Warm Up

Consider $f(x) = x^2 + 3x + 4$.

Evaluate the function for each given value.

1. $f(1) = (1)^2 + 3(1) + 4 = \boxed{8}$

2. $f(-1) = (-1)^2 + 3(-1) + 4 = \boxed{2}$

3. $f(2) = (2)^2 + 3(2) + 4 = \boxed{14}$

4. $f(-2) = (-2)^2 + 3(-2) + 4 = \boxed{2}$

Key Terms

- parabola
- vertical motion model
- root

Squaring It Up

Maddie is using pennies to create a pattern.

Figure 1 Figure 2 Figure 3 Figure 4

1. **Analyze the pattern and explain how to create Figure 5.**

   Add an additional row and column of pennies

2. **How many pennies would Maddie need to create Figure 5? Figure 6? Figure 7?**

   25 pennies, 36 pennies, 49 pennies

3. **Which figure would Maddie create with exactly $4.00 in pennies?**

   This would be figure 20

4. **Write an equation to determine the number of pennies for any figure number. Define your variables.**

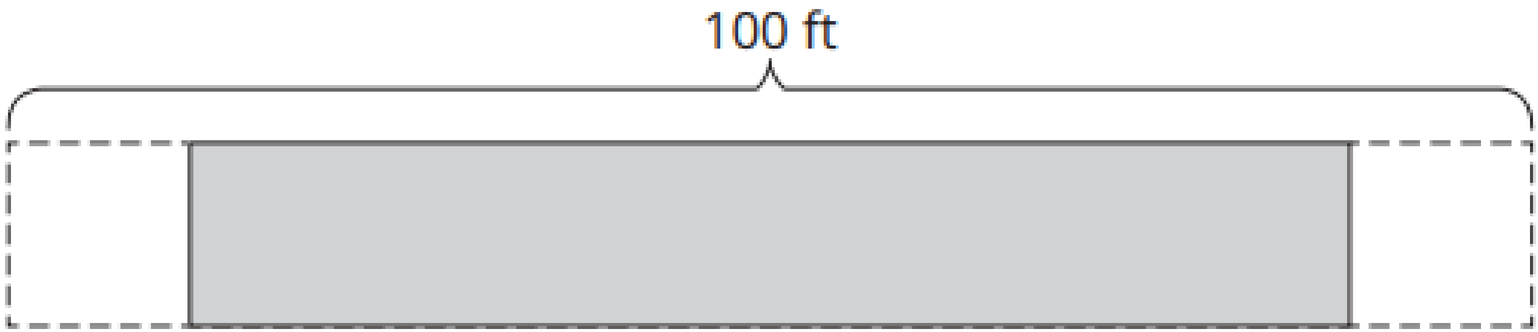
   x is the figure number, f(x) is the total number of pennies

   $$f(x) = x^2$$

5. **Describe the function family to which this equation belongs.**

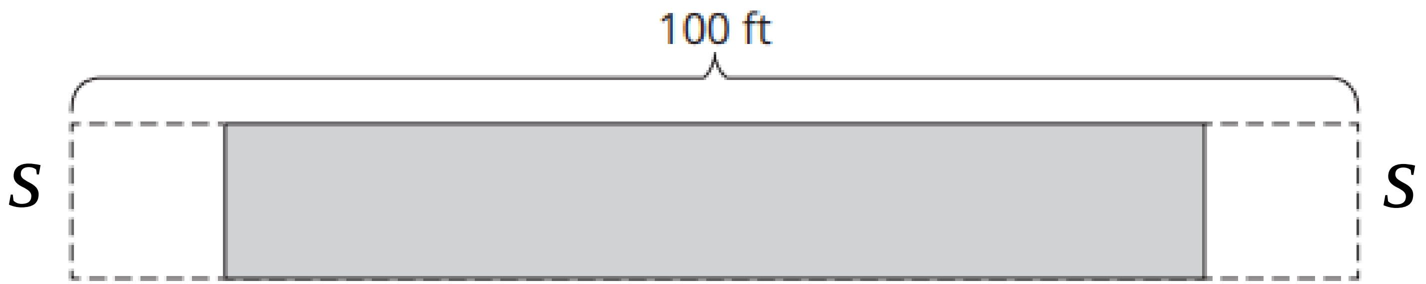
There is no constant difference or constant ratio, it belongs to the *quadratic function* family

A dog trainer is fencing in an enclosure, represented by the shaded region in the diagram. The trainer will also have two square-shaped storage units on either side of the enclosure to store equipment and other materials. She can make the enclosure and storage units as wide as she wants, but she can't exceed 100 feet in total length.



1. Let *s* represent a side length, in feet, of one of the storage units.

a. Label the length and width of the enclosure in terms of *s*.



b. **Write the function $L(s)$ to represent the length of the enclosure as a function of side length, s.**

$$L(s) = 100 - 2s$$

c. **Sketch and label a graph of the function on the given coordinate plane. Identify any key points.**

2. **Describe the domain and range of the context and of the function.**

For the context, the domain is $0 < s < 50$ and the range is $0 < L(s) < 100$.

For the function, the domain is all real numbers and the range is all real numbers.

$$L(s) = 100 - 2s$$

3. Identify each key characteristic of the graph. Then, interpret the meaning of each in terms of the context.

a. slope

-2

b. *y*-intercept

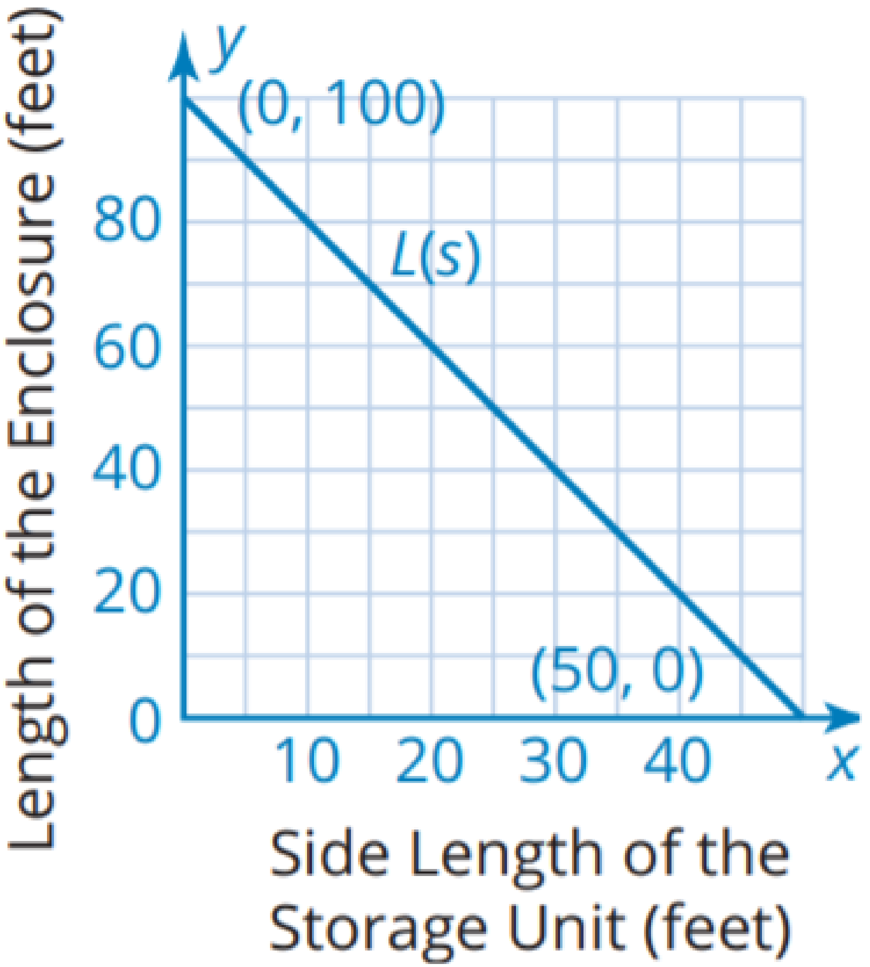
$(0, 100)$

c. increasing or decreasing

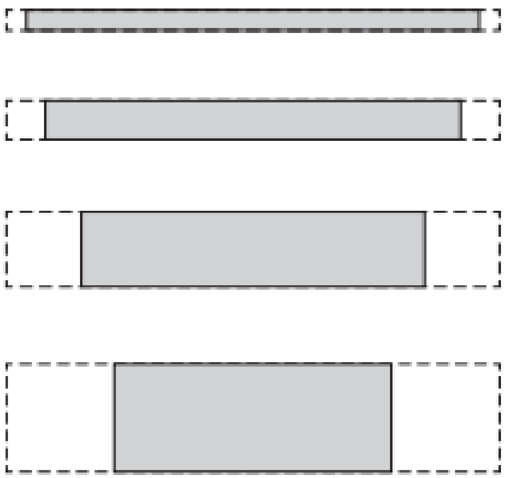
decreasing

d. *x*-intercept

$(50, 0)$



The progression of diagrams below shows how the area of the enclosure, *A*(*s*), changes as the side length, *s*, of each square storage unit increases.



4. Write the function *A*(*s*) to represent the area of the enclosure as a function of side length, *s*.

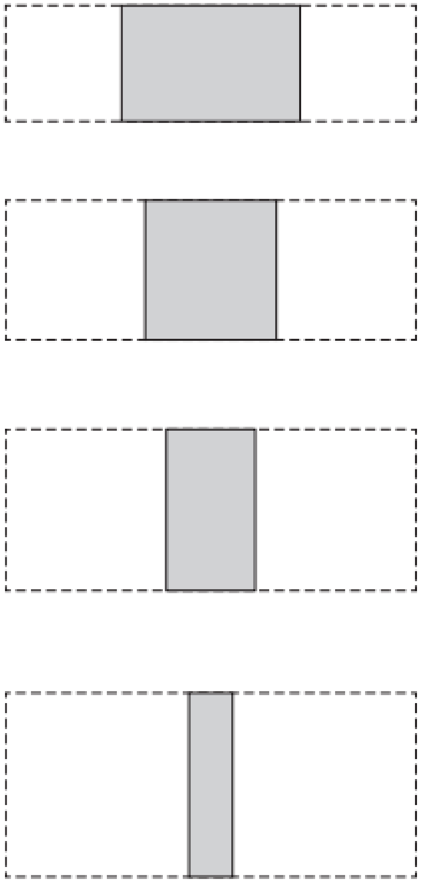
$$A(s) = s(100 - 2s)$$

5. Describe how the area of the enclosure changes as the side length increases.

As the side length increases, the area of the enclosure first increases and then decreases.

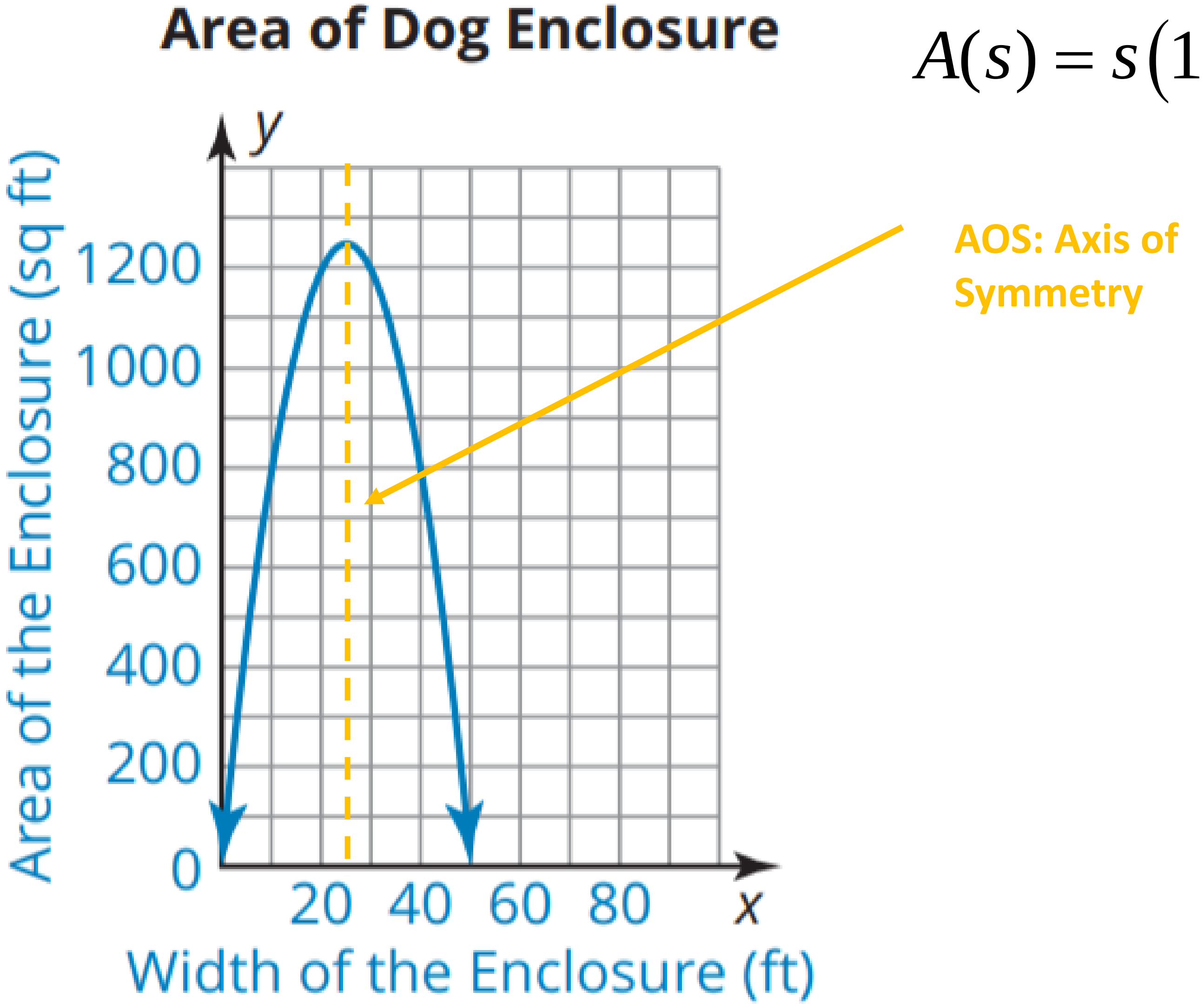
6. Consider the graph of the function, *A*(*s*).

a. Predict what the graph of the function will look like.



b. Use technology to graph the function *A*(*s*). Then sketch the graph and label the axes.

$$A(s) = s(100 - 2s)$$



The function $A(s)$ that you wrote to model area is a quadratic function. The shape that a quadratic function forms when graphed is called a **parabola**.

Think about:

Quadratic functions model area because area is measured in square units.

8. Think about the possible areas of the enclosure.

a. Is there a maximum area that the enclosure can contain? Explain your reasoning in terms of the graph and in terms of the context.

b. Use technology to determine the maximum of $A(s)$. Describe what the x- and y-coordinates of the maximum represent in this context.

The maximum is (25, 1250). When the side length is 25 feet, the area of the enclosure is 1250 square feet.

c. Determine the dimensions of the enclosure that will provide the maximum area. Show your work and explain your reasoning.

An enclosure with a side length of 25 feet and a length of 50 feet provides the maximum area.

9. Identify the domain and range of the context and of the function.

For the context, the domain is $0 < s < 50$ and the range is $0 < A(s) \leq 1250$.

For the function, the domain is the set of all real numbers and the range is $A(s) \leq 1250$.

10. Identify each key characteristic of the graph. Then, interpret the meaning of each in terms of the context.

a. *y*-intercept

$(0, 0)$

b. increasing and decreasing intervals

There is an increasing interval when $0 < s \leq 25$. There is a decreasing interval when $25 < s < 50$.

c. symmetry

There is symmetry between the increasing and decreasing intervals.

d. *x*-intercepts

The *x*-intercepts are (0, 0) and (50, 0).