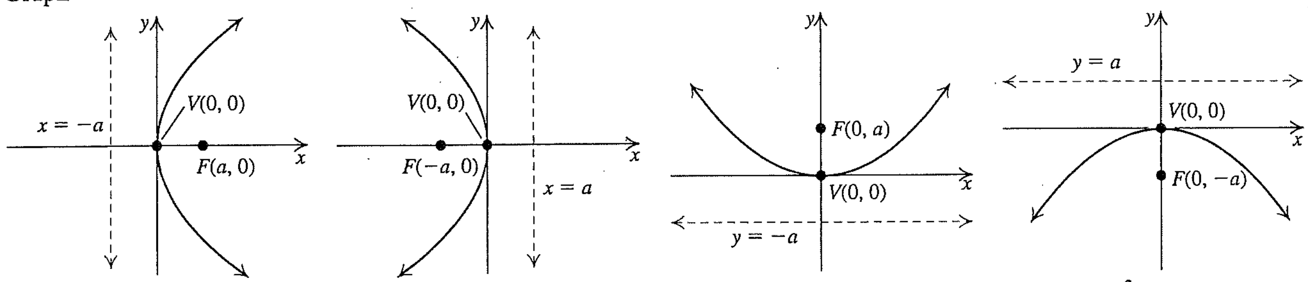
Main facts about a parabola with $a > 0$

Standard Equation	$y^2 = 4ax$	$y^2 = -4ax$	$x^2 = 4ay$	$x^2 = -4ay$
Vertex	$(0, 0)$	$(0, 0)$	$(0, 0)$	$(0, 0)$
Description	Opens right	Opens left	Opens up	Opens down
Axis of Symmetry	$y = 0$ (x-axis)	$y = 0$ (x-axis)	$x = 0$ (y-axis)	$x = 0$ (y-axis)
Focus	$(a, 0)$	$(-a, 0)$	$(0, a)$	$(0, -a)$
Directrix	$x = -a$	$x = a$	$y = -a$	$y = a$

Graph

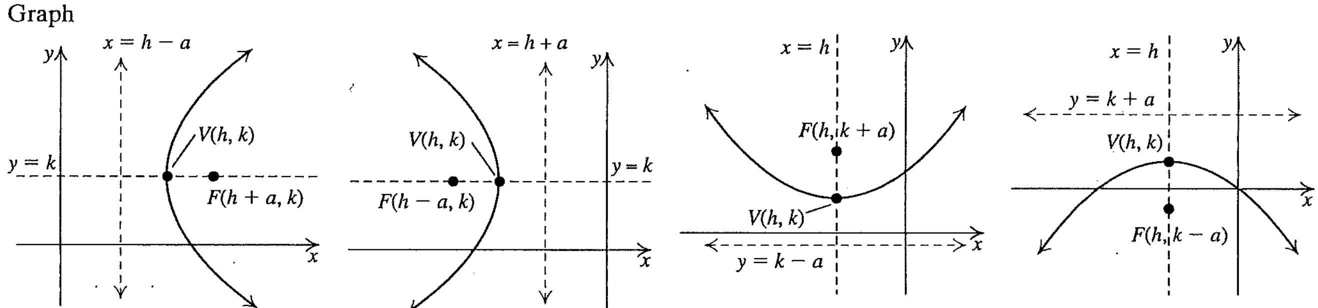


$y^2 = 4ax$ $\quad$ $y^2 = -4ax$ $\quad$ $x^2 = 4ay$ $\quad$ $x^2 = -4ay$

Main facts about a parabola with vertex (h, k) and $a > 0$

Standard Equation	$(y - k)^2 = 4a(x - h)$	$(y - k)^2 = -4a(x - h)$	$(x - h)^2 = 4a(y - k)$	$(x - h)^2 = -4a(y - k)$
Equation of axis	$y = k$	$y = k$	$x = h$	$x = h$
Description	Opens right	Opens left	Opens up	Opens down
Vertex	(h, k)	(h, k)	(h, k)	(h, k)
Focus	$(h + a, k)$	$(h - a, k)$	$(h, k + a)$	$(h, k - a)$
Directrix	$x = h - a$	$x = h + a$	$y = k - a$	$y = k + a$

Graph



$(y - k)^2 = 4a(x - h)$ $\quad$ $(y - k)^2 = -4a(x - h)$ $\quad$ $(x - h)^2 = 4a(y - k)$ $\quad$ $(x - h)^2 = -4a(y - k)$

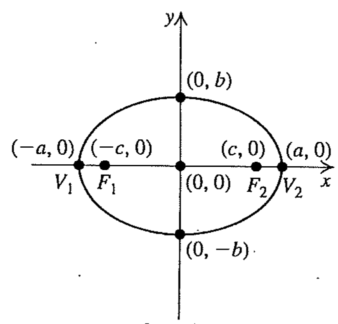
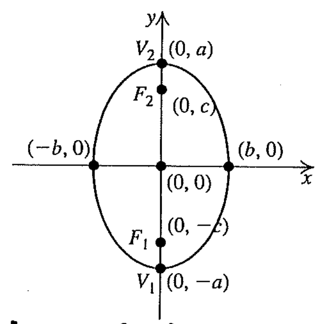
IDENTIFYING CONICS WITH AXES PARALLEL TO THE x- OR y-AXES

If we exclude the degenerate conics, the graph of the equation

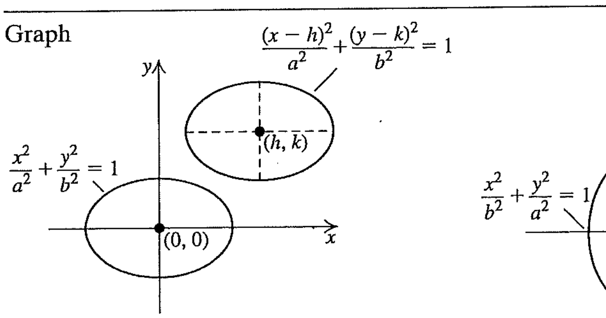
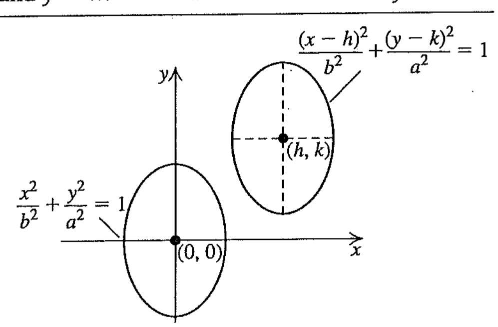
$$Ax^2 + Cy^2 + Dx + Ey + F = 0, \qquad (1)$$

where A and C are not both zero, is

1. a parabola if either $A = 0$ or $C = 0$ ($AC = 0$). (See page 613.)
2. an ellipse (or a circle if $A = C$) if A and C have the same sign ($AC > 0$). (See page 623.)
3. a hyperbola if A and C have opposite signs ($AC < 0$). (See page 638.)

Standard Equation	$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1; a>b>0$ **(Horizontal ellipse)**	$\frac{x^2}{b^2} + \frac{y^2}{a^2} = 1; a>b>0$ **(Vertical ellipse)**
Relationship between a, b, and c	$b^2 = a^2 - c^2$	$b^2 = a^2 - c^2$
Major axis along	x-axis	y-axis
Length of major axis	$2a$	$2a$
Minor axis along	y-axis	x-axis
Length of minor axis	$2b$	$2b$
Vertices	$(\pm a, 0)$	$(0, \pm a)$
Foci	$(\pm c, 0)$	$(0, \pm c)$
Endpoints of minor axis	$(0, \pm b)$	$(\pm b, 0)$
Symmetry	The graph is symmetric with respect to the x-axis, y-axis, and origin.	The graph is symmetric with respect to the x-axis, y-axis, and origin.
Graph	 $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ Horizontal ellipse	 $\frac{x^2}{b^2} + \frac{y^2}{a^2} = 1$ Vertical ellipse

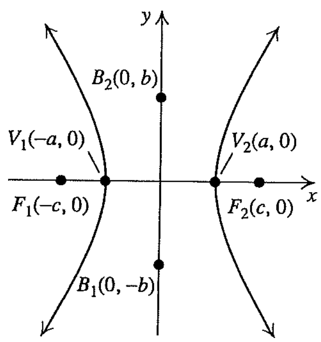
Main facts about horizontal and vertical ellipses with center (h, k)

Standard Equation	$\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1;$ $a>b>0$ **(Horizontal ellipse)**	$\frac{(x-h)^2}{b^2} + \frac{(y-k)^2}{a^2} = 1;$ $a>b>0$ **(Vertical ellipse)**
Center	(h, k)	(h, k)
Major axis along the line	$y = k$	$x = h$
Length of major axis	$2a$	$2a$
Minor axis along the line	$x = h$	$y = k$
Length of minor axis	$2b$	$2b$
Vertices	$(h + a, k), (h - a, k)$	$(h, k + a), (h, k - a)$
Endpoints of minor axis	$(h, k - b), (h, k + b)$	$(h - b, k), (h + b, k)$
Foci	$(h + c, k), (h - c, k)$	$(h, k + c), (h, k - c)$
Equation involving a, b, and c	$c^2 = a^2 - b^2$	$c^2 = a^2 - b^2$
Symmetry	The graph is symmetric about the lines $x = h$ and $y = k$.	The graph is symmetric about the lines $x = h$ and $y = k$.
Graph		

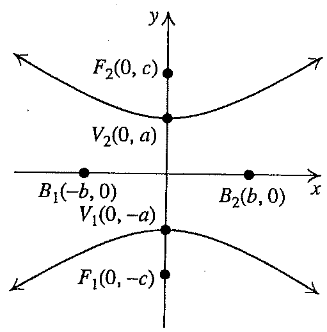
Main facts about hyperbolas centered at $(0, 0)$

Standard Equation	$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1;\ a>0,\ b>0$	$\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1;\ a>0,\ b>0$
Equation of transverse axis	$y = 0$ (x-axis)	$x = 0$ (y-axis)
Length of transverse axis	$2a$	$2a$
Equation of conjugate axis	$x = 0$ (y-axis)	$y = 0$ (x-axis)
Length of conjugate axis	$2b$	$2b$
Vertices	$(\pm a, 0)$	$(0, \pm a)$
Endpoints of conjugate axis	$(0, \pm b)$	$(\pm b, 0)$
Foci	$(\pm c, 0)$, where $c^2 = a^2 + b^2$	$(0, \pm c)$, where $c^2 = a^2 + b^2$
Description	Hyperbola has a *left branch* and a *right branch*. (Hyperbola opens left and right.)	Hyperbola has an *upper branch* and a *lower branch*. (Hyperbola opens up and down.)

Graph



Horizontal transverse axis



Vertical transverse axis

Main properties of hyperbolas centered at (h, k)

Standard Equation	$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1;$ $a>0,\ b>0$	$\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1;$ $a>0,\ b>0$
Equation of transverse axis	$y = k$	$x = h$
Length of transverse axis	$2a$	$2a$
Equation of conjugate axis	$x = h$	$y = k$
Length of conjugate axis	$2b$	$2b$
Center	(h, k)	(h, k)
Vertices	$(h - a, k)$ and $(h + a, k)$	$(h, k - a)$ and $(h, k + a)$
Endpoints of conjugate axis	$(h, k - b)$ and $(h, k + b)$	$(h - b, k)$ and $(h + b, k)$
Foci	$(h - c, k)$ and $(h + c, k)$; $c^2 = a^2 + b^2$	$(h, k - c)$ and $(h, k + c)$; $c^2 = a^2 + b^2$
Asymptotes	$y - k = \pm\frac{b}{a}(x - h)$	$y - k = \pm\frac{a}{b}(x - h)$