7 On the Move

7.1 Speed and Velocity

- **Displacement** is distance in a given direction.
- **Speed** is defined as change of distance per unit time.
- **Velocity** is defined as change in displacement per unit time, or
    - Velocity is speed in a given direction.

The unit of speed and velocity is the metre per unit second ms^{-1}.

An object moving at **constant speed** travels equal distance in equal times.

- For an object which travels distance s in time t at constant speed.

$$\text{speed } v = \frac{s}{t}$$
$$\text{distance travelled } s = vt$$

- For an object moving at constant speed on a circle of radius r, its speed

$$v = \frac{2\pi r}{T}$$

For an object moving at **changing speed** that travels a distance Δs in time Δt

$$v = \frac{\Delta s}{\Delta t}$$

The **delta notation** Δ means <u>a change of</u> something.

Distance-time Graphs

A distance-time graph is a graph of distance against time.

- For an object moving at **constant speed**, its distance-time graph is a **straight line with constant gradient**.

$$\text{speed } = \frac{s}{t} = \text{gradient of line}$$

- For and object moving at **changing speed**, the gradient of the line changes.
    - The gradient of the line at any point can be found by drawing a **tangent to the line** at that point.
    - Then measuring the gradient of the tangent.

Velocity

An object moving at **constant velocity** moves at the same speed without changing its direction of motion.

- If an object changes its **direction of motion** or its **speed** or both, its velocity changes.

- The velocity of an object moving on a **circular path** at constant speed **changes continuously** because its direction of motion changes continuously.

An object travelling along a straight line has two possible directions, so the **displacement-time graph** can have a negative gradient when the object moves in the **negative direction**.

7.2   Acceleration

Acceleration is defined as change of velocity per unit time, the unit of acceleration is metre per second per second ms^{-2}.

- Acceleration is a vector.

- **Deceleration values** are negative and signify that velocity **decreases with respect to time**.

Uniform Acceleration

Uniform acceleration is where the velocity of an object **moving along a straight line changes at a constant rate** such that the acceleration is constant.

For an object that **accelerates uniformly** from velocity u to velocity v in time t along a straight line.

$$a = \frac{v - u}{t}$$
$$v = u + at$$

Non-uniform Acceleration

Non-uniform acceleration is where the direction of motion of an object changes, or its speed changes, at a **varying rate**.

It can be seen from a **velocity-time graph** because the gradient is not constant.

Acceleration = gradient of the line on the velocity-time graph