Kinematics Equation Sheet

The five Kinematics Variables:

v_i = Initial Velocity (@ t = 0) (m/s)

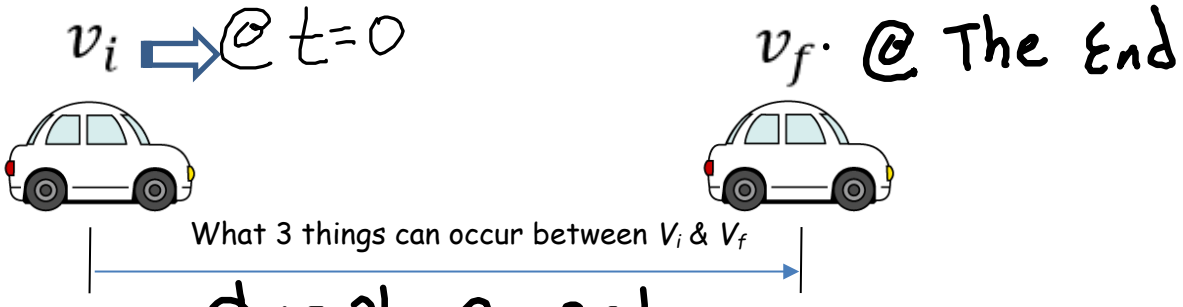
v_f = final Velocity (@ End) (m/s)

d = displacement (m)

a = acceleration → $\frac{m/s}{s} = \frac{m}{s} \cdot \frac{1}{s} = \boxed{m/s^2}$

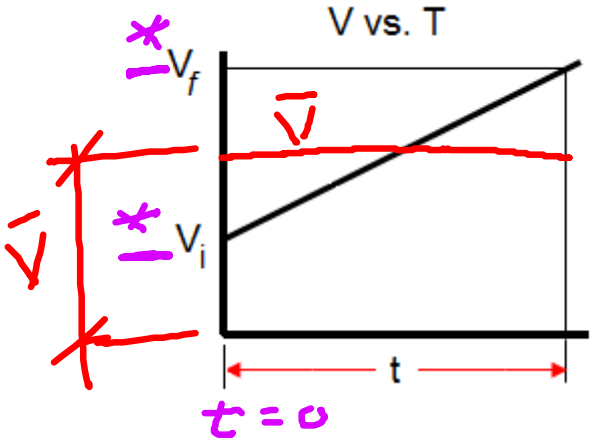
t = time (sec)

Equation Number	Unused variable	Equation
1	d	$V_f = V_i + at$
2	a	$d = V_{avg} \cdot t$ or $d = \frac{V_i + V_f}{2} \cdot t$
3		
4		
5		



displacement
accelerate
Time

Acceleration Worksheet



$V_{avg} = \frac{V_i + V_f}{2}$; $V_{avg} = \bar{V}$

d = area

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

1. The Velocity Time graph above shows an object that is Accelerating
2. The slope of the Velocity time graph gives us acceleration
3. The Equation for the slope is?

$a = \frac{\Delta V}{\Delta t} \Rightarrow t\,a = \frac{V_f - V_i}{t}$ ✗

4. This gives us one way to calculate acceleration. Rearrange the equation to solve for Velocity final.

$at = V_f - V_i \Rightarrow \boxed{V_i + at = V_f}$ #1

5. Given V_i and V_f, how do we calculate average velocity?
   Note: You can only use this to find the average velocity for an accelerating object.

$V_{avg} = \left(\frac{V_i + V_f}{2}\right)$

6. Given Average Velocity and time, how do we calculate the distance an object travels?

$d = (V_{avg}) \cdot t$

7. Using the results of questions 5 & 6, write an equation to calculate the distance that an accelerating object travels.

$d = \left(\frac{V_i + V_f}{2}\right) \cdot t$ #2

These are two very important equations in physics; let's work some example problems using these equations

Acceleration & Distance Example Problems

E1. A car starting from rest increases its velocity to 40 m/s in 5.0 seconds.

$v_i = 0$
$v_f = 40$
$d = *$
$a = ?$
$t = 5$

a. What is the car's acceleration?

$V_f = V_i + at$
$40 = a \cdot 5$
$a = \frac{40}{5} = 8\ m/s^2$

b. What is the car's average velocity?

$\bar{V} = \frac{V_i + V_f}{2} = \frac{40}{2} = 20\ m/s$

c. How far did the car go in the 5.0 seconds?

$d = \bar{V} \cdot t = 20(5) = 100\ m$

E2. A bicyclist going 14 m/s rolls to a stop in 7 s.

$v_i = 14$
$v_f = 0$
$d = *$
$a = ?$
$t = 7\ sec$

a. What was the bicyclist average velocity?

$\bar{V} = \frac{V_i + V_f}{2} = \frac{14}{2} = 7\ m/s$

b. What was the bicyclist acceleration?

$V_f = V_i + at$
$0 = 14 + 7a$
$\frac{7a}{7} = \frac{-14}{7}$
$a = -2\ m/s^2$

c. How far did the bicyclist travel while stopping?

$d = \bar{V} \cdot t = 7 \cdot 7 = 49\ m$

E3. A Physics student drops a rock from a 30m high cliff and times it. The rock falls for 2.47 seconds.

$v_i = 0$
$v_f = 24.3$
$d = 30$
$a = ?$
$t = 2.47$

a. What was the rock's average velocity?

$d = \bar{V} \cdot t \Rightarrow 30 = \bar{V}(2.47)$
$\bar{V} = 12.15\ m/s$

b. What was the final Velocity?

$\bar{V} = \frac{V_f + V_i}{2}$
$\frac{V_f}{2} = 12.15$
$V_f = 24.3\ m/s$

c. What was the rocks acceleration?

$V_f = V_i + at$
$24.3 = 2.47a$
$a = \frac{24.3}{2.47} = 9.8\ m/s^2$

Acceleration & Distance Practice Problems (Equations 1 & 2)

$$V_f = V_i + a \cdot t \qquad d = \bar{V} \cdot t = \frac{V_i + V_f}{2} t$$

1. Is a car driving in a circle at a constant speed accelerating? Explain why.

$a = \frac{\Delta V}{\Delta t}$ is accelerating because direction changed

Note: For the next problems, assume the objects are traveling in a straight-line motion and are going the same direction.

2. What is the acceleration of each car?

a) A Ford mustang can go from zero to 26.8 m/s to (60 mph) in 5.0 seconds.

$V_i =$
$V_f =$
$d =$
$a =$
$t =$

b) A Ford Escort can go from zero to 35.8 m/s (80 mph) in 10 seconds.

$V_i =$
$V_f =$
$d =$
$a =$
$t =$

3. Suppose a sprinter increases her speed each second, first from 0 to 5 meters/sec, then from 5 m/s to 10 m/s, then from 10 m/s to 15 m/s. What is her acceleration?

4. A car starting from rest increases its velocity to 24 m/s in 3.0 seconds.

a. What is the car's acceleration?

b. What is the car's average velocity?

c. How far did the car go in the 3.0 seconds?

$V_i =$
$V_f =$
$d =$
$a =$
$t =$

5 A ball rolls down a hill, starting from rest and travels 30.0 m in 6.0 s.

a. What was the balls average velocity?

b. What was the balls final velocity?

c. What was the balls acceleration?

V_i =

V_f =

d =

a =

t =

6. A skateboarder going 24 m/s rolls to a stop in 4 s.

a. What was the skateboarder's average velocity?

b. What was the skateboarder's acceleration?

c. How far did the skateboarder travel while stopping?

V_i =

V_f =

d =

a =

t =

V_i =

V_f =

d =

a =

t =

2) 5.36 m/s^2, 3.58 m/s^2 3) 5.0 m/s^2 4) 8.0 m/s^2, 12 m/s, 36 m, 5) 5 m/s, 10 m/s, 1.66 m/s^2
6) 12 m/s, -6.0 m/s^2, 48 m