Kinematics Equation Sheet

Number	Unused Variable	Equation
1	d	$v_f = v_i + at$
2	a	$d = \bar{V} \cdot t \quad or \quad d = \left(\frac{v_i + v_f}{2}\right) t$
3	Vf	$d = vi \cdot t + \frac{1}{2} at^2$
4		
5		

$acceleration\ due\ to\ gravity\ g = 9.8\ m/s^2$

Kinematics Variables:

V_i = Initial Velocity, the start of the problem

V_f = Final Velocity, the end of the problem

d = displacement, the change in position between V_i and V_f

a = acceleration which changes V_i to V_f

t = time that it takes to go from V_i and V_f

Acceleration & Distance Example Problem opener

E1. A car traveling 25 ft/sec increases its velocity to 40 ~~ft~~/sec in 3.5 seconds.

$v_i = 25$ ft/sec
$v_f = 40$
$d = *$
$a = ?$
$t = 3.5$

a. What is the car's acceleration?

$V_f = V_i + at$

$40 = 25 + 3.5a$

$15 = 3.5a$ $\quad a = 4.29\ ft/s^2$

b. What is the car's average velocity?

$\bar{V} = \frac{V_i + V_f}{2} = \frac{25+40}{2} = 32.5\ \frac{m}{s}$

c. How far did the car go in the 3.5 seconds?

$d = \bar{V} \cdot t$

$32.5(3.5) = 114\ m$

Revisiting Area under the Curve

Finding the "area underneath the curve" for the **velocity vs. time** graph gives some interesting results. (You will always find the area between the curve (or line) and the horizontal axis.)

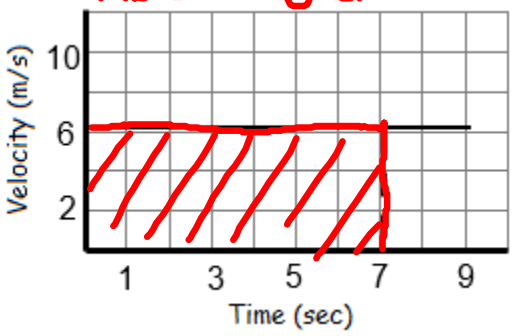
1 Find the area underneath the **velocity vs. time** line below.

a. How would you describe the motion of this object in the graph below?

CONSTANT Velocity

b. What shape is represented in the graph below, how would you calculate the area of this object?

RECTangle B·h



What is the length of the base? (Include units!)

7(s)

What is the height? (Include units!)

$6\ \frac{m}{s}$

Calculate the area. (Include units!)

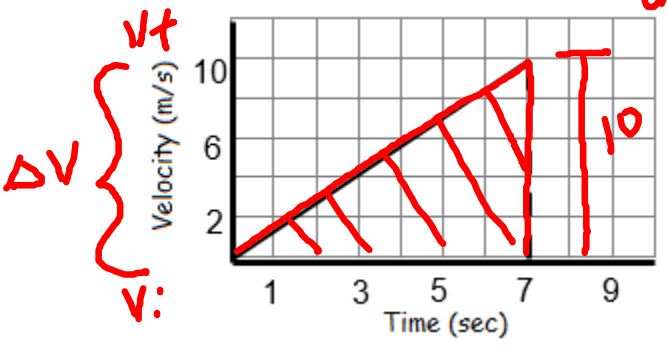
$7(s)\,6\left(\frac{m}{s}\right) = 42m$

b. What do the units of the area under a velocity vs. time graph show us?

AREA = displacement

2. How would you describe the motion of the object in the **velocity vs. time** graph below?

accelerating



a) What is the equation for the area of a triangle?

$\frac{1}{2}B \cdot h$

b) What is the length of the base? (Include units!)

7s

c) What is the height? (Include units!)

10 m/s

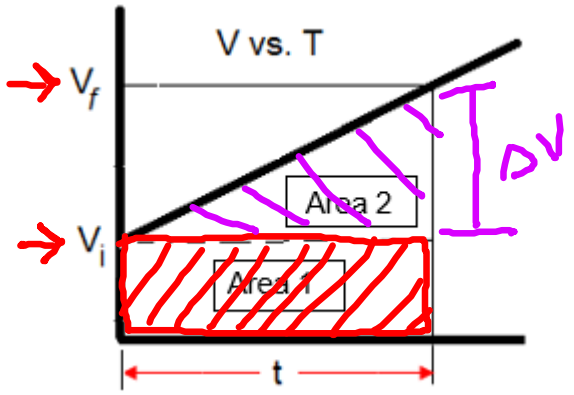
Calculate the area. (Include units!)

$\frac{1}{2}(7s)\left(10\ \frac{m}{s}\right) = 35m$

d. What does the height represent?

$V_f - V_i = \Delta V$

Let's combine the two!



1. Write an equation for the displacement in terms of the variables d (displacement) V_i (initial velocity), a (acceleration), and t (time) that you can use to determine the area under the velocity vs. time graph below.

   a) Let's start by finding the area of the rectangle, "Area 1".

$d_1 = V_i \cdot t$

Triangle A_2

b) Let's start by finding the area of the ~~rectangle, "Area 1"~~.

$d = \frac{1}{2} t \cdot \Delta V = \frac{1}{2} \Delta V \cdot t$

$d = \frac{1}{2} \Delta V \cdot t \frac{t}{t}$

acceleration

$d = \frac{1}{2}\left(\frac{\Delta V}{t}\right) t \cdot t = \frac{1}{2} a t^2$

c) Combine the combine the two displacements to find the total displacement of the object.

$d = d_1 + d_2$

#3 $d = V_i t + \frac{1}{2} a t^2$ doesn't Use V_f

More Acceleration & Distance Example Problems

E1. A car starting from rest accelerates at 2.6 m/s^2 how far does the car travel in 10 seconds?

$V_i = 0$
$V_f = *$
$d = ?$
$a = 2.6$
$t = 10s$

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

$d = \frac{1}{2}(2.6)(10)^2$

$d = 1.3(100)$

$d = 130m$

E2. A truck starting from rest and accelerates at 3.0 m/s^2. How long does it take for the truck to travel 150?

$V_i = 0$
$V_f = *$
$d = 150$
$a = 3$
$t = ?$

$d = V_i t + \frac{1}{2} a t^2$ ($V_i = 0$)

$150 = \frac{1}{2}(3) t^2$

$\frac{150}{1.5} = \frac{1.5\, t^2}{1.5}$

$t^2 = 100$

$t = \sqrt{100}$

$t = 10$ Sec

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

Acceleration & Distance Problems Part 2

1. A skier, going 16 m/s accelerates down a slope at 1.6 m/s^2 how far does the skier travel in 5 seconds?

V_i =
V_f =
d =
a =
t =

2. A skateboarder rolls to a stop over a distance of 60 m in 4 s how fast was the skate boarder initially going?

V_i =
V_f =
d =
a =
t =

3. A car starting from rest accelerates down the road at 5 m/s^2. How long will it take the car to go 100 m?

V_i =
V_f =
d =
a =
t =

4. Jamie fires a bullet through a block of ballistics gel on your favorite Myth Busters episode. The bullet enters the 0.30 meter thick block at 320 m/s and leaves the block at 50 m/s, what is the acceleration of the bullet? (**Hint: Find time first using equation #2)**

V_i =
V_f =
d =
a =
t =

1) 100 m 2) 30 m 3)6.32 sec 4) -166,500 m/s^2