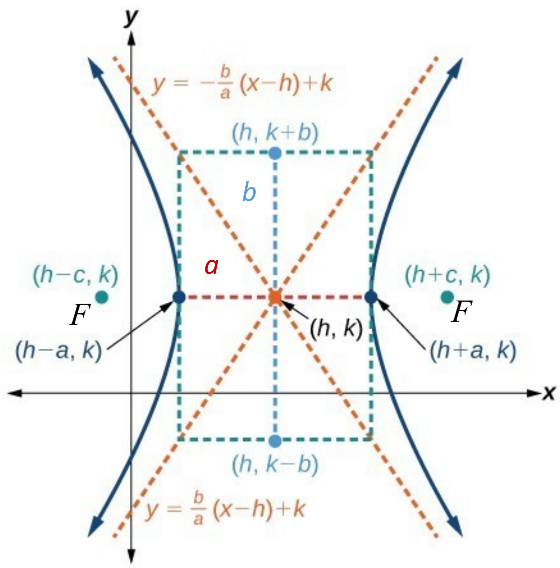
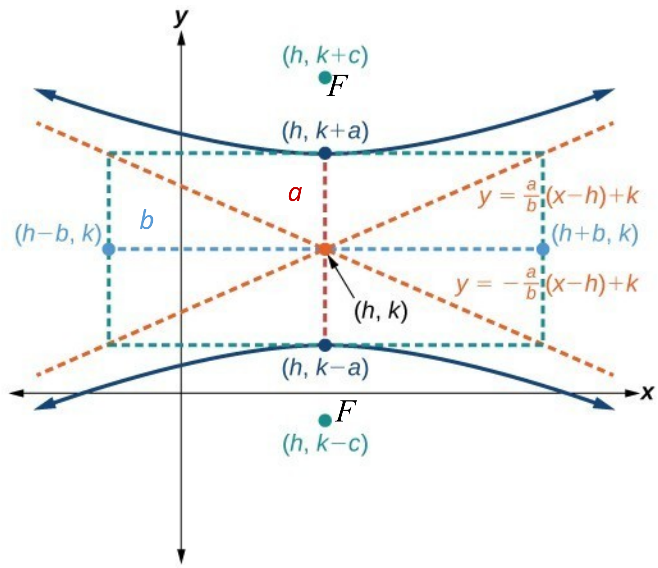
Hyperbola



Horizontal Hyperbola



Vertical Hyperbola

$$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1 \qquad \frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1$$

Observe that

F *– focus* (plural is foci)

(h, k) *- center*

c - distance from center *(h, k)* to a focus *F*. You can find *a, b,* or *c* using following equation

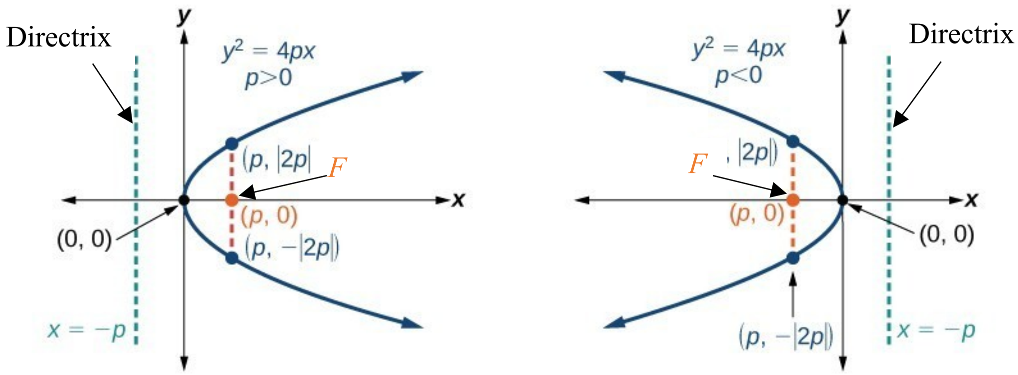
$$c^2 = a^2 + b^2$$

2a *– transverse axis*

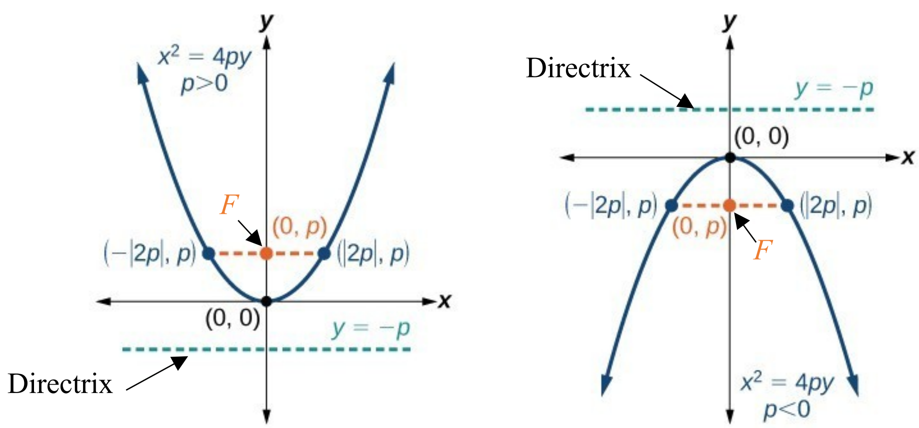
2b *– conjugate axis*

Note: Observe that $a < b, b < a$, or $a = b$. What is more important is what variable the first term contains. If the first term contains ***x***, then it is a horizontal hyperbola with the transverse axis ***2a*** parallel to the ***x-axis*** and the conjugate axis *2b* parallel to the *y-axis*. If the first term contains ***y***, then it is a vertical hyperbola with the transverse axis ***2a*** parallel to the ***y-axis*** and the conjugate axis **2*b*** parallel to the *x-axis.*

Parabola



(a) Horizontal Parabola (b)



(c) Vertical Parabola (d)

<u>Note:</u>
Observe the equation of the ***horizontal parabola*** with a center *(h, k)* (not in the origin) is $\boldsymbol{(y-k)^2 = 4p(x-h)}$, where the term with *y* variable is squared.

The equation of the ***vertical parabola*** with a vertex *(h, k)* is
$\boldsymbol{(x-h)^2 = 4p(y-k)}$, where the term with *x* variable is squared.

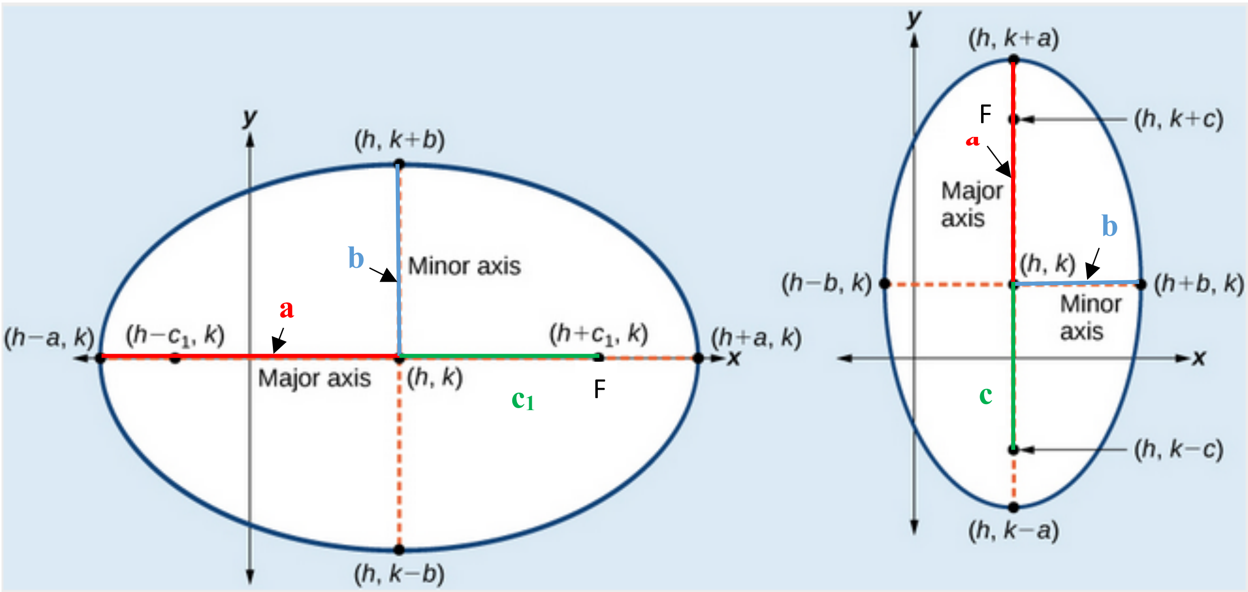
p – distance between the vertex and the focus *F* or directrix.

Dividing both sides by *4p* and adding *k* to both sides of any equations, we can rewrite both equations as follows

Equation of the horizontal parabola $x = a(y-k)^2 + h$, where $a = \frac{1}{4p}$

Equation of the vertical parabola $y = a(x-h)^2 + k$, where $a = \frac{1}{4p}$

Ellipse



Horizontal Ellipse Vertical Ellipse

Equation of the ***horizontal ellipse***

$$\frac{(\boldsymbol{x}-\boldsymbol{h})^2}{\boldsymbol{a}^2}+\frac{(\boldsymbol{y}-\boldsymbol{k})^2}{\boldsymbol{b}^2}=\mathbf{1}$$

Equation of the ***vertical ellipse***

$$\frac{(\boldsymbol{x}-\boldsymbol{h})^2}{\boldsymbol{b}^2}+\frac{(\boldsymbol{y}-\boldsymbol{k})^2}{\boldsymbol{a}^2}=\mathbf{1}$$

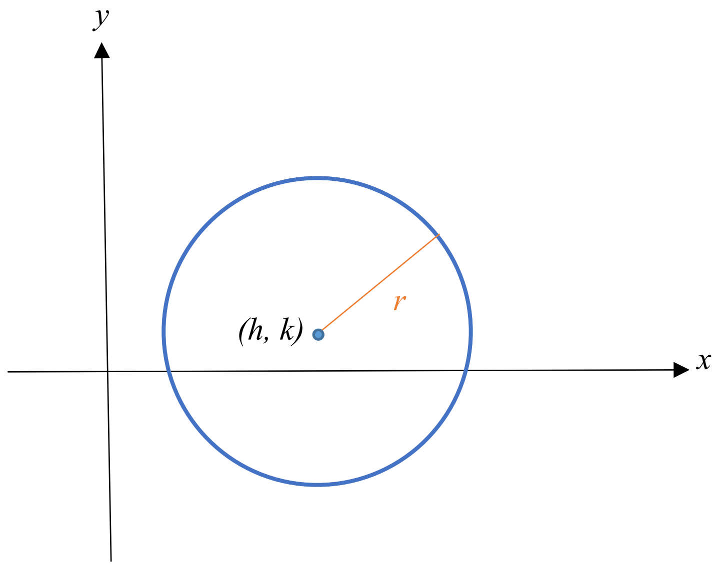
Where ***a*** - *major axis* and ***b*** is the *minor axis*, and $a > b$
(h, k) - *center*
c or $\boldsymbol{c_1}$ - distance from the center to a focus ***F.***

You can find *a, b,* or *c* using following equation

$$c^2 = a^2 - b^2$$

Note: Simply, think about denominators of the equation: if the term with the *x* variable has the bigger denominator, then the ellipse is horizontal and has the major axis parallel to the *x*-axis. If the term with the *y* variable has the bigger denominator, then the ellipse is vertical and has the major axis parallel to the *y*-axis.

Circle



Equation of the ***circle***

$$(\boldsymbol{x}-\boldsymbol{h})^{2}+(\boldsymbol{y}-\boldsymbol{k})^{2}=\boldsymbol{r}^{2}$$

where *(h, k)* is the *center*, and *r* is the *radius* of a circle.