# Physics Terms and Equations

**Position:** The place where you are located.

**Origin:** The reference point. The position from which you will take your measurements.

**Displacement**: The change in position between an "Origin" and "End" point.

**Delta (▲):** The Greek symbol for "Change in" = ▲ and the "d" refers to position.

▲d: Change in position.

Displacement = final position – initial position

$\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$

**Distance:** A measurement of "how far" two objects are apart or how far something traveled.

**Note: Distance** refers to the **total movement** in all directions. Ex: 3 → + 3 ↑ = 6

**Note: Displacement** refers to the **net movement** from an origin. Ex: 3 → + 3 ← = 0

**Note: Directions** could be: (north, south, east, west, left, right, up, down, forwards, backwards)

**Note: Displacement** can be: (Positive or Negative numbers)

**Vector:** A vector notation indicates that direction is identified.

**Vector Quantity:** Any measurement including both a "Quantity" or "size", (in Units) and a "direction".

**Scalar:** A scalar notation indicates only something that can be counted or measured.

**Scalar quantity:** Any quantities that have a "size" or a "magnitude" that can be measured.

**Note: <u>Scalars</u>** are measured with a size or a magnitude but without regard to direction. (It does **not** indicate a direction!)

**Note: <u>Vectors</u>** are quantities with magnitude *and* Direction.

(It has a measurement **and** indicates in what direction!)

**Scalar Measurements:** Mass, Length, Volume Time. = Measurements without a direction.

**Vector Measurements:** Speed with Direction = (velocity), Direction of travel = (displacement)

Vector: A specific measurement with magnitude and direction

(quantity) (size) ( N,E,S,W) (Left, right, up, down)

**Instant** of time: **(<u>Time</u>):** is a reading at a particular, precise moment.

**Time interval:** relates to the difference between two instants (of time).

**Note: <u>Time intervals</u>** are represented by ▲t: (change in time), t = time.

Interval of Time = Final Instant – Initial Instant

$\Delta t = t_2 - t_1$

**Speed:** Describes how fast an object is moving, regardless of direction.

**Velocity:** Describes how fast an object is moving and in which direction it moves in.

**Note: Speed** is determined by the distance you travel during an interval of time.

**Note: Velocity** is a certain speed in a stated direction.

**Average Velocity = change in position/change in time**

or

**Average Velocity = displacement/time interval**

$$\vec{v}_{avg} = \Delta\vec{d} / \Delta t$$

**Motion:** Describes **how far** and **how fast** an object moves.

**Uniform motion**: an object that continues to move in the same direction at the same speed.

**Note: Uniform motion** means "its motion is constant" (not changing).

**Position-Time Graph:** A graph where **time** is monitored on the Horizontal X-axis and **position** is tracked on the vertical Y-axis

**Note for graphs: Position** is tracked over the **Time** it took to happen.

**Slope:** On a graph of Position -Time the "slope" is equal to its "velocity" of the object.

**Note:** A flat line on a Position -Time graph means, there is no motion. The object is not moving.

**Note:** An increasing line on a Position -Time graph means, there is motion. Object moving away.

**Note:** A decreasing line on a Position -Time graph means, there is motion. Object moving closer.

**Note:** The steeper the slope, the faster the object is moving.

**Acceleration:** is the rate at which an object changes velocity over time.

**Note:** An objects speed is changing every moment, (there is no constant speed).

**Slope:** On a graph of Velocity -Time the "slope" is equal to its "velocity" of the object.

**Note:** A straight line on a Velocity -Time graph means, velocity is constant. (not changing)

**Note:** An increasing straight line on a Velocity -Time graph means, velocity is increasing at a constant rate. Object is speeding up. (changing its speed each second)

**Note:** A decreasing straight line on a Velocity -Time graph means, velocity is decreasing at a constant rate. Object is slowing down. (changing its speed each second)

**Note:** The steeper the slope, the faster the object's speed is changing.

**Note: Velocity** can be Positive or can be Negative. Speed can only be Positive.

**Aristotle's theory of motion (384 to 322 BC)**

- Falling bodies fall at a constant speed.
- Falling bodies fall faster if they are heavier.
- Falling bodies fall slower if they are met by some sort of resistance.
- You must apply a **"force"** to move an object.

**Galileo's theory of motion (1564 to 1642 AD)**

- Once you stop applying force to an object, friction will slow the object down to a complete stop.
- A body in motion will continue in motion at the same speed unless a force acts on the object from the opposite direction.
- In a vacuum, with all forces or friction removed, all objects fall at the same speed regardless of their mass.
- An object falling freely through the air or rolling freely down an inclined plane will undergo a constant acceleration.

**Newton's theory of motion (1642 to 1727)** **Newton's Three Laws**

- Newton's First Law: An object at rest stays at rest, and an object in motion stays in motion in a straight line and at constant velocity, unless acted upon by an outside for force.
  - **Note:** Newton's First Law is often called the **"Law of Inertia"**

- Newton's Second Law: When a force acts on a mass, acceleration is produced. The greater the mass, the greater the amount of force needed to cause acceleration.
  - **Note:** Newton's Second Law is often an explained as an equation: **F = M x A**
    **Force = Masse x Acceleration**

- Newton's Third Law: For every action, there is an equal and opposite reaction. (in other words: For every force, there is an equal force that opposes it.)
  - **Note:** Newton's Third Law uses symbols for identifying forces such as: "**Fa" and "fr"**
    Fa = the force that initiates the reaction, the "**action force**".
    Fr = the force that responds to the initial action, the "**reaction force**".

# Newton's laws of Motion

**Newton's First Law:**
Objects in motion tend to stay in motion, (in a straight line) **and** objects at rest tend to stay at rest unless acted upon by an outside force.

**Newton's Second Law:**
Force equals mass times acceleration (F=ma)

**Newton's Third Law:**
For every action there is an equal and opposite reaction.

**Note:** Aristotle stated that matter preferred to be at rest. He also stated that the speed of falling objects depends on their mass (weight).

**Note:** Galileo stated that objects of different masses, when dropped at the same time fall at the same speed, thus hitting the ground at the same time.

**Note:** Newton stated that objects move or stay at rest because that is what they want to do.

**Note:** Newton's First Law is often called the **"Law of Inertia"**

**Note:** Newton's Second Law explains that a heavy object will accelerate more slowly with a small force.

**Note:** Newton's Second Law explains that a heavy object will accelerate more quickly with a large force.

**Note:** Newton's Second Law explains that a light object will accelerate somewhat with a small force.

**Note:** Newton's Second Law explains that a light object will accelerate much more quickly with a large force.

**Note:** Newton's Third Law explains that when something or someone pushes on an object, the object does indeed push back.

# Reference Table for Motion Vocabulary

| Symbol | Quantity | Scalar/ Vector | Description | Question | Example |
|---|---|---|---|---|---|
| t | time | S | When something Occurs | When? | The train leaves @ 3:30pm |
| ▲t | time interval | S | How long something takes. It means the duration of the event | How Long | It lasted one minute |
| d | distance | S | How far two objects are apart | How far? | I travelled 13 km |
| $\vec{d}$ | position | V | Where the object is! | Where is the object? | The car is 2 km north of the school. |
| $\vec{\Delta d}$ | displacement | V | Change in position. | Where is the object Now? | The car is now 3km north. It was “displaced” 1km to the north. |
| v | speed | S | The distance covered in a specific period of time | How fast? | The car is travelling 110km/hr. |
| $\vec{v}$ | velocity | V | Speed and direction of motion | How fast and in what direction? | The boat is traveling 20km/h west. |
| $\vec{a}$ | acceleration | V | Change in velocity in a certain time or direction | Is the object changing velocity? | The driver is moving from 50km/hr to 100km/hr |