



Name: _____

Date: _____

Student Exploration: Parabolas

Vocabulary: axis of symmetry, conic section, directrix, focus of a parabola, parabola, vertex of a parabola

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

Flashlights contain a bulb in front of a curved mirror. The light reflects off the mirror and sends a bright beam of light forward. The mirror is called a parabolic mirror, because a cross section forms a **parabola**.

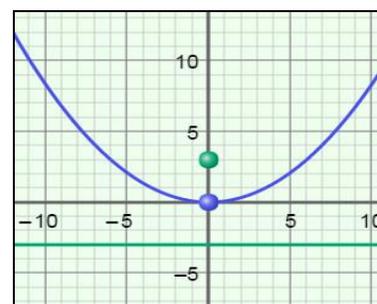


Cross section of parabolic mirror

1. Draw a point inside the parabola to the right to estimate location of the bulb. (The bulb is actually placed at the **focus** of the parabola. This is important, so the light reflects off the mirror in parallel rays.)
2. Draw a point on the parabola showing where the very back (in this case leftmost point) of the mirror is. This is the **vertex** of the parabola.

Gizmo Warm-up

A parabola is an example of a **conic section**, a shape formed when a plane intersects a cone. In the *Parabolas* Gizmo, you can explore parabolas in the coordinate plane and their equations in two different forms.



In the Gizmo, set **p** to 3, **h** to 0, and **k** to 0. (Change the values by dragging the sliders, or by clicking in the text box, typing in a value, and hitting **Enter**.)

1. Be sure **Vertical** is selected. With the values above, you should have $x^2 = 12y$ graphed.

A. The vertex of this parabola is its lowest point. Mouseover the vertex.

What are the coordinates of the vertex? _____

B. Vary the value of **h**. How does the parabola change? _____

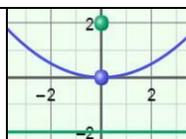
C. Vary the value of **k**. How does the parabola change? _____

2. Reset **h** and **k** to 0. Select **Horizontal**.

A. How is the equation different? _____

B. How is the parabola different? _____



Activity A: Graphs of parabolas	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> • Select Vertical. • Set p to 2, h to 0, and k to 0. 	
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1. A parabola is a curve defined by a fixed point called the focus, and a fixed line called the **directrix**. In the Gizmo, the focus is the green point, and the directrix is the green line.

A. Vary the value of p for positive values only. How does the parabola change?

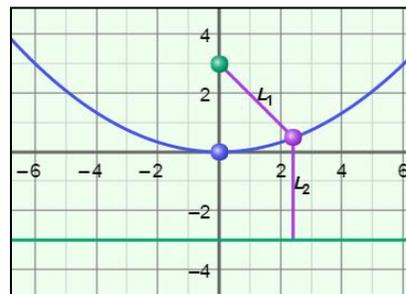
B. What is true about the parabola when p is negative? _____

C. Keep varying p . What distances does p seem to represent? _____

D. Select **Horizontal** and vary p . How does the parabola change? _____

2. Select **Vertical**. Click on **Explore geometric definition**. The purple point can be any (x, y) point on the parabola.

A. Drag the purple point around the parabola. What distances do L_1 and L_2 represent?



B. Now drag the purple point onto the vertex. Compare L_1 and L_2 to the value of p . Based on this, what does p tell you about the parabola?

C. Drag the purple point. What is true about the values of L_1 and L_2 ? _____

D. Select **Horizontal** and repeat. Is this always true about L_1 and L_2 ? _____

E. Based on what you found above, fill in the blanks to write the definition of a parabola.

Definition: A parabola is the set of all (x, y) points that are _____

(Activity A continued on next page)



Activity A (continued from previous page)

3. The equation of a parabola that has its vertex at the origin and opens vertically is $x^2 = 4py$. If the parabola opens horizontally, the equation is $y^2 = 4px$.

- A. Suppose a parabola opens vertically, has a vertex at $(0, 0)$, and the value of p is -2 . State the equation of the parabola, coordinates of the focus, and equation of the directrix. Then graph the equation in the Gizmo to check.

Equation: _____ Focus: _____ Directrix: _____

- B. Suppose a parabola opens horizontally, has a vertex at $(0, 0)$, and $p = 3$. State its equation, coordinates of the focus, and equation of the directrix. Then graph the equation in the Gizmo to check.

Equation: _____ Focus: _____ Directrix: _____

4. Select **Vertical**. Turn off **Explore geometric definition**. Set p to 3, h to 1, and k to -4 to graph $(x - 1)^2 = 12(y + 4)$.

- A. Find the coordinates of the vertex, the coordinates of the focus, and the equation of the directrix of this parabola.

Vertex: _____ Focus: _____ Directrix: _____

- B. The vertex form of the equation of a parabola that opens vertically is $y = a(x - h)^2 + k$. Write $(x - 1)^2 = 12(y + 4)$ in vertex form. Show your work to the right. Select **Show vertex form** to check your answer.

- C. How is a in the vertex form related to p ? _____

5. The graph of $(y + 2)^2 = 20(x - 3)$ is a parabola that opens horizontally with vertex $(3, -2)$.

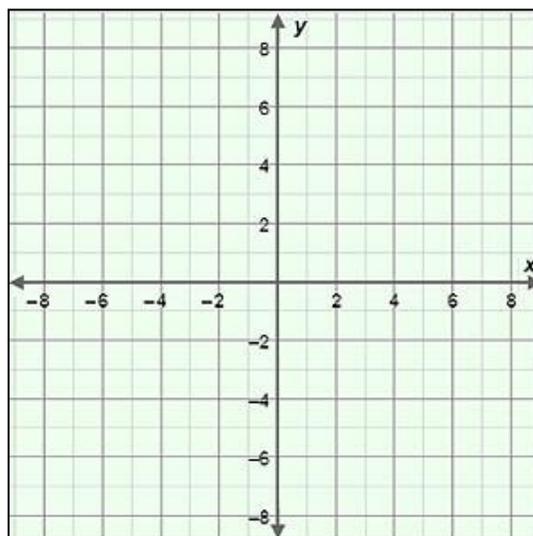
- A. Find the value of p , the coordinates of the focus, and the equation of the directrix of this parabola.

$p =$ _____ Focus: _____

Directrix: _____

- B. Sketch the graph of $(y + 2)^2 = 20(x - 3)$ on the grid to the right.

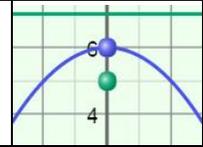
Then check your graph in the Gizmo.



Activity B:
Equations of parabolas

Get the Gizmo ready:

- Turn off **Explore geometric definition**.



- A parabola that opens vertically has a vertex at $(0, 6)$ and a focus at $(0, 5)$.
 - Find the value of p for this parabola. Show your work to the right.
 - Find the equation of this parabola. Show your work to the right. Then graph the equation in the Gizmo to check.
- A parabola that opens horizontally has a vertex at $(2, 4)$ and a directrix at $x = -1$.
 - Find the value of p for this parabola. Show your work to the right.
 - Find the equation of this parabola. Show your work to the right. Then graph the equation in the Gizmo to check.
- For each equation given below, state the coordinates of the vertex and focus, and the equation of the directrix. Then graph each equation in the Gizmo to check your answers.

- $(x + 4)^2 = -12(y - 7)$ Vertex: _____ Focus: _____ Directrix: _____
- $(y - 5)^2 = 2(x + 6)$ Vertex: _____ Focus: _____ Directrix: _____
- $y^2 = -8(x - 2)$ Vertex: _____ Focus: _____ Directrix: _____

- Write the equation of the parabola shown in each graph. Check your equation in the Gizmo.

