kg	× 1000
	1 kg	1000 g	× 1000
	1 g	1000 mg	× 1000
Time	1 hour	60 minutes	× 60
	1 minute	60 seconds	× 60
Area	1 m^2	10,000 cm^2	× 10^4
	1 cm^2	100 mm^2	× 100
Volume	1 m^3	1,000,000 cm^3	× 10^6
	1 cm^3	1000 mm^3	× 1000
Density	1 g/cm^3	1000 kg/m^3	× 1000
Speed	1 km/h	0.27 m/s	÷ 3.6

Density

Definition: Density is the mass per unit volume of a substance.

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

Unit: kg/m^3

Finding Density in Practice

1. **Measure mass** using a **digital/electronic balance**.
2. **Measure volume**:
    - **Regular object**: Use the formula for its volume.
    - **Irregular object**: Use a **measuring cylinder** and apply **displacement method**.

Motion & Everything Evil

Scalar VS Vector Quantities

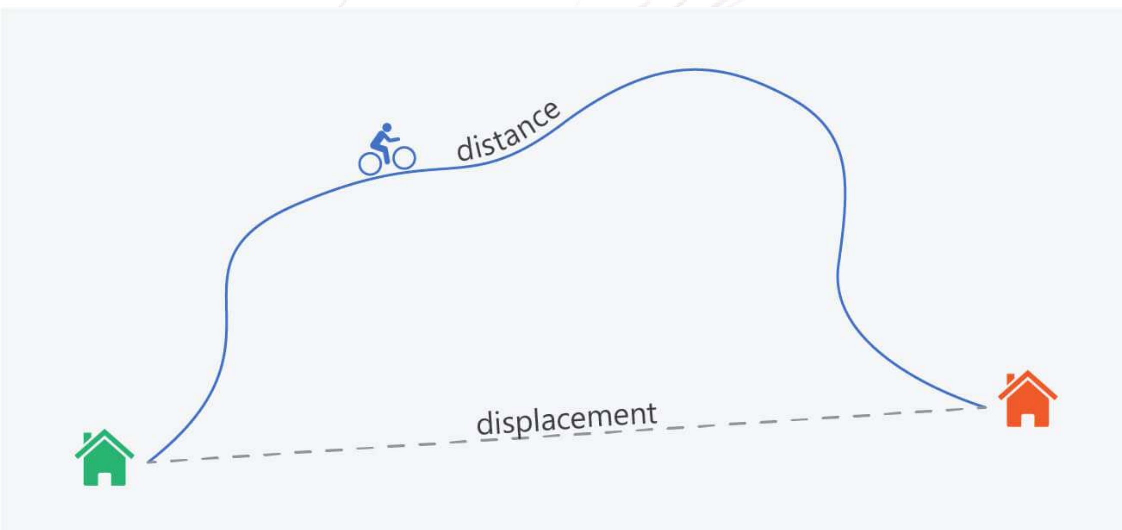
Scalar Quantity: A quantity with only magnitude and no direction.

Vector Quantity: A quantity with both magnitude and direction.

Examples

Scalars (No Direction)	Vectors (With Direction)
Distance	Displacement
Speed	Velocity
Time	Acceleration
Mass	Force
Energy	Weight
Temperature	Momentum
Volume	

Distance & Displacement

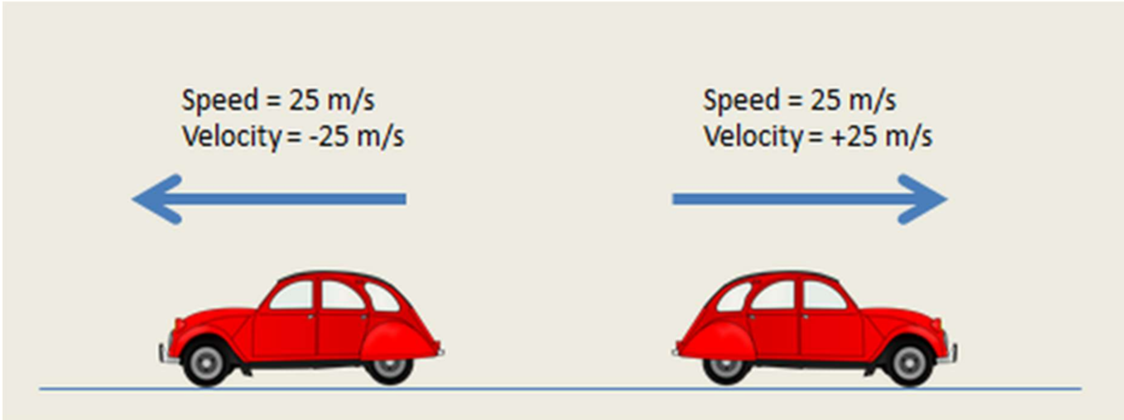


Distance vs Displacement

Distance: The total distance you travelled to reach a point.

Displacement: The closest distance between point A and point B with **direction**.

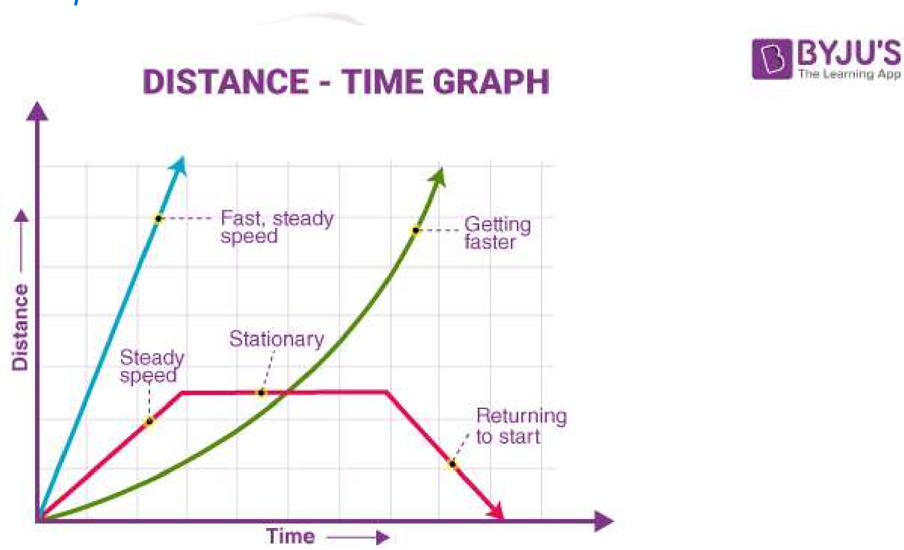
Speed & Velocity



Speed: the rate of change of distance with no particular direction

Displacement: the rate of change of displacement in a particular direction.

Distance-Time Graphs



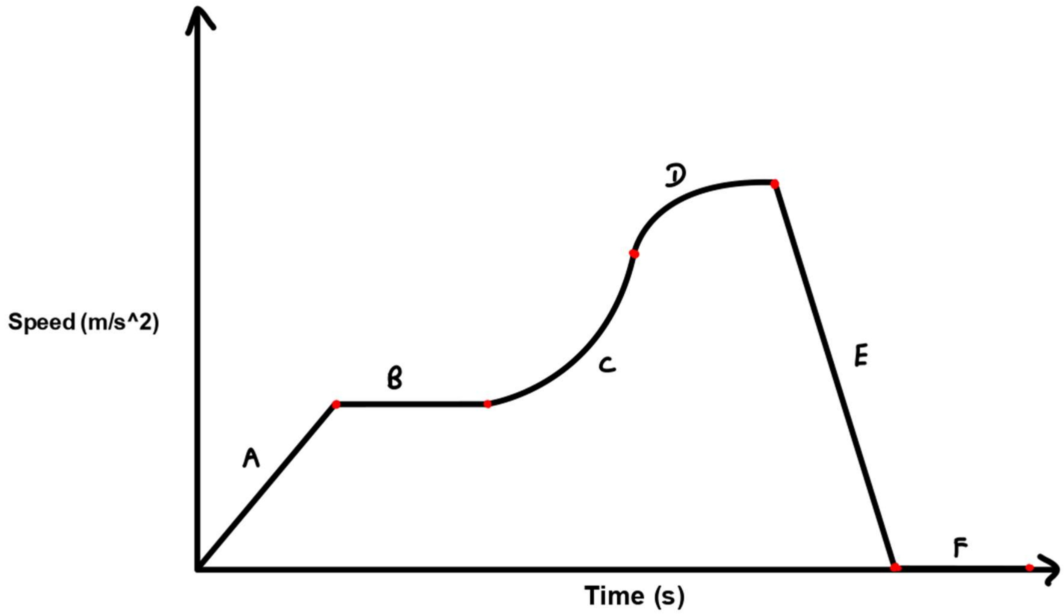
1. The blue line represents the object travelling at a **constant speed**. (straight diagonal line)

2. The green line represents the object **accelerating**. (curved upwards)

3. The red line represents the object:
   A. **Moving at a constant speed (straight upwards)**
   B. **At rest (horizontal line)**
   C. **Moving backwards at a constant speed (straight downwards)**

The gradient of a distance time graph tells you the speed/velocity of the object.

Speed-Time Graphs



A: Constant acceleration **[slope is straight and diagonal upwards]**

B: Constant speed **[slope is horizontal and above y=0]**

C: Increasing acceleration (or non-constant acceleration) **[slope is curving upwards]**

D: Decreasing acceleration (or non-constant acceleration) **[slope is getting smaller but still positive]**

E: Constant Deceleration **[slope is diagonally straight downwards]**

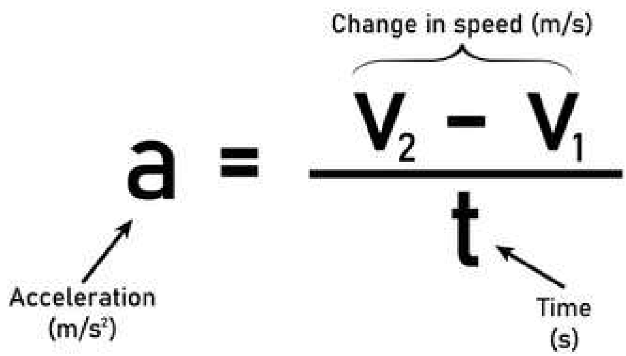
F: At rest **[graph is at y = 0]**

The gradient of a speed-time graph tells you the acceleration.

The area under the graph tells you the total distance travelled.

Acceleration

Acceleration is the rate of change of speed.



Deceleration is negative acceleration.

- When calculating **deceleration,** don't forget to convert the negative value to positive.

Acceleration can be uniform or non-uniform.

Equations of Motion

Quantity	Formula	Units
Speed	$\text{speed} = \frac{\text{distance}}{\text{time}}$	m/s
Average speed	$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$	m/s
Acceleration	$a = \frac{v-u}{t}$	m/s^2
Distance (from velocity-time graph)	$\text{distance} = \text{area under v–t graph}$	m

Free Fall, Gravity, and Air Resistance

Definition: Free fall is motion under only the **gravitational force**, with **no air resistance**.

- In free fall, all objects accelerate downwards at the **same rate (9.8m/s^2)**

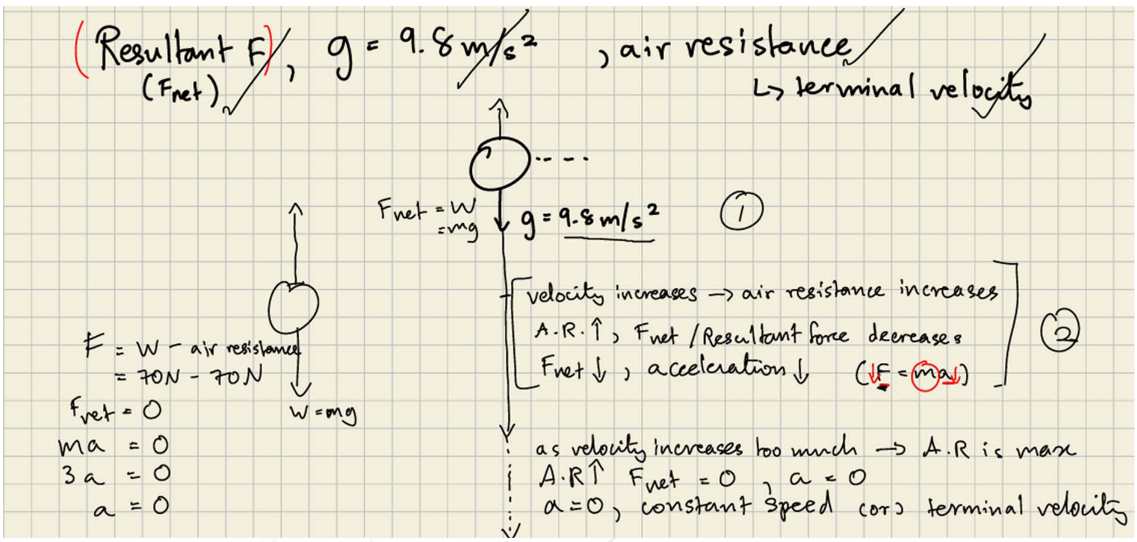
Gravity on earth has a value of **9.8m/s^2**.

Air resistance is a drag force that resists motion of objects through air.

Air resistance is **increased** by:

- larger surface area,
- faster velocity
- bigger overall size

Lecture notes/falling object notes regarding resultant force (F_{net}):



Newton's Laws of Motion

1st Law – Law of Inertia

An object will remain at rest or in uniform motion in a straight line unless acted upon by an external force.

Key Points:
- No resultant force → No change in motion.
- Motion continues at constant speed and same direction.
- Explains why seatbelts are needed (you keep moving when car stops suddenly).

2nd Law – F = ma

The acceleration of an object is directly proportional to the resultant force acting on it, and inversely proportional to its mass.

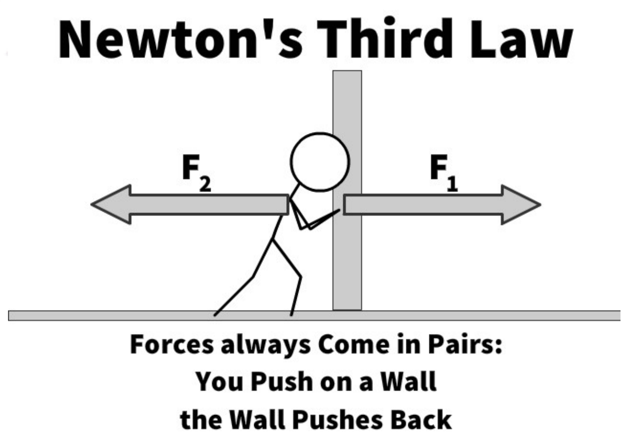
$$F = ma$$

Key Points:
- **More force = more acceleration**
- **More mass = less acceleration** for the same force
- Direction of force = direction of acceleration

3rd Law – Action and Reaction

For every action, there is an equal and opposite reaction.

Key Points:
- Forces always act in **pairs**.
- **Forces are:**
  - Equal in magnitude
  - Opposite in direction
  - Act on different objects



Different Types of Forces

Force	Description	Examples
Weight	Gravitational pull on an object	An apple falling from a tree
Normal Contact Force	Reaction force exerted by a surface perpendicular to the object	Book resting on a table
Friction	Force that opposes motion between two surfaces in contact	Brakes slowing down a car
Air Resistance	Frictional force acting against motion through air	A parachute slowing a fall
Tension	Force in a stretched string, rope, or cable	Rope in tug-of-war
Upthrust	Upward force in liquids and gases opposing weight	Object floating in water
Electrostatic Force	Force between charged objects	Rubbing a balloon on hair, then attracting paper bits
Magnetic Force	Force between magnets or magnetic materials	Magnet attracting iron nail
Applied Force	General push or pull by a person or object	Pushing a trolley
Resultant Force	Single force that represents the vector sum of all forces acting on an object	Combines multiple forces to determine acceleration

Centre of Mass, Centre of Gravity & Stability

Centre of Mass
- The **point where the mass** of an object is considered to be concentrated.
- For symmetrical objects of uniform density, it is **at the geometric centre**.

Centre of Gravity
- The **point where the weight** of the object acts vertically downward.
- In uniform gravity, centre of gravity and centre of mass are usually **the same point**.

Stability
- An object is **stable** if it **returns to its original position** after being slightly tilted.
- Stability depends on:
  - The position of the centre of gravity.
  - The width of the base.

How to Increase the Stability of an Object

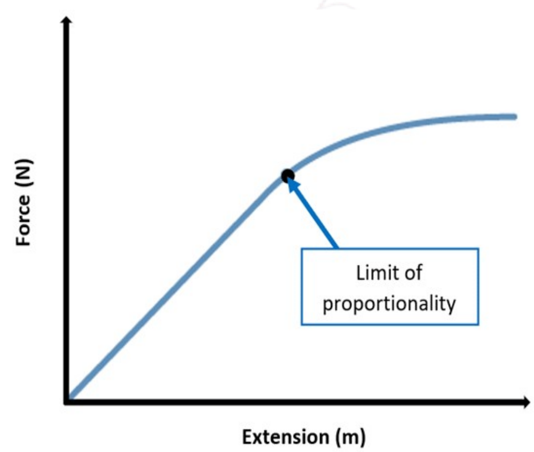
Method	Why it Increases Stability
Lower the centre of gravity	Makes the object harder to tip over
Widen the base area	Increases the range of angles before toppling occurs (larger base)
Ensure weight is evenly distributed	Avoids unbalanced turning forces

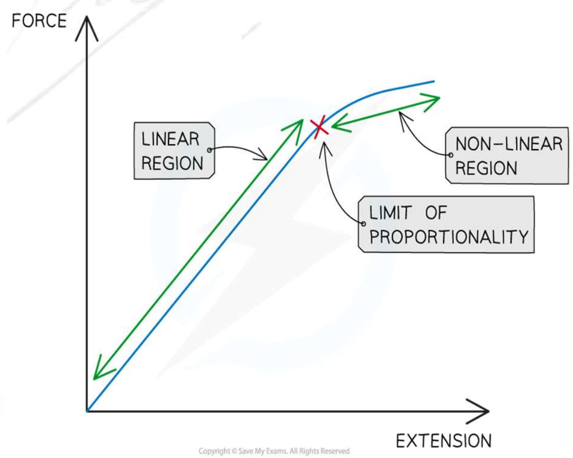
Hooke's Law & Limit of Proportionality

Hooke's Law states that the extension of a spring is **directly proportional** to the force applied, **provided the limit of proportionality is not exceeded**.

$$F = kx$$

F = Force applied on the spring
k = spring constant
x = extention of the spring





Force vs Extension Graph:

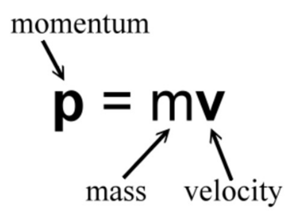
- **Straight line through origin** → obeys Hooke's Law
- **Curve starts forming** → limit of proportionality exceeded
- **Beyond elastic limit** → permanent deformation occurs

Limit of Proportionality: The limit of proportionality is the point beyond which the extension of a spring is **no longer directly proportional** to the applied force.

Momentum

Momentum: Momentum is the produce of the **mass** of the body and its **velocity**.

SI unit: $kgms^{-1}$



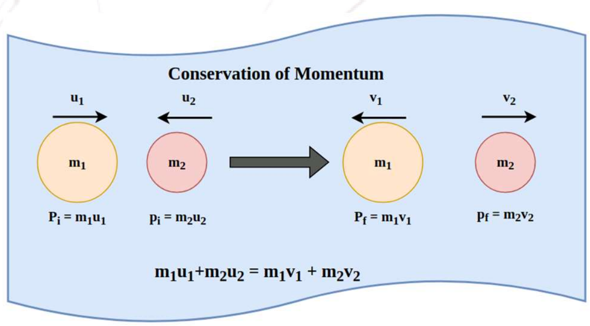
- Velocity if a vector quantity, hence momentum is also a vector quantity.
- If an object has **positive** momentum, then an object travelling in the **opposite direction** will have **negative** momentum.

Law of conservation of momentum

In the closed system, if there is no net external force acting on a system consisting of two bodies, the sum of the momentum of the two bodies will remain constant.

The total momentum before a collision = The total momentum after a collision

$$\mathbf{m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2}$$



- An object **at rest** has a momentum of **zero**. (zero velocity)

Impulse

F = ma

F = m ($\frac{v-u}{t}$)

Ft = mv – mu

Ft = impulse, mv – mu = change in momentum

Impulse = change in momentum

Ft = mv – mu

Unit: kgms^{-1} (or) Newton seconds (Ns)

Force and momentum

F = $\frac{mv-mu}{t}$

Therefore, **force** can be defined as **rate of change of momentum**.

Vector Diagrams

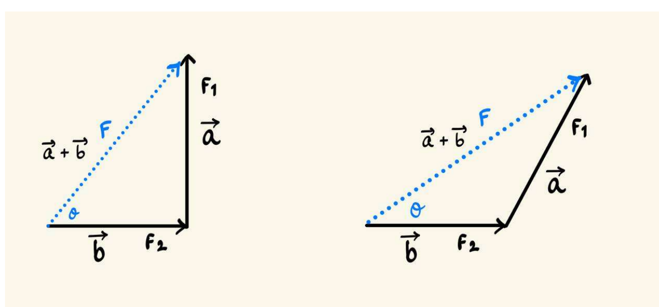
Vectors are represented by arrows:

- Length of arrow – magnitude
- Direction of arrow – direction of force

Vector addition

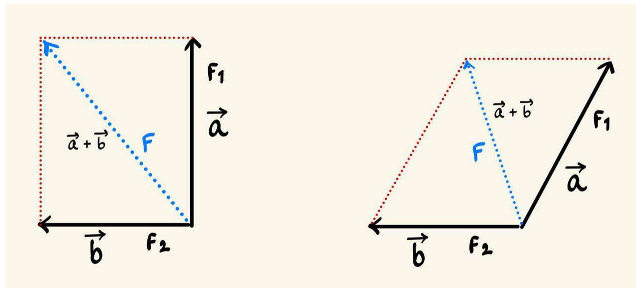
1. **Head-to-tail method**

- Draw the first vector. (F_1)
- Draw the second vector (F_2) starting at the **head** (arrow tip) of the first.
- The **resultant vector (F)** is drawn from the **tail of the first to the head of the last vector**.



2. **Parallelogram method**

- Draw both vectors to scale, forming adjacent sides of a parallelogram.
- Complete the parallelogram.
- The **resultant** vector is **diagonal** from the starting point.



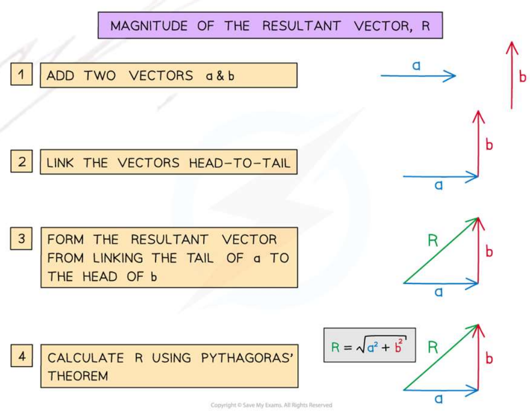
Which method to use?

Situation	Method
Vectors in a sequence (one after another)	Head-to-tail
Vectors from same origin point	Parallelogram

How to calculate the resultant vector?

Methods to use:

- Pythagoras' Theorem
- Trigonometric ratios
- Sine Rule
- Cosine Rule

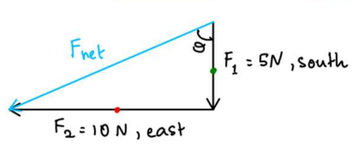


How to calculate the direction (theta)?

Methods to use:

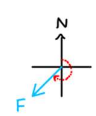
- Trigonometric ratios
- Sine Rule
- Cosine Rule

An object is acted on by two forces.
One force acts due east of the object with 10 N
The other force acts due south of the object with 5 N
Find the magnitude and the direction of the force.



$F_{net} = \sqrt{5^2 + 10^2}$
$= 11.2$ N
magnitude: 11.2 N

$\tan\theta = \frac{10}{5}$
$\theta = \tan^{-1}(2)$
$\theta = 63.4°$



Direction = Bearing + θ
$= 180° + 63.4°$
$= 243.4°$

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