2.3 Uniform Acceleration

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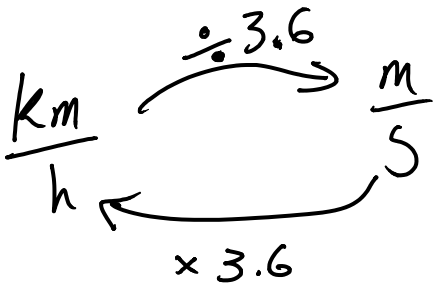
Quick Note! $\frac{km}{h} \Leftrightarrow \frac{m}{s}$ $\quad \frac{km}{h} \quad \frac{1000m}{1km} \times \frac{1h}{3600s} = \frac{m}{s}$



#1 $\vec{d} = \frac{v_i + v_f}{2} \cdot t$ $\quad$ #2 $\vec{a} = \frac{v_f - v_i}{t}$

What if we don't want v_f?

#2 solve for v_f

$\vec{a}t = \frac{v_f - v_i}{t} \cdot t \Rightarrow \vec{a}t = v_f - v_i$

$+v_i \qquad +v_i$

$v_f = (v_i + at)$

Substitute into #1

$d = \frac{v_i + (v_i + at)}{2} \cdot t \Rightarrow \vec{d} = \left(\frac{2v_i}{2} + \frac{at}{2}\right) \cdot t$

#3 $\boxed{\vec{d} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2}$

Ex. Dead Jeff is strapped into a wing suit and kicked out of a plane. The

wingsuit lets him fall with an acceleration of $5\ m/s^2$ and his initial velocity $0.5\ m/s$ downward. How far has Dead Jeff fallen is 15 seconds?

$d = v_i t + \frac{1}{2} a t^2$

$v_i = 0.5\ m/s$

~~$v_f =$~~

$a = 5\ m/s^2$

$d = ?$

$t = 15\ s$

$\vec{d} = 0.5(15) + \frac{1}{2}(5)(15)^2$

$\vec{d} = 7.5 + \frac{1}{2}(5)(225)$

$\vec{d} = 7.5 + 562.5$

$\boxed{\vec{d} = 570\ m}$

What if we don't have time?

#1 $d = \frac{v_i + v_f}{2} t$

#2 $a = \frac{v_f - v_i}{t}$

#2 solve for t

$t \cdot \frac{\vec{d}}{t} = \frac{\vec{v}_f - \vec{v}_i}{a} \cdot t$

$t = \frac{v_f - v_i}{a}$ ⇒ substitute into #1

$\vec{d} = \frac{v_i + v_f}{2}\left(\frac{v_f - v_i}{a}\right) \Rightarrow \vec{d} = \frac{(v_i + v_f)(v_f - v_i)}{2a}$

$\vec{d} = \frac{-v_i^2 + v_f^2}{2a}$

$\Rightarrow \vec{d} = \frac{v_f^2 - v_i^2}{2a} \cdot 2a$

2a

$2ad = v_f^2 - v_i^2$

$+v_i^2 \qquad +v_i^2$

$\Rightarrow$

#4 $\boxed{v_f^2 = v_i^2 + 2ad}$

Example: An investigater is investigating a car crash. Through observation and science she determines the cars slid 47m and decelerated at a rate of $3.2\,m/s^2$. How fast was the car going just before it crashed? To a stop $v_f = 0$

$v_i = ?$

$v_f = 0\,m/s$

$a = -3.2\,m/s^2$

$d = 47m$

$v_f^2 = v_i^2 + 2ad$

Solve for v_i

$\sqrt{v_i^2} = \sqrt{v_f^2 - 2ad}$

$v_i = \sqrt{(v_f^2 - 2ad)}$

$v_i = \sqrt{((0)^2 - 2(-3.2)(47))}$

$v_i = \sqrt{0 + 300.8} = \sqrt{300.8}$

$v_i = 17.345386$

$\boxed{v_i = 17\,m/s}$

#2 #3

#1 $\vec{d} = \frac{v_i + v_f}{2} \cdot t$

#2 $\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t}$

#3 $\vec{d} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$

#4 $\vec{v}_f^{\,2} = \vec{v}_i^{\,2} + 2ad$

① Write down the variables and what you know. v_i a / v_f d t

② Figure out which formula to use write it down.

③ Solve for the wanted variable.
General solving → no number

④ Plug in numbers, get your answer.

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