Solving For Time When the Initial Velocity is Not Zero

QUADFORM
TO THE RESCUE

(we will discuss an alternate method as well…)

- A stone is dropped from a helicopter while the helicopter is **rising** with a constant velocity of 3.0 m/s. If the stone was dropped from a height of 30.0 meters how long will it take for the rock to reach the ground?

$v_i = 3.0 m/s$
$\Delta y = -30 m$
$a = -9.8 m/s^2$
$t = ?$

$$\Delta y = v_i t + \frac{1}{2} a t^2$$

$$-30 m = (3.0 m/s) t + \frac{1}{2}(-9.8 m/s^2) t^2$$

$$4.9t^2 - 3.0t - 30 = 0$$

Quadratic equation:

$ax^2 + bx + c = 0$

Solving with the quadratic equation:

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{-(-3) \pm \sqrt{3^2 - 4(4.9)(-30)}}{2(4.9)}$$

Do a bunch of math and you get two answers:

2.80 sec **and -2.19 sec**

Always choose the positive answer. Time is never negative. If both positive choose the *reasonable* answer for the problem.

QUADFORM

Or you could choose to use Quadform. A Ti calculator program that solves the quadratic equation for you.

$$4.9t^2 - 3.0t - 30 = 0$$

Quadratic equation: $ax^2 + bx + c = 0$

Use the quadform program on your calculator!!!!! If you don't have it; get it.

You get two roots: 2.80 sec and -2.19 sec

Time is always positive!!

Enter these variables:

A = 4.9

B = -3.0

C = -30

Note: If you mess up the signs for v_i or Δy then the roots you get will not be correct!!!!!!!!!!!

Sample Problem 2

Laying on the second floor in the F Wing a Bowie student spits up into to the air. The phlegm leaves his mouth at 7.50 m/s. How long do the unfortunate students 4.0 meters below have to get out of harm's way.

$v_i = +7.5 m/s$
$\Delta y = -4.0 m$
$a = -9.8 m/s^2$
$t = ?$

$$\Delta y = v_i t + \frac{1}{2} a t^2$$

$$-4.0 m = (7.5 m/s) t + \frac{1}{2}(-9.8 m/s^2) t^2$$

$$4.9t^2 - 7.5t - 4.0 = 0$$

A = 4.9

B = -7.5

C = -4.0

Roots = +1.95 s and -0.419 s

Practice

- The cliff diving gazelle is at it again This time it jumps straight downward with a velocity of 4 m/s. If cliff was 30 meters high, how long was the gazelle in the air?

Known:

V_i = -4 m/s

a = -9.8 m/s²

Δy = -30m

Unknown:

t = ??

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

$$-30 m = (-4 m/s) t + \frac{1}{2}(-9.8 m/s^2) t^2$$

$$4.9t^2 + 4t - 30 = 0$$

Using quadform: t = 2.1 s; or -2.92 s. We always use the positive root … so t = 2.1 s is the answer.