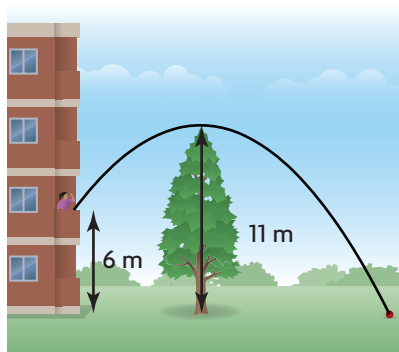


## Up and Over



On Earth, the quadratic relation  $h = -5t^2 + ut + h_0$  can be used to determine the height of an object that has been thrown as it travels through the air, measured from a reference point. In this relation,  $h$  is the height of the object in metres,  $t$  is the time in seconds since the object was thrown,  $u$  is the initial velocity, and  $h_0$  is the initial height.

Myrtle throws a ball upward from a second-floor balcony, 6 m above the ground, with an initial velocity of 2 m/s. In this situation,  $u = 2$  and  $h_0 = 6$ , so the relation that models the height of the ball is  $h = -5t^2 + 2t + 6$ . Myrtle knows that changing the velocity with which she throws the ball will change the maximum height of the ball. Myrtle wants to know with what velocity she must throw the ball to make it pass over a tree that is 11 m tall.

**?** What initial velocity will result in a maximum height of 11 m?

- A. Suppose that Myrtle just dropped the ball from the balcony, with an initial velocity of 0 m/s. Write a quadratic relation to model this situation.
- B. What is the maximum height of the ball in part A?
- C. Complete the square of  $h = -5t^2 + 2t + 6$  to determine the maximum height of the ball when Myrtle throws the ball with an initial velocity of 2 m/s.
- D. Will Myrtle have to increase or decrease the initial velocity with which she throws the ball for it to clear the tree? Explain how you know.
- E. Create relations to model the height of the ball when it is thrown from a second-floor balcony with initial velocities of 4 m/s and 6 m/s. Then determine the maximum height of the ball for each relation.
- F. Create a scatter plot to show the maximum heights for initial velocities of 0 m/s, 2 m/s, 4 m/s, and 6 m/s. Is this relation quadratic? Explain how you know.
- G. Use quadratic regression to determine an algebraic model for your graph for part F.
- H. Use the model you created for part G to determine the initial velocity necessary for the ball to clear the tree.

### Task Checklist

- ✓ Did you show all your calculations?
- ✓ Did you draw and label your graph accurately?
- ✓ Did you answer all the questions reflectively, using complete sentences?
- ✓ Did you explain your thinking clearly?