Finding the Focus and Directrix of a Parabola Worksheet

A focus and directrix worksheet for Algebra II and Precalculus: one point, one line, and the small number that connects them — 20 practice problems with a full answer key.

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Quick Reference

OPENS UP OR DOWN

$(x - h)^2 = 4p(y - k)$

Focus (h, k + p)
Directrix y = k - p
x is squared.

OPENS LEFT OR RIGHT

$(y - k)^2 = 4p(x - h)$

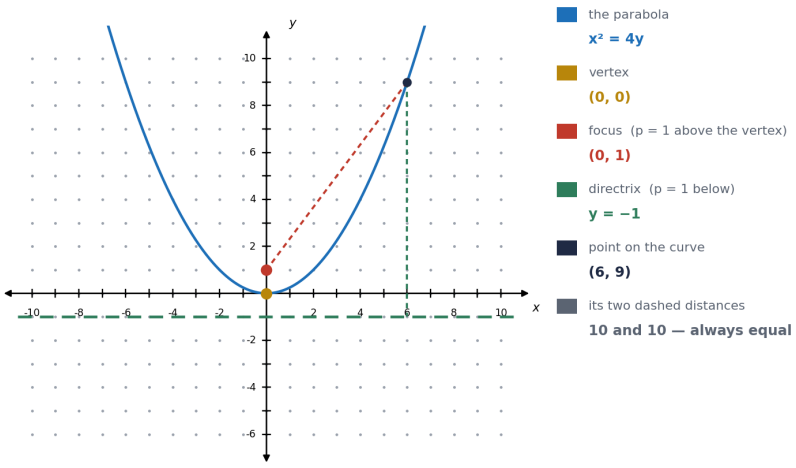
Focus (h + p, k)
Directrix x = h - p
y is squared.

FINDING p

$p = 1 / (4a)$

From $y = ax^2$, divide.
Sign of p = direction.
|p| = vertex to focus.

Every parabola is built from a point and a line — the focus and the directrix. The curve is every spot that is equally far from both, and the vertex sits exactly halfway between them. That is the whole trick in one sentence, and the rest of this focus and directrix worksheet is practice at using it.



Both dashed segments are 10 units. Pick a different point and they change together.

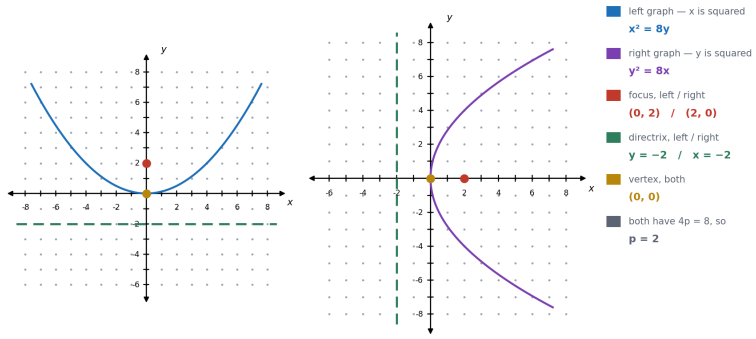
Colour	Piece	Where it comes from
Blue	**$x^2 = 4y$**	4p = 4, so p = 1
Gold	**Vertex (0, 0)**	h and k in the equation
Red	**Focus (0, 1)**	p = 1 unit above the vertex
Green	**Directrix y = -1**	p = 1 unit below the vertex

READ THE WHOLE NUMBER, THEN DIVIDE

Given $(x - 3)^2 = 8(y + 1)$, the 8 is **4p**, not p. So p = 2: the focus is 2 above the vertex and the directrix is 2 below. Calling p = 8 puts the focus four times too far out. Same trap with a: in $y = ax^2$ you flip and divide, since p = 1/(4a).

Where the Focus and Directrix Move on a Sideways Parabola

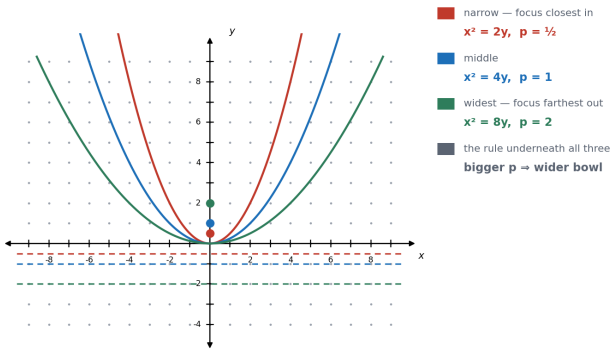
If x is squared, the parabola opens up or down and the directrix is horizontal. If y is squared, the whole picture tips ninety degrees.



Colour	Equation	Focus and directrix
Blue	$x^2 = 8y$	Focus (0, 2), directrix y = -2
Purple	$y^2 = 8x$	Focus (2, 0), directrix x = -2

The Focus and Directrix Also Set the Width

Move the focus and directrix farther apart and the curve opens wider. Push them together and it pinches shut.



Colour	Equation	p and shape
Red	$x^2 = 2y$	p = 1/2 - narrowest
Blue	$x^2 = 4y$	p = 1 - middle
Green	$x^2 = 8y$	p = 2 - widest

Practice Problems

Part A is straight identification: vertex, focus, directrix. Part B works backwards from the focus and directrix, or into a word problem. Show your work in the space provided.

Part A — state the vertex, the focus, and the directrix

1. $x^2 = 8y$

2. $y^2 = 12x$

3. $x^2 = -16y$

4. $y = (1/4)x^2$

5. $y^2 = -4x$

6. $(x - 3)^2 = 8(y + 1)$

7. $(y + 2)^2 = 12(x - 1)$

8. $(x + 4)^2 = -4(y - 2)$

9. $y = 2x^2$

10. $y = -(1/12)x^2 + 3$

Part B — work backwards, then answer the question

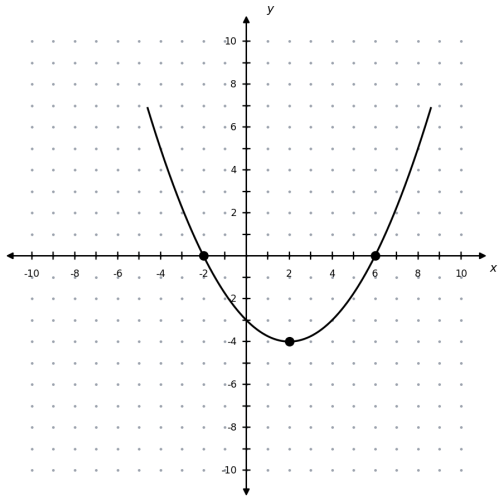
11. Focus (0, 5), directrix y = -5. Write the equation.

12. Focus (-2, 0), directrix x = 2. Write the equation.

13. Vertex (2, -3), focus (2, -1). Write the equation and give the directrix.

14. Vertex (-1, 4), directrix x = 3. Write the equation and give the focus.

15. Use the graph below. Write the equation in the form $(x - h)^2 = 4p(y - k)$, then state the focus and directrix.



16. $y = x^2 - 6x + 5$. Rewrite it, then find the focus and directrix.

17. A satellite dish is 8 ft across and 2 ft deep at the centre. How far from the vertex does the receiver go?

18. A flashlight reflector is 6 in across and 3 in deep. How far from the vertex is the bulb?

19. On $x^2 = 12y$, a point sits 9 units from the focus. How far is it from the directrix, and what is its y-coordinate?

20. Which has its focus farther from the vertex, $y = (1/2)x^2$ or $y = (1/8)x^2$? Give both foci.

Answer Key

Part A

1. $x^2 = 8y$

4p = 8, so p = 2. x is squared, so it opens up from (0, 0).

Vertex (0, 0) · Focus (0, 2) · Directrix y = -2

2. $y^2 = 12x$

y is squared, so it opens sideways. 4p = 12 gives p = 3, positive, so it opens right.

Vertex (0, 0) · Focus (3, 0) · Directrix x = -3

3. $x^2 = -16y$

4p = -16, so p = -4. Negative p drops the focus below the vertex.

Vertex (0, 0) · Focus (0, -4) · Directrix y = 4

4. $y = (1/4)x^2$

Multiply both sides by 4 to get $x^2 = 4y$, so 4p = 4 and p = 1.

Vertex (0, 0) · Focus (0, 1) · Directrix y = -1

5. $y^2 = -4x$

Sideways again, and 4p = -4 gives p = -1, so it opens left.

Vertex (0, 0) · Focus (-1, 0) · Directrix x = 1

6. $(x - 3)^2 = 8(y + 1)$

Vertex (3, -1). The 8 is 4p, so p = 2 - up 2 for the focus, down 2 for the directrix.

Vertex (3, -1) · Focus (3, 1) · Directrix y = -3

7. $(y + 2)^2 = 12(x - 1)$

Vertex (1, -2), p = 3, and y is squared, so move right 3 and left 3.

Vertex (1, -2) · Focus (4, -2) · Directrix x = -2

8. $(x + 4)^2 = -4(y - 2)$

Vertex (-4, 2), 4p = -4, so p = -1 and it opens down.

Vertex (-4, 2) · Focus (-4, 1) · Directrix y = 3

9. $y = 2x^2$

Rewrite as $x^2 = (1/2)y$, so 4p = 1/2 and p = 1/8. Steep curve, tiny p.

Vertex (0, 0) · Focus (0, 1/8) · Directrix y = -1/8

10. $y = -(1/12)x^2 + 3$

Move the 3 and multiply by -12: $x^2 = -12(y - 3)$, so p = -3 from (0, 3).

Vertex (0, 3) · Focus (0, 0) · Directrix y = 6

Answer Key — Part B

11. Focus (0, 5), directrix y = -5

The vertex is halfway between, at (0, 0), and p = 5. Then 4p = 20.

$x^2 = 20y$

12. Focus (-2, 0), directrix x = 2

Vertical directrix means y gets squared. Vertex (0, 0), focus to the left, so p = -2.

$y^2 = -8x$

13. Vertex (2, -3), focus (2, -1)

Same x-coordinate, so it opens up. Focus is 2 above, so p = 2 and 4p = 8.

$(x - 2)^2 = 8(y + 3)$ · Directrix y = -5

14. Vertex (-1, 4), directrix x = 3

Vertical directrix, so y is squared. It sits 4 right of the vertex, so p = -4.

$(y - 4)^2 = -16(x + 1)$ · Focus (-5, 4)

15. From the graph

Vertex (2, -4), passes through (6, 0). Substituting: 16 = 4p(4), so 4p = 4 and p = 1.

$(x - 2)^2 = 4(y + 4)$ · Focus (2, -3) · Directrix y = -5

16. $y = x^2 - 6x + 5$

Complete the square: $y = (x - 3)^2 - 4$, so $(x - 3)^2 = 1(y + 4)$. Then p = 1/4.

Vertex (3, -4) · Focus (3, -3.75) · Directrix y = -4.25

17. Dish 8 ft across, 2 ft deep

Vertex at the origin puts the rim at (4, 2), so 16 = 4p(2) and 4p = 8.

p = 2 - the receiver goes 2 ft above the vertex

18. Reflector 6 in across, 3 in deep

Rim at (3, 3), so 9 = 4p(3) and 4p = 3.

p = 3/4 - the bulb sits 0.75 in from the vertex

19. $x^2 = 12y$, point 9 units from the focus

Both distances are always equal. p = 3, directrix y = -3, so y + 3 = 9.

9 units from the directrix · y = 6

20. $y = (1/2)x^2$ against $y = (1/8)x^2$

They become $x^2 = 2y$ and $x^2 = 8y$, so p = 1/2 and p = 2.

$y = (1/8)x^2$, focus (0, 2), against focus (0, 1/2)

Every answer above was checked for accuracy against the original equation or graph before publishing. Problems are prepared from previous class notes and assigned homework. Spot an error? Email burketutoringinfremont@outlook.com or text (510) 453-0350 and it will be corrected.