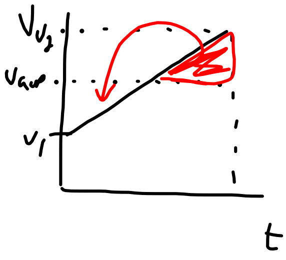
Kinematics Equations

Constant Velocity - $V = \frac{\Delta d}{\Delta t}$

Constant Acceleration - $a = \frac{\Delta V}{\Delta t}$ (where $\Delta V = V_2 - V_1$)



$V_{ave} = \frac{\Delta d}{\Delta t}$ $\left(V_{ave} = \frac{V_1 + V_2}{2}\right)$

Maybe Useful:

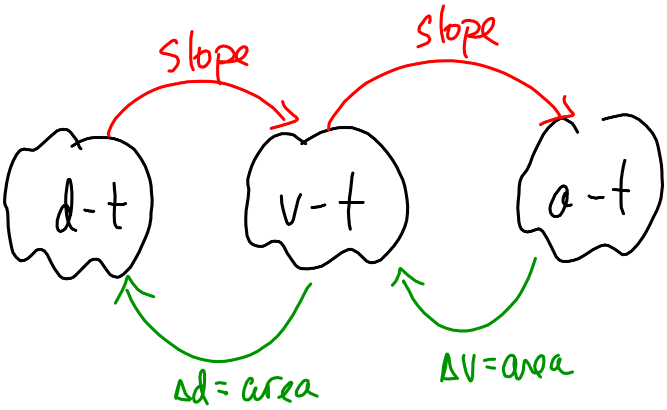
① $\Delta d = v_1 \Delta t + \frac{1}{2} a (\Delta t)^2$

② $\Delta d = V_2 \Delta t - \frac{1}{2} a (\Delta t)^2$

③ $V_2^2 = v_1^2 + 2 a \Delta d$

If you know 3 of the 5 kinematics variables you can find the other 2. ($V_1, V_2, a, \Delta t, \Delta d$)

GRASP is important.



PP|89

7. $V_1 = 20.0\,m/s$

$\Delta d = 1.50 \times 10^2\,m$

$\Delta t = 10.0\,s$

$V_2 = ?$

$$V_{ave} = \frac{\Delta d}{\Delta t}$$

$$\frac{V_1 + V_2}{2} = \frac{\Delta d}{\Delta t}$$

$$V_1 + V_2 = \frac{2\Delta d}{\Delta t}$$

$$V_2 = \frac{2\Delta d}{\Delta t} - V_1$$

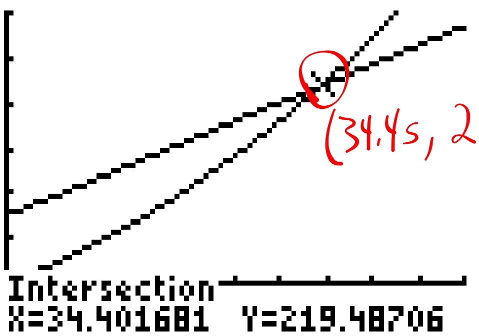
$$V_2 = \frac{2(1.50 \times 10^2\,m)}{10.0\,s} - 20.0\,m/s$$

$$V_2 = 30.0\,m/s - 20.0\,m/s$$

$$V_2 = 10.0\,m/s$$

The final velocity will be 10.0 m/s.

5. Robert + Michael



(34.4s, 219.5m)

← graph R $y_1 = 4.2x + 75$

m $y_2 = 3.8x + 0.075x^2$

Michael catches Robert after 34.4s and 219.5m from start.

Example

An airplane must reach a velocity of 71 m/s for takeoff. If the runway is 1.0 km long, what must the constant acceleration be?

$v_1 = 0\ m/s$

$v_2 = 71\ m/s$

$\Delta d = 1.0\ km = 1.0 \times 10^3\ m$

$a = ?$

$$v_2^2 = v_1^2 + 2a\Delta d$$

$$\frac{v_2^2 - v_1^2}{2\Delta d} = \frac{2a\Delta d}{2\Delta d}$$

$$a = \frac{v_2^2 - v_1^2}{2\Delta d}$$

$$a = \frac{\left((71\ m/s)^2 - 0^2\right)}{\left(2(1.0 \times 10^3\ m)\right)}$$

$$a = 2.5\ m/s^2$$

The plane must have a constant acceleration of $2.5\ m/s^2$