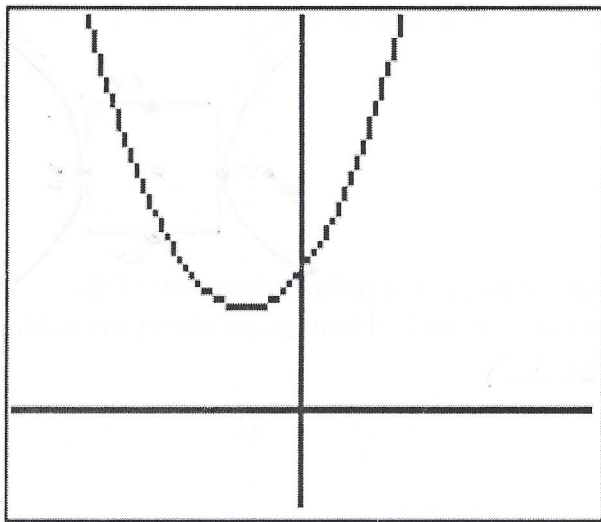


## 5.1 Parabolas

A parabola is the set of all points  $P(x,y)$  in the plane whose distance to a fixed point, called the focus, equals the distance to a fixed line, directrix.



- ❖ Focus is inside the curve + lies on the line of symmetry with the vertex.
- ❖ Directrix is a horizontal/vertical line that is outside the parabola.

**Horizontal Directrix:**  $y = \frac{1}{4p}x^2$

**Vertical Directrix:**  $x = \frac{1}{4p}y^2$

Opens Up or Down

$$y - k = \frac{1}{4p}(x - h)^2$$

- ☞  $V(h, k)$
- ☞  $F(h, k + p)$
- ☞ Directrix  $y = k - p$
- ☞ Axis of Symmetry  $x = h$
- ☞ If  $p > 0$  opens Up
- ☞ If  $p < 0$  opens Down

Opens Left or Right

$$x - h = \frac{1}{4p}(y - k)^2$$

- ☞  $V(h, k)$
- ☞  $F(h + p, k)$
- ☞ Directrix  $x = h - p$
- ☞ Axis of Symmetry  $y = k$
- ☞ If  $p > 0$  opens Right
- ☞ If  $p < 0$  opens Left

\*\*\*Note that a parabola only has one term squared\*\*\*

### Example 1

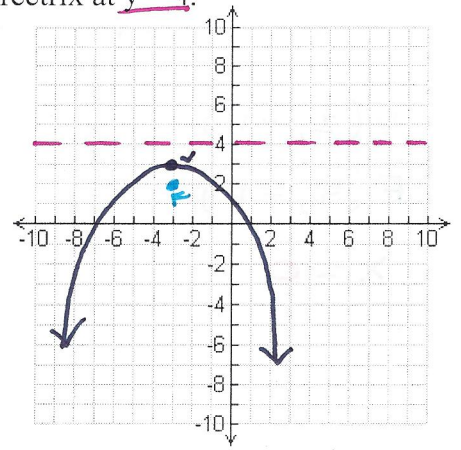
Find the standard form equation for the parabola with a focus at (-3, 2) and a directrix at y = 4.

Horizontal

$$v(-3, 2) \\ p = -1$$

$$y - k = \frac{1}{4p} (x - h)^2$$

$$y - 2 = \frac{1}{-4} (x + 3)^2$$



### Example 2

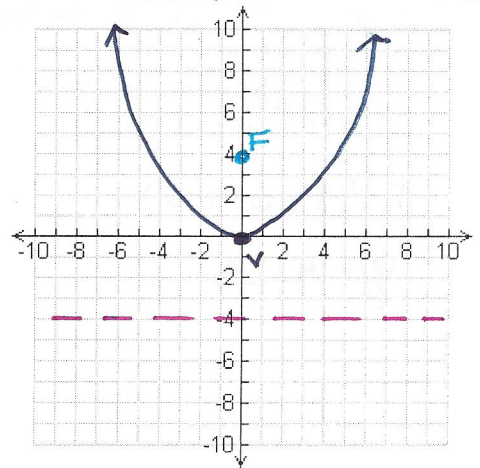
Find the standard form equation for the parabola with a vertex at (0, 0) and a directrix at y = -4.

Horizontal

$$y = \frac{1}{4p} x^2$$

$$y = \frac{1}{16} x^2$$

$$p = 4$$



### Example 3

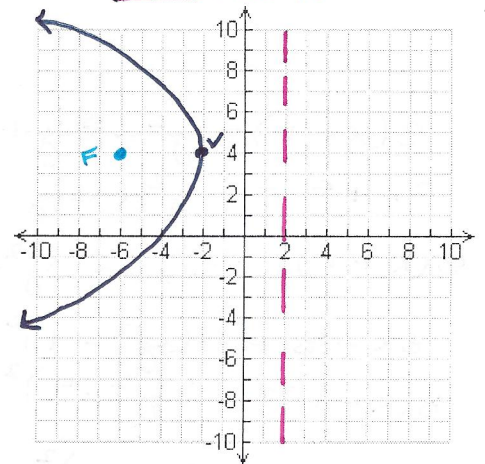
Find the standard form equation for the parabola with a focus at (-6, 4) and a directrix at x = 2.

Vertical

$$v(-2, 4) \\ p = -4$$

$$x - h = \frac{1}{4p} (y - k)^2$$

$$x + 2 = \frac{1}{-16} (y - 4)^2$$



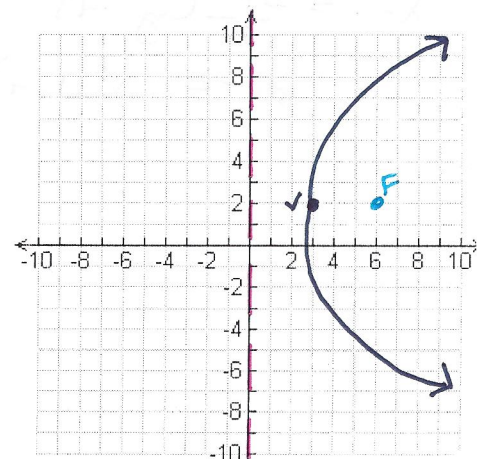
### Example 4

Find the standard form equation for the parabola with a focus at (6, 2) and a vertex at (3, 2).

$$p = 3$$

Vertical  
 $x = 0$

$$x - h = \frac{1}{4p} (y - k)^2 \rightarrow (x - 3) = \frac{1}{12} (y - 2)^2$$



### Example 5

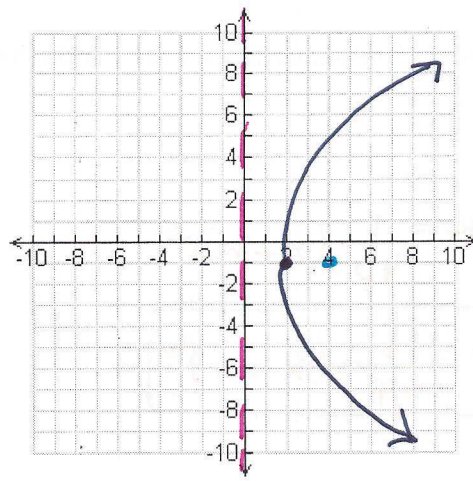
Find the vertex, focus & directrix for  $x - 2 = \frac{1}{8}(y + 1)^2$ .

$$V(2, -1)$$

$$F(4, -1)$$

$$x = 0$$

$$p = 2$$



### Example 6

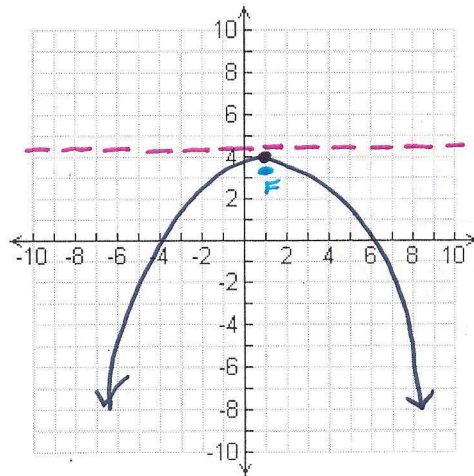
Find the vertex, focus & directrix for  $y - 4 = -(x - 1)^2$ .

$$V(1, 4)$$

$$F(1, 3.75)$$

$$y = 4.25$$

$$\begin{aligned} \downarrow \\ -1 &= \frac{1}{4p} \\ -4p &= 1 \\ p &= -1/4 \end{aligned}$$



### Example 7

Graph the parabola and label the vertex, focus and directrix.

$$y^2 - 8y + 8x + 8 = 0$$

$$8x + 8 = -y^2 + 8y$$

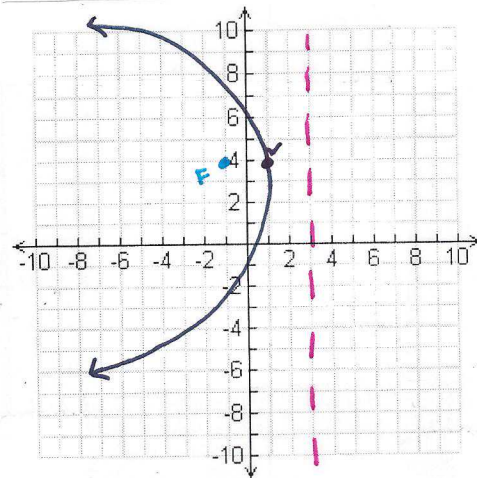
$$8x + 8 - \left(\frac{16}{4}\right) = -(y^2 - 8y + \frac{16}{4})$$

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

$$8(x - 1) = -(y - 4)^2 \quad \div \text{by } 8$$

$$x - 1 = -\frac{1}{8}(y - 4)^2$$

$$p = -2 \quad v(1, 4)$$



$x - 1 = -\frac{1}{8}(y - 4)^2$