Lesson 1.2: Kinematics in 1D

Unit 1: Kinematics, Vectors, and Mathematics

Kinematics:

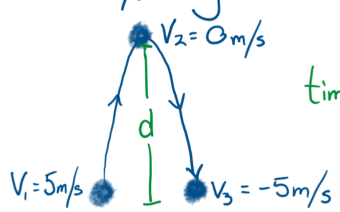
* The study of motion, not considering forces.

* we will keep acceleration constant.

Variables in Kinematics	**Equations in Kinematics**
$\vec{V}_0$ = initial velocity	$\vec{V}_f = \vec{V}_0 + \vec{a}t$
$\vec{V}_f$ = final velocity	$\vec{d} = \vec{V}_0 t + \frac{1}{2}\vec{a}t^2$
$\vec{a}$ = acceleration	$\vec{V}_f^2 = \vec{V}_0^2 + 2ad$
$\vec{d}$ = displacement	$\underbrace{\bar{V}}_{\text{Average Velocity}} = \frac{\vec{V}_f + \vec{V}_0}{2}$
$\vec{V}_0, \vec{V}_f, \vec{a}, \vec{d}$: Vector quantities (magnitude and direction)	$\bar{V} = \frac{\Delta \vec{d}}{\Delta t}$ (Δ = delta = "change in")
t = time	$\bar{a} = \frac{\Delta \vec{v}}{\Delta t}$

Free Fall:

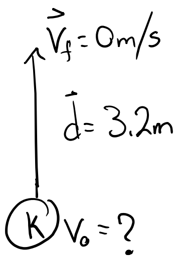
* $\vec{a}$ of Earth's gravity at sea level $\sim 9.81 m/s^2 =$ "g"
* Ignore air resistance.
* $\vec{a} = \pm 9.81 m/s^2$ (you define the coordinate system.



time up = time down.

Example 1: At what initial velocity must a kangaroo leave the ground to reach a max height of 3.2 m?

Model



Variables

$\vec{V}_0 = ?$

$\vec{V}_f = 0 m/s$

$\vec{a} = -9.81 m/s^2$

$\vec{d} = 3.2 m$

$\cancel{t =}$

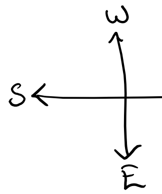
Equation(s)

$$\left.\begin{aligned} \vec{V}_f^2 &= \vec{V}_0^2 + 2\vec{a}\vec{d} \\ \vec{V}_0^2 &= \vec{V}_f^2 - 2\vec{a}\vec{d} \\ \vec{V}_0 &= \sqrt{\vec{V}_f^2 - 2\vec{a}\vec{d}} \end{aligned}\right\}$$

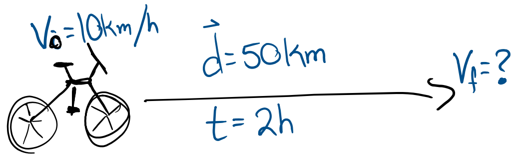
good practice rearranging first.

$$\vec{V}_0 = \sqrt{0 - 2(-9.81 m/s)(3.2 m)} = 7.9236 m/s \sim \boxed{7.9 m/s}$$

Example 2: A cyclist travelled 50 km north in 2 hours. If they started with a velocity of 10 km/h, what was the final velocity?



You choose the coordinate system!



$\vec{V}_0 = 10km/h$

$\vec{V}_f = ?$

$\vec{a} =$ need this!

$\vec{d} = 50km$

$t = 2h$

Find $\vec{a}$

$\vec{d} = \vec{V}_0 t + \frac{1}{2}\vec{a}t^2$

$50km = 10km/\cancel{h}(2\cancel{h}) + \frac{1}{2}a(2h)^2$

$50km = 20km + (2h^2)a$

$30km = (2h^2)a$

$a = 15km/h^2$

use to find $\vec{v}_f$

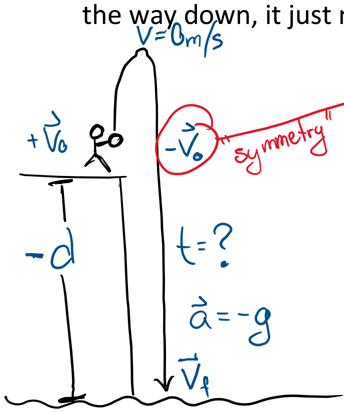
Find $\vec{V}_f$

$V_f = V_0 + at$

$V_f = 10km/h + 15km/h^{\cancel{2}}(2\cancel{h})$

$\boxed{V_f = 40km/h}$

Example 3: A ball is thrown upward from the edge of a 160 m high cliff with a velocity of 20.0 m/s. On the way down, it just misses the cliff and falls to the bottom. How long is the ball in the air?



"symmetry"

$\vec{V}_0 = \pm 20.0m/s$

$\vec{V}_f =$

$\vec{a} = -9.81m/s^2$

$\vec{d} = -160m$

$t = ?$

Method A:

*find $\vec{v}_f$ 1st

$\vec{v}_f^{\,2} = \vec{V}_0^{\,2} + 2\vec{a}\vec{d}$

$V_f = \pm\sqrt{(20)^2 + 2(-9.81)(-160)}$

$= -59.46m/s$

*Find t

$\vec{V}_f = \vec{V}_0 + \vec{a}t$

$t = \dfrac{\vec{V}_f - \vec{V}_0}{\vec{a}}$

$= \dfrac{(-59.46m/s) - (20.0m/s)}{9.81m/s^2}$

$t = 8.0999 \sim \boxed{8.1s}$

OR

$d = v_0 t + \frac{1}{2}at^2$

$-160 = 20t + \frac{1}{2}(-9.81)t^2$

$4.9t^2 - 20t - 160 = 0$

$t = \dfrac{20 \pm \sqrt{(-20)^2 - 4(4.9)(-160)}}{2(4.9)}$

$t = 8.1s$ or $\cancel{t = -4.0s}$

Assignment: WS 1.2 – Kinematics in 1D Practice