Kinematics Equations

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

Constant Acceleration: $v_{ave} = \frac{\Delta d}{\Delta t}$ (where $v_{ave} = \frac{v_1 + v_2}{2}$)

$a = \frac{\Delta v}{\Delta t}$ (where $\Delta v = v_2 - v_1$)

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

There are 5 variables: $v_1, v_2, \Delta t, a$ and Δd

If you know any 3 of these, you can find the other 2.

Try to keep it simple!

Example - Calculating Acceleration from Displacement + Velocity

An airplane must reach a velocity of 71 m/s (V_2) for takeoff. If the runway is 1.0 km (Δd) long, what must the constant acceleration ($a = ?$) be?

$V_1 = 0$

$V_2 = 71 \text{ m/s}$

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

$a = ?$

$$V_2^2 = V_1^2 + 2a\Delta d$$

$$V_2^2 - V_1^2 = 2a\Delta d$$

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

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

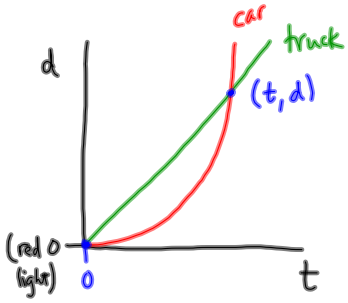
$$a = 2.5 \frac{\text{m}}{\text{s}^2}$$

UNITS: $\frac{\text{m}^2/\text{s}^2}{\text{m}}$

$\frac{\text{m}^2}{\text{s}^2} \cdot \frac{1}{\text{m}}$

$\frac{\text{m}}{\text{s}^2}$

MP|87



Truck - constant velocity

$v = 22\frac{m}{s}$ $\quad v = \frac{\Delta d}{\Delta t}$

$\Delta d = v\,\Delta t$

$d - 0 = (22\frac{m}{s})(t - 0)$

$d = (22\frac{m}{s})t$

$(y = mx + b)$

Car - constant acceleration

$a = 4.8 m/s^2$

$v_1 = 0$

$\Delta d = ?$

$\Delta t = ?$

$\Delta d = \cancel{v_1 \Delta t}^{0} + \frac{1}{2}a(\Delta t)^2$ $\quad (\Delta d = d - 0,\ \Delta t = t - 0)$

$d = \frac{1}{2}at^2$

$d = \frac{1}{2}(4.8\frac{m}{s^2})t^2$

$d = (2.4\frac{m}{s^2})t^2$

Using substitution:

$(22\frac{m}{s})t = (2.4\frac{m}{s^2})t^2$

$0 = 2.4t^2 - 22t$ (set equal to zero)

$0 = t(2.4t - 22)$

Set each factor equal to zero

$t = 0$ and $2.4t - 22 = 0$

$(2.4\frac{m}{s^2})t = 22 m/s$

$t = \frac{22 m/s}{2.4 m/s^2}$

$t = 9.2s$

Sub $t = 9.2s$ into: $d = (22\frac{m}{s})t$

$d = (22\frac{m}{s})(9.2s)$

$d = 2.0 \times 10^2 m$

$\vec{d} = 2.0 \times 10^2 m\ [N]$

To Do: PP|89 (all)

Calculator Pad (1-15)