Kinematics Equations

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

d = distance measured in m
v_i = initial velocity measured in m/s
t = time measured in s
a = acceleration measured in m/s²

$$V_f = V_i + at$$

v_f = final velocity measured in m/s
v_i = initial velocity measured in m/s
a = acceleration measured in m/s^2
t = time measured in s

$$V_f^2 = V_i^2 + 2ad$$

v_f = final velocity measured in m/s
v_i = initial velocity measured in m/s
a = acceleration measured in m/s^2
d = distance measured in m

Example #1:

A car starts from rest and accelerates uniformly over a time of 5.21 seconds for a distance of 110 m. Determine the acceleration of the car.

Formula: $d = v_i t + \frac{1}{2}at^2$

Plug in numbers:

$$110m = (0 m/s)(5.21s) + \frac{1}{2}(a)(5.21s)^2$$
$$110 m = \frac{1}{2}(a)(5.21)^2$$

Answer:
$$\frac{110m}{13.57} = \frac{13.57a}{13.57}$$
$$a = 8.10 m/s^2$$

Example #2:

Rocket-powered sleds are used to test the human response to acceleration. If a rocket-powered sled is accelerated to a speed of 444 m/s in 1.83 seconds, then what is the acceleration and what is the distance that the sled travels?

Formula: ① $V_f = V_i + at$

Plug in numbers:

$$\frac{444 m/s}{1.83 s} = \frac{0 m/s + (a)(1.83s)}{1.83}$$
$$242.6 m/s^2 = a$$

②
$$d = V_i t + \frac{1}{2}at^2$$
$$d = (0 m/s)(1.83s) + \frac{1}{2}(242.6 m/s^2)(1.83s)^2$$
$$d = 406.2 m$$

Answer:

Example #3:

A bike accelerates uniformly from rest to a speed of 7.10 m/s over a distance of 35.4 m. Determine the acceleration of the bike.

Formula: $V_f^2 = V_i^2 + 2ad$

Plug in numbers: $(7.10\,m/s)^2 = (0\,m/s)^2 + 2(a)(35.4m)$

$\frac{50.41}{70.8} = \frac{70.8a}{70.8}$

Answer: $a = 0.71\,m/s^2$

Free Fall Notes

The acceleration of an object due to gravity is a constant $9.8\,m/s^2$.

All objects (in a vacuum) fall at the same rate regardless of Shape, Size, mass, etc. If we dropped a bowling ball and a pencil at the same time, they would hit the ground at the same time because of gravity.

Gravity on Earth is $-9.8\,m/s^2$ (always, always, always) ** MEMORIZE THIS NUMBER**

Gravity is an acceleration. Always pulling DOWN which makes it a negative number.

Any time an object is being dropped or is at rest, it has an initial velocity of 0 m/s.

Any time an object is thrown straight up into the air, we give it an initial velocity and the final velocity is then 0 m/s. (Tennis ball example) at the top of its path.

As the ball is going up, the velocity is positive and the acceleration is negative—the ball is slowing down.

As the ball is coming back down, the velocity is negative and the acceleration is negative—the ball is speeding up.

$v_f = v_i + gt$

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

$v_f^2 = v_i^2 + 2gd$

Replaced acceleration with g! $g = -9.8\,m/s^2$