

# Understanding Acceleration, Time, Distance, and Velocity

GCSE Physics

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# Distance

**Distance** is the total length of the path traveled by an object.

*Units:* Meters (m)

**Example:**

If you walk around a park and cover 500 meters, your distance is 500 m.

# Time

**Time** is the duration in which an event occurs.

*Units:* Seconds (s)

**Example:**

If it takes you 5 minutes to walk a distance, that's 300 seconds.

# Displacement

**Displacement** is the change in position of an object from its starting point to its final point, in a straight line and with direction.

*Units:* Meters (m)

## **Example:**

If you walk 3 meters east and then 4 meters west, the total distance is 7 meters, but your displacement is 1 meter to the west.

# Velocity

**Velocity** is the rate of change of displacement with respect to time.

**Formula:**

$$v = \frac{d}{t}$$

*Where:*

$v$  = velocity (m/s)

$d$  = displacement (m)

$t$  = time (s)

**Example:**

Using the previous displacement example: If it takes you 10 seconds to walk 1 meter west (your displacement), your velocity is:

$$v = \frac{1 \text{ m}}{10 \text{ s}} = 0.1 \text{ m/s west}$$

# Acceleration

**Acceleration** is the rate of change of velocity with respect to time.

**Formula:**

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

*Where:*

$a$  = acceleration ( $\text{m/s}^2$ )

$\Delta v$  = change in velocity ( $\text{m/s}$ )

$\Delta t$  = change in time ( $\text{s}$ )

**Example:**

If a car speeds up from 10 m/s to 20 m/s in 5 seconds, its acceleration is:

$$a = \frac{20 - 10}{5} = 2 \text{ m/s}^2$$

# Kinematic Equation for Distance

**Equation:**

$$v^2 - u^2 = 2ax$$

*Where:*

$v$  = final velocity (m/s)

$u$  = initial velocity (m/s)

$a$  = acceleration (m/s<sup>2</sup>)

$x$  = distance (m)

## Example Problem: Aircraft Take-off

### **Problem:**

An aircraft accelerates from 20 km/h to 180 km/h along a runway with an acceleration of  $4 \text{ m/s}^2$ . Calculate the distance it travels along the runway.



## Solution: Aircraft Take-off

### Solution:

Convert speeds from km/h to m/s:

$$20 \text{ km/h} = \frac{20 \times 1000}{3600} = 5.56 \text{ m/s}$$

$$180 \text{ km/h} = \frac{180 \times 1000}{3600} = 50 \text{ m/s}$$

Use the formula:

$$x = \frac{v^2 - u^2}{2a}$$

$$x = \frac{50^2 - 5.56^2}{2 \times 4} \approx \frac{2500 - 30.9}{8} \approx 308.89 \text{ m}$$

Therefore, the distance is approximately 308.89 meters.

## Example Problem: Car Acceleration

### **Problem:**

A car accelerates from 5 m/s to 25 m/s over a distance of 1500 cm. Calculate the acceleration.

## Solution: Car Acceleration

### **Solution:**

Convert distance from cm to m:

$$1500 \text{ cm} = 15 \text{ m}$$

Use the formula:

$$a = \frac{v^2 - u^2}{2x}$$

$$a = \frac{25^2 - 5^2}{2 \times 15} = \frac{625 - 25}{30} = \frac{600}{30} = 20 \text{ m/s}^2$$

Therefore, the acceleration is  $20 \text{ m/s}^2$ .