YOU & MATHS A water rocket is launched upward with an initial velocity of 48 ft/s. Its height h, in feet, after t seconds, is given by $h = 48t - 16t^2$. When will the rocket be exactly 32 feet above the ground?

(USA *Tacoma Community College, Review for Test,* 2002)

In order to find out when the rocket will be exactly 32 feet above the ground, we have to substitute the height h in the quadratic equation with the value of 32. We get:

$$32 = 48t - 16t^2 \rightarrow 16t^2 - 48t + 32 = 0 \rightarrow$$

$$16(t^2 - 3t + 2) = 0 \rightarrow$$

$$t^2 - 3t + 2 = 0 \rightarrow$$

$$t = \frac{+3 \pm \sqrt{9-8}}{2} = \frac{+3 \pm 1}{2} \rightarrow t = 2 \vee t = 1.$$

We notice that the equation's middle coefficient, -3, is made up of the sum of -2 and -1, while the constant term comes from multiplying the same two numbers, which are the opposites of the solutions. Then the equation can be rewritten as

$$(t-2)(t-1) = 0,$$

which has solutions 1 and 2. We can thus conclude that the rocket will be at a height of 32 feet above the ground twice: once at $t = 1$ second (on his way up) and then at $t = 2$ seconds (on his way down).