The kinematics equations can only be applied in cases (sweat) where the acceleration is constant in both magnitude & direction.

**Example**

A car travelling at 15 $ms^{-1}$ (u) accelerates by 1.2 $ms^{-2}$ (a) for 10s (t). What is its final velocity? (v)

$u = 15\ ms^{-1}$

$a = 1.2\ ms^{-2}$

$t = 10\ s$

$V = ?$

$V = u + at$ (ΔV)

$V = 15\ ms^{-1} + (1.2\ ms^{-2})(10\ s)$

$V = 15\ ms^{-1} + 12\ ms^{-1}$

$V = 27\ ms^{-1}$

**Example**

How far (s) does a bird travel if it accelerates by 0.15 $ms^{-2}$ (a) from a speed of 3.0 $ms^{-1}$ (u) to a speed of 5.0 $ms^{-1}$ (v)?

$a = 0.15\ ms^{-2}$

$u = 3.0\ ms^{-1}$

$V = 5.0\ ms^{-1}$

$s = ?$

$V^2 = u^2 + 2as$

$V^2 - u^2 = 2as$

$s = \frac{V^2 - u^2}{2a}$

$s = \frac{(5.0\ ms^{-1})^2 - (3.0\ ms^{-1})^2}{2(0.15\ ms^{-2})}$

$s = \frac{25\ m^2s^{-2} - 9\ m^2s^{-2}}{0.30\ ms^{-2}}$

$s = \frac{16\ m^2s^{-2}}{0.30\ ms^{-2}}$

$s \doteq 53\ m$

Example

An electron travelling at $2.0 \times 10^7 \text{ ms}^{-1}$ accelerates uniformly to a speed of $3.0 \times 10^7 \text{ ms}^{-1}$ in a time of 5.0 ns. How far does the electron travel in this time?

$\times 10^{-9}$

$u = 2.0 \times 10^7 \text{ ms}^{-1}$

$v = 3.0 \times 10^7 \text{ ms}^{-1}$

$t = 5.0 \times 10^{-9} \text{ s}$

$s = ?$

$$s = \left(\frac{u+v}{2}\right)t$$

$$s = \left(\frac{2.0 \times 10^7 \text{ ms}^{-1} + 3.0 \times 10^7 \text{ ms}^{-1}}{2}\right)(5.0 \times 10^{-9}\text{s})$$

$$s = (2.5 \times 10^7 \text{ ms}^{-1})(5.0 \times 10^{-9}\text{s})$$

$$s = 12.5 \times 10^{-2} \text{ m}$$

$$s = 1.25 \times 10^{-1} \text{ m}$$

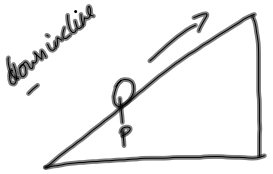
$$s \doteq 1.2 \times 10^{-1} \text{ m} \quad (0.12 \text{ m})$$

Example

A ball starts at a point P and is rolled up an incline with an initial speed of $2.5 \text{ ms}^{-1}$. Over a period of 4.0s its acceleration down the incline is $1.8 \text{ ms}^{-2}$. What is the ball's final displacement from P?

up +

define up as +, down as negative (the incline)




$u = +2.5 \text{ ms}^{-1}$

$t = 4.0\text{s}$

$a = -1.8 \text{ ms}^{-2}$

$s = ?$

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

$$s = (+2.5 \text{ ms}^{-1})(4.0\text{s}) + \frac{1}{2}(-1.8 \text{ ms}^{-2})(4.0\text{s})^2$$

$$s = 10 \text{ m} - 14.4 \text{ m}$$

$$s \doteq -4 \text{ m}$$

The ball finishes at 4 m below P. (downhill from P)

Example

A driver in her car slows down and stops at the traffic lights. The deceleration of the car is $1.4 m s^{-2}$ and it travels 25m before it stops. How long does it take to stop?

6.0s