Vectors and Kinematics Notes

1 – Review

Velocity is defined as the change in displacement with respect to time.

$$\vec{v} = \frac{\Delta \vec{d}}{\Delta t}$$

remember
"→" means vector
"Δ" means change in

Note that this formula is only valid for finding **constant** velocity or **average** velocity. Also, if acceleration is constant:

$$v_{avg} = \frac{v + v_0}{2}$$

Ex: A sprinter runs from the 50.0 m mark to the 100.0 m mark in 4.50 s, what is his velocity?

$$v = \frac{\Delta d}{t} = \frac{d_f - d_i}{t} = \frac{100.0\text{ m} - 50.0\text{ m}}{4.50\text{ s}} = 11.1\text{ m/s}$$

Ex: A car traveling at 22 m/s slows down to 14 m/s in 3.00 s. What is its average velocity during this time?

$$v_{avg} = \frac{v + v_0}{2} = \frac{22\text{ m/s} + 14\text{ m/s}}{2} = 18\text{ m/s}$$

Whenever an object undergoes acceleration, we need to rely on our 3 kinematics equations. The variables for these are:

v : final velocity
v_0 : initial velocity
a : acceleration
d : displacement
t : time

There are three kinematics equations that use these variables.

1) $v = v_0 + at$

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

3) $v^2 = v_0^2 + 2ad$

Ex: A jet traveling at 65 m/s accelerates at 25 m/s^2 for 8.00 s. What is its final velocity?

$v = ?$
$v_0 = 65\text{ m/s}$
$a = 25\text{ m/s}^2$
$d =$
$t = 8.00\text{ s}$

$v = v_0 + at$
$v = 65\text{ m/s} + (25\text{ m/s}^2)(8.00\text{ s})$
$= 265\text{ m/s}$

Ex: A textbook is dropped from a high cliff and hits the ground 3.5 s later. What is the book's displacement?

$v =$
$v_0 = 0\text{ m/s}$
$a = -9.80\text{ m/s}^2$
$d = ?$
$t = 3.5\text{ s}$

$d = v_0 t + \frac{1}{2} a t^2$
$= \frac{1}{2}(9.80)(3.5)^2$
$= -60.\text{ m}$

Remember: acceleration due to gravity *near the Earth's surface* is the same for all objects regardless of mass!!!

$g = -9.80\text{ m/s}^2$

Note:
We generally assign up and right as "+" down and left as "−"

Ex: A student throws a ball straight up in the air at 14.2 m/s. What is its velocity when it is 6.0 m above its point of release?

$v = ?$
$v_0 = 14.2\text{ m/s}$
$a = -9.80\text{ m/s}^2$
$d = 6.0\text{ m}$
$t =$

$v^2 = v_0^2 + 2ad$
$v = \sqrt{v_0^2 + 2ad}$
$= \sqrt{(14.2\text{ m/s})^2 + 2(-9.80)(6.0)}$
$= \pm 9.2\text{ m/s}$

wait... what? Why is that?

Note: Displacements, velocities and accelerations can all be negative because they are *vectors*, which have both a magnitude and direction.