Quadratic Formula

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Ex. Graham is base jumping. He leaps downward off the cliff at a velocity of 2m/s. The cliff 350m tall and the acceleration due to gravity is $9.8\ m/s^2$ downward. How long does it take Graham to hit the ground?

Down is positive.

$v_i = +2\ m/s$

~~v_f~~

$a = +9.8\ m/s^2$

$d = +350\ m$

$t = ?$

$d = vt + \frac{1}{2}at^2$ ← Doesn't algebra nicely

We have to use the quadratic formula.

For the equation where x is unknown and a, b, c are non-zero coefficients

$$ax^2 + bx + c = 0$$

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

Use the Quadratic Formula when using Eq #3 and looking for time.

Back to our example:

$v_i = 2\ m/s$

~~v_f~~

$a = 9.8\ m/s^2$

$d = 350$

$t = ?$

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

$0 = \frac{1}{2}at^2 + vit - d$

$0 = \frac{1}{2}(9.8)t^2 + 2t - 350$

$0 = 4.9t^2 + 2t - 350$

① Rearrange the formula to be $0 = \frac{1}{2}at^2 + vit - d$

② Plug in values

$a=4.9$ $b=2$ $c=-350$ ③ Identify a, b, c

④ Plug into the Quadratic Formula

$$t = \frac{-2 \pm \sqrt{2^2 - 4(4.9)(-350)}}{2(4.9)}$$

$$t = \frac{-2 \pm \sqrt{6864}}{9.8}$$

$$t = \frac{-2 \pm 82.8}{9.8}$$

$+$: $\frac{-2+82.8}{9.8} = 8.24_5$

$-$: $\frac{-2-82.8}{9.8} = -8.65$ Can't have negative time.

Graham takes 8.24s to hit the ground.