

Speed, Velocity and Acceleration

Typical Speeds

- Walking = 1.5 m/s
- Running = 3 m/s
- Cycling = 6 m/s
- Car = 25 m/s
- Train = 55 m/s
- Plane = 250 m/s

Speed is how fast something is going without reference to a direction. It is a scalar quantity.

Velocity is a speed in a given direction. It is a vector.

$$s = vt$$

Labels: Distance (m) for 's', Time (s) for 't', Speed (m/s) for 'v'.

Acceleration

How **quickly** something is **speeding up**.
Deceleration is negative acceleration.

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

Labels: Acceleration (m/s²) for 'a', Change in velocity (m/s) for 'Δv', Time (s) for 't'.

Uniform Acceleration

This can happen due to gravity acting on an object in free fall.

$$v^2 - u^2 = 2as$$

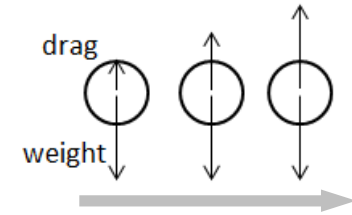
Labels: Final velocity (m/s) for 'v', Initial velocity (m/s) for 'u', Acceleration (m/s²) for 'a', Distance (m) for 's'.

eg. If a car travelling at 24m/s decelerates uniformly at 2m/s² as it enters a housing estate 120m away, what will its speed be as it reaches the housing estate?

1. Rearrange the equation: $v^2 = u^2 + 2as$
2. Put in numbers and calculate v²: $v^2 = 24^2 + (2 \times -2 \times 120) = 96$
3. Find the square root to give v: $v = \sqrt{96} = 9.8\text{m/s}$

Terminal Velocity

The maximum speed an object will fall at through a fluid (liquid or gas).

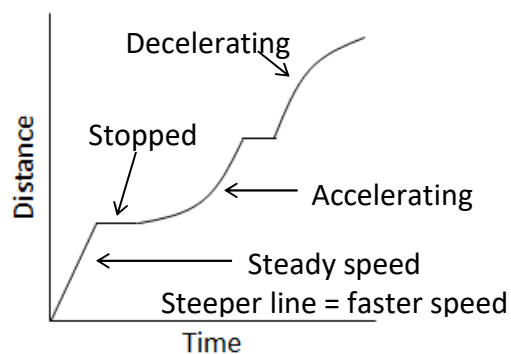


Speed increases so frictional force (drag) increases.

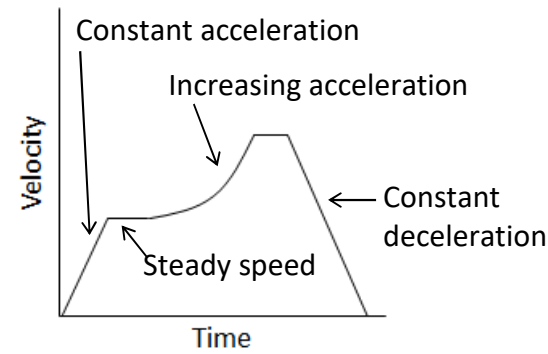
Acceleration is reduced until the drag is equal to the weight.
Terminal velocity is reached.

The **shape**, and **surface area** will affect terminal velocity. A larger surface area will increase air resistance so decrease terminal velocity.

Velocity-Time Graphs

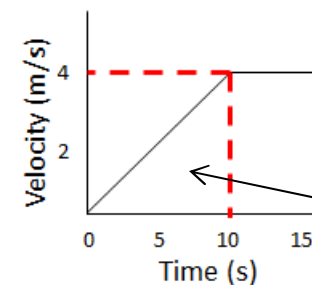


Velocity-Time Graphs



The **acceleration** is the **gradient** of the line ($\Delta v \div t$).

To work out the **distance** travelled, find the **area** under the line.



Eg. the distance over the first 10s is:

$$\frac{1}{2} \times 10 \times 4 = 20\text{m}$$

The area under the line is a triangle, so $\frac{1}{2}$ the area of a rectangle.