Motion is the displacement of an object from one place to another in time and space.
The physical quantities involved in describing motion are:

1. Displacement
2. Velocity
3. Acceleration

SCALARS AND VECTORS

Scalars are quantities that are fully described by **magnitude alone** (e.g., length, area, energy, temperature).
Vectors are quantities that are fully described by both **magnitude and direction** (e.g., displacement, velocity, acceleration, momentum, force).

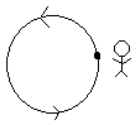
DISPLACEMENT

Displacement is defined as the **change in position** of an object.
***Note**: Displacement is not the same as distance.

It is a vector quantity given by:
$\Delta x = x_f - x_i$ in meters (m)

x_f is the final position of the object, in m
x_i is the initial position of the object, in m

Example 1: A person walks around a circle with radius 2m and returns to his or her initial position. Find the displacement and distance covered by the person.



VELOCITY

Velocity is defined as the **rate and direction of change in position** of an object.
***Note**: **Speed** is a scalar quantity; it is defined as the **distance travelled** per unit time. **Velocity** is a vector quantity; it is defined as the **displacement** per unit time.

It is a vector quantity given by:
Average velocity = $\Delta x/\Delta t$ meters/second (m/s)

ACCELERATION

Acceleration is defined as the **rate of change in velocity** of an object.
***Note**: If an object's velocity and acceleration are in the same direction, then the object's speed increases. If an object's velocity and acceleration are in opposite directions, then the object's speed decreases. (deceleration).

It is a vector quantity given by:
Average acceleration = $\Delta v/\Delta t$ meters/second ^{2} (m/s^2)

Example 2: An object starting from rest moves 100 meters in 50 seconds. Find the average velocity and average acceleration of the object.

ONE DIMENSIONAL MOTION WITH CONSTANT ACCELERATION*

The equations used to describe the motion of an object with constant acceleration are:

1. $v = v_0 + at$
2. $\Delta x = v_0 t + \frac{1}{2}at^2$
3. $v^2 = v_0^2 + 2a\Delta x$

v is the final velocity, in m/s
v_0 is the initial velocity, in m/s
a is the acceleration, in m/s^2
t is the time, in s
Δx is the displacement, in m

Example 3: A car starting from rest accelerates at a constant rate of 5.00 m/s^2. What is the velocity of the car after it has travelled 10 m? How much time does the car take to travel this distance?

FREELY FALLING OBJECTS

Objects falling in the presence of earth's gravitational force exhibit free fall acceleration (e.g., an object falling to the ground). The equations for freely falling objects are the same as the equations for motion of constant acceleration*.

***Note**: The value of acceleration (a) for freely falling objects is 9.8 m/s^2.

ANSWERS

Example 1:

1. The displacement of the person is zero because the initial and final positions of the person are the same.
2. The distance covered by the person is the circumference of the circle ($2\pi r$) =12.56 m.

Example 2:

1. The average velocity is: 100/50 = 2 m/s
2. The average acceleration is: 2/50 = 0.04 m/s^2

Example 3:

The time taken by the car to travel 10m is given by the equation:

$\Delta x = v_0 t + 1/2at^2$

Using values:
Δx = 10 m
v_0 = 0 m/s
a = 5.00 m/s^2

t = 2 s