Motion, Forces & Newton's Laws

Speed involves distance & time

Average speed – can be calculated by dividing total distance by total time.

$$S = D/T$$

Instantaneous speed – an object's speed at a specific moment

When instantaneous speed does not change, an object is moving at **constant speed**; in this situation *average speed and instantaneous speed are the same*.

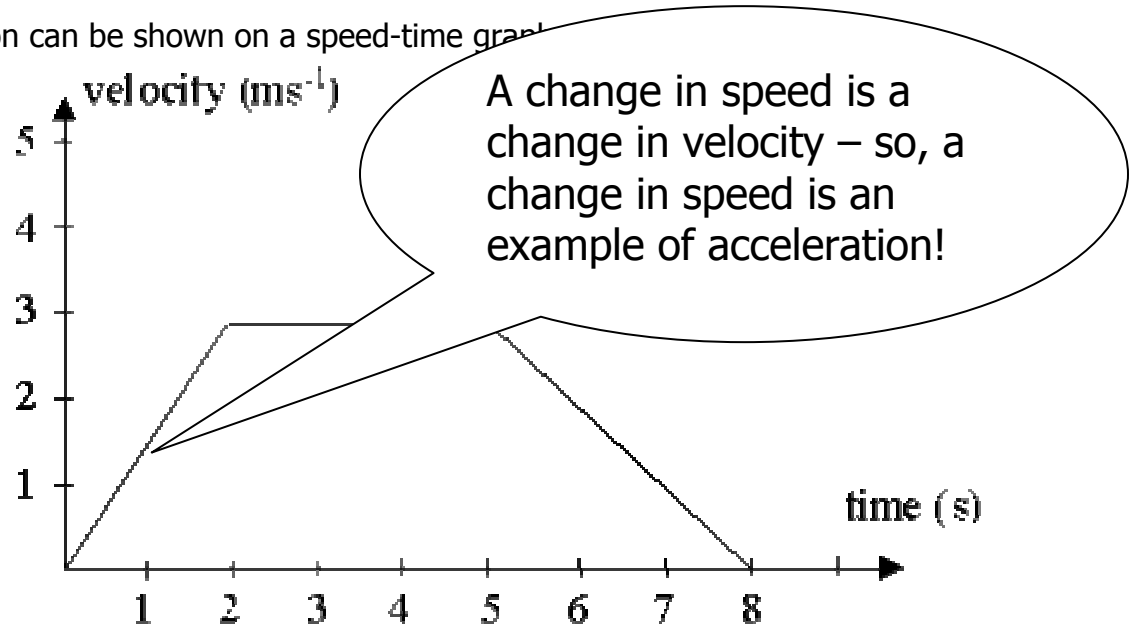
Speed and direction of motion is **velocity**.

Acceleration is the change in velocity divided by the time it takes for the change to happen. *It can be a change in speed or a change in direction or both*.

Acceleration can be calculated using this formula:

$$\mathbf{a} = \frac{\text{(final speed - initial speed)}}{\text{time}}$$

Acceleration can be shown on a speed-time graph



Acceleration may be *positive* or *negative*. Negative acceleration is sometimes called *deceleration*.

Force – a push or pull

When a *force* acts on an object; it may change the object's acceleration (speed, direction, or both).

Two or more forces that cancel each other out are **balanced forces**.

Two or more forces that do not cancel each other out are **unbalanced forces**.

The combination of all forces acting on an object is the **net force**.

Forces are measured in **newtons** (**n**).

Newton's Laws of Motion – explain how forces cause motion

Newton's 1st law – a moving object moves in a straight line with constant speed unless a force acts on it.

- ✓ An object will not start moving unless a force acts on it
- ✓ An object will not stop moving unless a force acts on it
- ✓ An object will not change speed unless a force acts on it
- ✓ An object will not change direction unless a force acts on it

Friction – a force that resists movement between two surfaces.

An object's tendency to resist a change in motion is **inertia**.

The more mass an object has, the more inertia it has.

This means that the more mass an object has, the harder it is to move, stop, or change the speed or direction of the object.

Newton's 2nd law – if an object is acted upon by a net force, the change in velocity will be in the direction of the force. - Objects move in the direction they are pushed or pulled.

Acceleration can be calculated as

Acceleration = force/mass

~or~

Force = mass X acceleration

The more mass an object has the more force it takes to cause acceleration.

- ✓ Big masses are hard to accelerate.
- ✓ Small masses are easy to accelerate.
- ✓ Objects accelerate more quickly when a greater force is used.

Newton's 3rd law – forces always occur in equal but opposite pairs.

When one object exerts a force on another object, the second object exerts a force of *equal strength in the opposite direction* on the first object

The equal and opposite forces act on *different objects*.