# quadratic equations – Applications

Name:_____

**1.** A science contest has students drop eggs in containers from various heights. The goal is to make a container that will keep the egg from breaking. If a student drops a container from 32 feet, how long will it take to reach the ground? (Assume there is no air resistance.)

$h(t) = -16t^2 + 32$

$0 = -16t^2 + 32$

$0 = -16t^2 + 0t + 32$

$a = -16 \quad b = 0 \quad c = 32$

$t = \frac{-0 \pm \sqrt{0^2 - 4(-16)(32)}}{2(-16)} = \frac{\pm\sqrt{2048}}{-32}$

$t \approx -1.41$

$t \approx 1.41$ seconds

**2.** NASA's Vehicle Assembly Building is one of the largest structures in the world; originally built for the Saturn V rocket to the moon. It was used for the Space Shuttle and now serves as a playpen for giant babies.

The building is 525 feet high. Suppose a worker drops a wrench from the top level. About how long would he have to warn people on the floor to get out of the way?

solve for t

$h = 0$

$h(t) = -16t^2 + h_0$

$0 = -16t^2 + 525$

$0 = -16t^2 + 0t + 525$

$t = \frac{\pm\sqrt{0 - 4(-16)(525)}}{2(-16)} = \frac{\pm\sqrt{33600}}{-32}$

$t = \frac{\sqrt{33600}}{-32}$

$t \approx -5.73$

$t = \frac{-\sqrt{33600}}{-32}$

$t \approx 5.73$ seconds

**3.** The Detonator at Worlds of Fun quickly propels riders to the top of a tower where they begin a free-fall to the bottom. The ride starts slowing them down at the 40-foot mark. If it takes riders about 3.16 seconds to reach the 40-foot mark, how tall is the tower?

**4.** In professional fireworks displays, aerial fireworks carry "stars" upward, ignite them, and project them into the air.

Suppose a particular star is carried up to 520 feet with an upward velocity of 72 ft/s. Then the fuel runs out and gravity takes over.

Write an equation to represent the star's height $h$ at time $t$.

$h(t) = -16t^2 + 72t + 520$

vertex

$t$ – How long will it take for the star to reach its maximum height?

$\frac{-b}{2a} = \frac{-72}{2(-16)} = \frac{-72}{-32}$ $\boxed{t = 2.25}$

How far above the ground will it be?

$h(2.25) = -16(2.25)^2 + 72t + 520$

$\boxed{h = 601 \text{ ft}}$

$x = \frac{-(72) \pm \sqrt{(72)^2 - 4(-16)(520)}}{2(-16)}$

**5.** A five-foot tall sasquatch throws a rock into the air with an initial upward velocity of 40 ft/s. Write an equation for the height $h$ of the rock at time $t$.

$h(t) = -16t^2 + 40t + 5$

After how many seconds does the rock reach its maximum height? — find the vertex

$t = \frac{-b}{2a} = \frac{-40}{-32} = \boxed{t = 1.25 \text{ seconds}}$

What is the rock's maximum height?

$h(1.25) = -16(1.25)^2 + 40(1.25) + 5$ $\boxed{h = 30 \text{ feet}}$

How long does it take the rock to reach the ground?

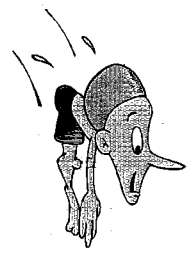
$h = 0$

$0 = -16t^2 + 40t + 5$

$t = \frac{-40 \pm \sqrt{(40)^2 - 4(-16)(5)}}{2(-16)} = \frac{-40 \pm \sqrt{1920}}{-32}$

$t \approx 2.62 \text{ sec}$

**6.** A diver jumps off a 13-foot-high diving board with an initial upward velocity of ~~15 feet per~~ does it take the diver to hit the water?



$h(t) = -16t^2 + 15t + 13$

$0 = -16t^2 + 15t + 13$

$t = \frac{-15 \pm \sqrt{(15)^2 - 4(-16)(13)}}{2(-16)}$

$t = \frac{-15 + \sqrt{1057}}{-32}$ $t = \frac{-15 - \sqrt{1057}}{-32}$

$t \approx -0.55$ $t \approx 1.48 \text{ sec.}$

**7.** You are on the 15th floor of a building, 135 feet above the ground. You lean out the window and throw a set of keys with an initial *downward* velocity of 10 ft/sec. to a friend on the 13th floor. Your friend does not catch them. How long will it take the keys to hit the ground?

$h(t) = -16t^2 - 10t + 135$

$0 = -16t^2 - 10t + 135$

$t = \frac{-(-10) \pm \sqrt{(-10)^2 - 4(-16)(135)}}{2(-16)}$

$t = \frac{10 \pm \sqrt{8540}}{-32}$

$t = \frac{10 + \sqrt{8540}}{-32}$

$t \approx -3.20$

$t = \frac{10 - \sqrt{8540}}{-32}$

$t \approx 2.58$ seconds

**8.** A raven dives toward a squirrel on the ground. When the raven is 100 feet above the ground, the squirrel sees the raven, which is diving at 220 feet per second. How long does the squirrel have to escape?

$h(t) = -16t^2 - 220t + 100$

$0 = -16t^2 - 220t + 100$

$t = \frac{-(-220) \pm \sqrt{(-220)^2 - 4(16)(100)}}{2(-16)}$

$t = \frac{220 + \sqrt{54800}}{-32} \approx -14.19$

$t = \frac{220 - \sqrt{54800}}{-32} \approx 0.44$s

**9.** A construction worker on the ground tosses an apple to a fellow worker who is 20 feet above the ground. The starting height of the apple is 5.5 feet. Its initial upward velocity is 25 ft/s. Will the apple reach the worker?

$h(t) = -16t^2 + 25t + 5.5$

$\frac{-b}{2a} = \frac{-25}{-32} \approx .78$

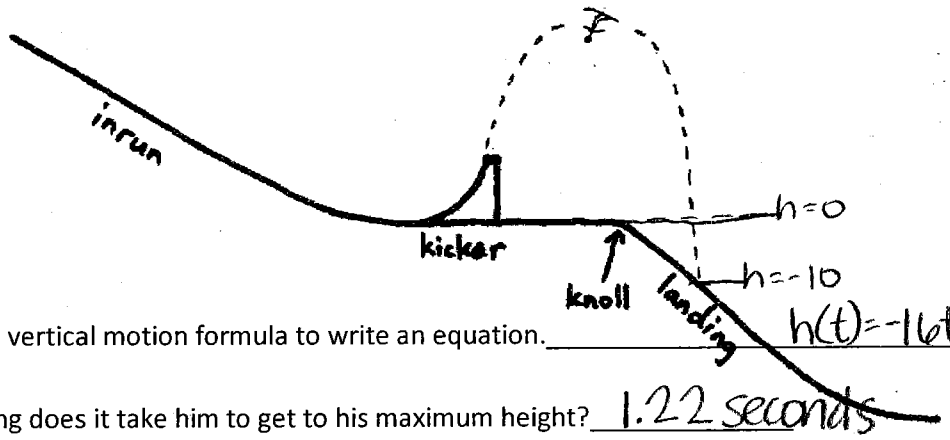
is the max @ least 20?

$h(\frac{25}{32}) = -16(\frac{25}{32})^2 + 25(\frac{25}{32}) + 5.5$

$h = 15.27$

No it will not.

**10.** Freestyle aerials skier Jeret "Speedy" Peterson flies off a kicker going 39 ft/sec. The top of the kicker is 13.5 feet above the knoll. Speedy lands 10 feet *below* the knoll.




Use the vertical motion formula to write an equation. $h(t)=-16t^2+39t+13.5$

How long does it take him to get to his maximum height? 1.22 seconds

$\frac{-b}{2a}=\frac{-39}{-32}=$

What is that maximum height? 37.27 feet

$h(1.22)=-16(1.22)^2+39(1.22)+13.5$

How long is he in the air? 2.94s

$-10=-16t^2+39t+13.5$

$0=-16t^2+39t+23.5$

$t=\frac{-39\pm\sqrt{39^2-4(-16)(23.5)}}{2(-16)}$ (3025)

$t\approx -0.5$ $\quad t\approx 2.94$ s

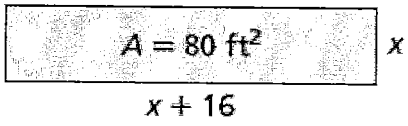
~~If Speedy's horizontal speed is 19 feet per second, how far forward does he travel?~~

# quadratic equations – Area & Profit Applications

Name:_____

Find the dimensions of each rectangle.

**11.**




$A=(x)(x+16)$

$80=x^2+16x$

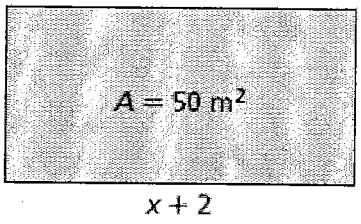
$0=x^2+16x-80$

$0=(x+20)(x-4)$

$x=-20$ $x=4$

dimensions: $20 \times 4$

**12.**




$5 \times 10$

$A=(x+2)(x-3)$

$A=x^2-3x+2x-6$

$50=x^2-x-6$

$0=x^2-x-56$

$0=(x-8)(x+7)$

$x=8$ $x=-7$

~~12~~ a) A rectangle has a length that is 10 meters less than twice the width.

Write an expression for this. $l=2w-10$ $w=w$

b) Suppose 3 meters are added to the width. Write an expression for this. $w+3$

c) The area is 256 $m^2$. Write an equation for this. _____

d) Solve your equation to find the dimensions of the original rectangle.

BONUS

**13.** A metal box has a height of 6 inches.

The width is $w$ inches.

The length is 30 inches longer than its width. $l=w+30$

The volume of the box is 1050 cubic inches.

What are the length and width of the box?

$V=l \cdot w \cdot h$

$V=(w+30)(w)(6)=1050$

$l \cdot w = V \div 6 = A = 175$

$(w+30)(w)=175$

$w^2+30w-175=0$

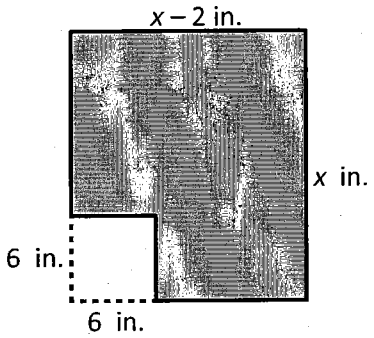
$(w-5)(w+35)=0$

$w=5$ $w=-35$

$w=5$

$l=5+30=35$

**14.** A square is cut out of the figure at right, as shown.




a) Write an expression for the area of the original rectangle, before the cutout. $(x-2)(x)$

$x^2-2x$

b) What is the area of the cutout? 36

c) Write an expression for the area of the shaded region. $x^2-2x-36$

d) The area of the shaded region is 188 in$^2$. What were the dimensions of the original rectangle?

$x^2-2x-36=188$

$x^2-2x-224=0$

$(x-16)(x+14)=0$

$x=16$ ~~$x=-14$~~

$l=16-2=14$ in

$w=16$ in