

Name: Key  
 Date: \_\_\_\_\_ Period: \_\_\_\_\_

**Quadratic Formula Word Problems**

1. Jason jumped off of a cliff into the ocean in Acapulco while vacationing with some friends. His height as a function of time could be modeled by the function  $h(t) = -16t^2 + 16t + 480$ , where  $t$  is the time in seconds and  $h$  is the height in feet.

$a = -16, b = 16, c = 480$

a. How long did it take for Jason to reach his maximum height?

Max height @  $t = \frac{-b}{2a} = \frac{-16}{2(-16)} = \frac{-16}{-32} = \frac{1}{2}$

∴ It took Jason  $\frac{1}{2}$  a second to reach max height.

b. What was the highest point that Jason reached?

Highest pt. happens @  $h(\frac{1}{2})$ , the max height.

$h(\frac{1}{2}) = -16(\frac{1}{2})^2 + 16(\frac{1}{2}) + 480 = 484$

∴ Jason's max height was 484 ft.

c. Jason hit the water after how many seconds?

Jason hits water @  $h(t) = 0$ . Solve  $0 = -16t^2 + 16t + 480$   
 Use quadratic formula or factor (if possible).

$0 = -16(t^2 - t - 30) \Rightarrow 0 = -16(t+5)(t-6) \Rightarrow t = -5$  or  $t = 6$

Jason hit the water 6 seconds after jumping.

2. If a toy rocket is launched vertically upward from ground level with an initial velocity of 128 feet per second, then its height  $h$  after  $t$  seconds is given by the equation  $h(t) = -16t^2 + 128t$  (if air resistance is neglected).

a. How long will it take for the rocket to return to the ground?  $h(t) = 0$

$0 = -16t^2 + 128t$        $-16t = 0$  or  $t - 8 = 0$

$0 = -16t(t - 8) \Rightarrow t = 0$  or  $t = 8$

∴ It will take 8 seconds for rocket to return to the ground.

b. After how many seconds will the rocket be 112 feet above the ground?

Set  $h(t) = 112$  and solve for  $t$ .

$112 = -16t^2 + 128t \Rightarrow 0 = -16t^2 + 128t - 112$

$0 = -16(t^2 - 8t + 7) \Rightarrow 0 = -16(t-7)(t-1) \Rightarrow t = 7$  or  $t = 1$

c. How long will it take the rocket to hit its maximum height?

$t = \frac{-b}{2a} = \frac{-128}{2(-16)} = \frac{-128}{-32} = 4$

∴ The rocket will be @ 112 ft 1 sec after launch and then @ 7 seconds.

∴ It will take the rocket 4 seconds to reach max height

d. What is the maximum height?

$h(4) = -16(4)^2 + 128(4) = -16(16) + 512 = 256$

∴ The rocket's max height is 256 ft.

3. A rocket is launched from atop a 101-foot cliff with an initial velocity of 116 ft/s.
- Substitute the values into the vertical motion formula  $h(t) = -16t^2 + vt + h_0$ . Let  $h(t) = 0$
  - Use the quadratic formula to find out how long the rocket will take to hit the ground after it is launched. Round to the nearest tenth of a second.

a)  $h(t) = -16t^2 + 116t + 101 \Rightarrow 0 = -16t^2 + 116t + 101$      $a = -16, b = 116, c = 101$

$$t = \frac{-116 \pm \sqrt{(116)^2 - 4(-16)(101)}}{2(-16)} = \frac{-116 \pm \sqrt{19,920}}{-32} = \begin{cases} \frac{-116 + \sqrt{19,920}}{-32} \approx -0.8 \\ \frac{-116 - \sqrt{19,920}}{-32} \approx 8.0 \end{cases}$$

∴ Rocket hits ground @  $\approx 8.0$  seconds

4. You and a friend are hiking in the mountains. You want to climb to a ledge that is 20 ft. above you. The height of the grappling hook you throw is given by the function  $h(t) = -16t^2 - 32t + 5$ . What is the maximum height of the grappling hook? Can you throw it high enough to reach the ledge?

$$t = \frac{-b}{2a} = \frac{-(-32)}{2(-16)} = \frac{32}{-32} = -1$$

$$h(-1) = -16(-1)^2 - 32(-1) + 5 = -16 + 32 + 5 = 21$$

∴ Max height of grappling hook is 21 ft.

Since max height I can throw grappling hook is 21 ft, I can throw it high enough to reach ledge.

5. You are trying to dunk a basketball. You need to jump 2.5 ft. in the air to dunk the ball. The height that your feet are above the ground is given by the function  $h(t) = -16t^2 + 12t$ . What is the maximum height your feet will be above the ground? Will you be able to dunk the basketball?

$$t = \frac{-b}{2a} = \frac{-12}{2(-16)} = \frac{12}{32} = 0.375 \text{ seconds}$$

$$h(0.375) = -16(0.375)^2 + 12(0.375) = 2.25$$

The max height my feet are off the ground is 2.25 ft.

Since I need to be 2.5 ft in air to dunk, I won't be able to dunk.

6. A diver is standing on a platform 24 ft. above the pool. He jumps from the platform with an initial upward velocity of 8 ft/s. Use the formula  $h(t) = -16t^2 + vt + s$ , where  $h$  is his height above the water,  $t$  is the time,  $v$  is his starting upward velocity, and  $s$  is his starting height. How long will it take for him to hit the water?

$$h(t) = -16t^2 + 8t + 24 \quad \text{Hits water @ } 0 = h(t).$$

$$0 = -16t^2 + 8t + 24$$

$$0 = -8(2t^2 - t - 3)$$

$$0 = -8\left(t - \frac{3}{2}\right)\left(t + \frac{1}{2}\right)$$

$$0 = -8(2t - 3)(t + 1)$$

$$\begin{matrix} 2(-3) \\ -6 \\ -3 \cdot 2 \end{matrix}$$

$$2t - 3 = 0 \quad \text{or} \quad t + 1 = 0$$

$$2t = 3$$

$$t = 1.5$$

∴ Hits water 1.5 seconds after diving.