# Topic 2 - Kinematics

## 1 Basic quantities

| Scalar | Vector |
|---|---|
| ***Distance, x***<br>the total length of path followed by object | ***Displacement, s***<br>The distance moved in a specified direction from a reference point |
| ***speed, v***<br>instantaneous speed is the rate of change of distance wrt time<br>$v = \frac{dx}{dt}$ | ***velocity, v***<br>instantaneous velocity is the rate of change of displacement wrt time<br>$v = \frac{ds}{dt}$ |
| average speed is the total distance travelled over total time taken<br>$\langle v \rangle = \frac{\Delta x}{\Delta t}$ | average velocity is the total change in displacement over total time taken<br>$\langle v \rangle = \frac{\Delta x}{\Delta t}$ |
| | ***Acceleration, a***<br>instantaneous acceleration is the rate of change of velocity wrt time<br>$a = \frac{dv}{dt}$ |
| | Average acceleration is the total change in velocity over total time<br>$\langle a \rangle = \frac{\Delta v}{\Delta t}$ |

## 2 Equations for uniformly accelerated motion

$$v = u + at \tag{1}$$

$$s = \frac{1}{2}(u + v)t \tag{2}$$

$$s = ut + \frac{1}{2}at^2 \tag{3}$$

$$v^2 = u^2 + 2as \tag{4}$$

## 3 kinematics of free fall and the effect of air resistance

objects in the uniform gravitational field of earth undergo uniformly accelerated motion downwards, and experience a constant acceleration with magnitude

$$g = 9.81 ms^{-2}$$

Objects experience air resistance, whose magnitude is proportional to velocity and whose direction is opposite to velocity

- on an object's way up, it experiences air resistance in the direction of downward acceleration due to gravity, hence

$$a_{up} > g$$

- on its way down, it experiences air resistance opposite gravity, hence

$$a_{down} < g$$

## 4 non-linear motion