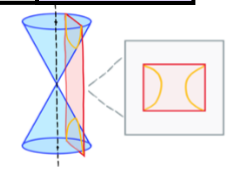
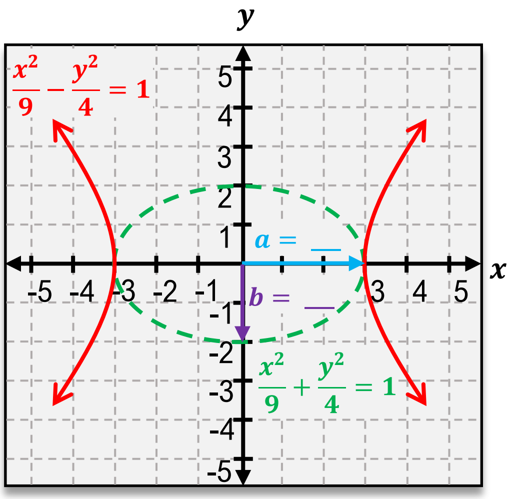
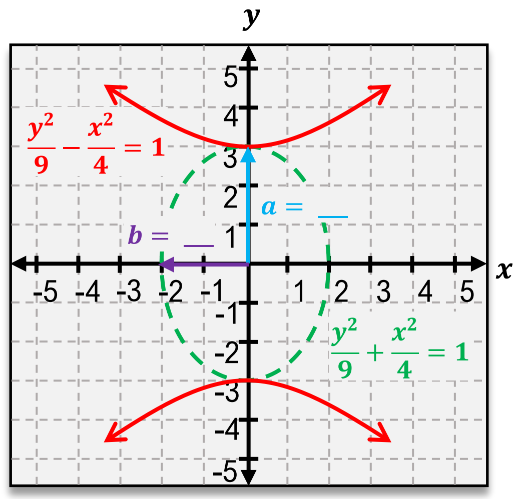
Circle	Ellipse	Parabola	**Hyperbola**



TOPIC: Hyperbolas at the Origin

Introduction to Hyperbolas

- The equation for a hyperbola is the same as an ellipse, but with a ______.
  - Visually, a hyperbola appears as two ____________ facing away from each other.

Horizontal Hyperbola	**Vertical Hyperbola**
	
$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ (Horiz. Ellipse) $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ (Horiz. Hyperbola)	$\frac{x^2}{b^2} + \frac{y^2}{a^2} = 1$ (Vert. Ellipse) $\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$ (Vert. Hyperbola)

- The axis major axis (a) is always **[LARGEST | FIRST]** for an ellipse, and **[LARGEST | FIRST]** for a hyperbola.

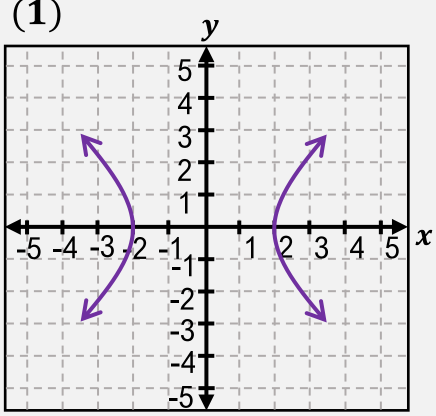
EXAMPLE: Match the equation to the graph

$(\boldsymbol{A})$ $\frac{y^2}{16} - \frac{x^2}{9} = 1$

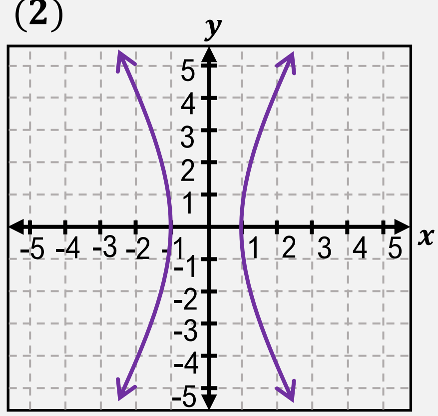
$(\boldsymbol{B})$ $\frac{x^2}{4} - \frac{y^2}{1} = 1$

$(\boldsymbol{C})$ $\frac{x^2}{1} - \frac{y^2}{25} = 1$

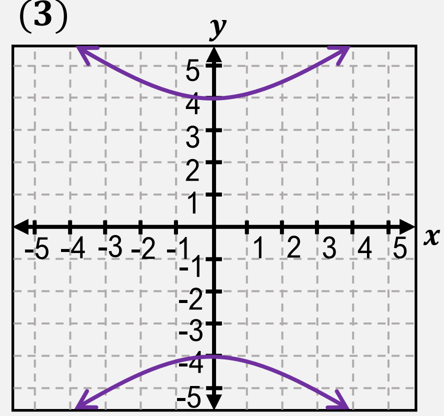
$(\mathbf{1})$



$(\mathbf{2})$



$(\mathbf{3})$



TOPIC: Hyperbolas at the Origin

PRACTICE: Given the hyperbola $\frac{x^2}{25} - \frac{y^2}{9} = 1$, find the length of the a-axis and b-axis.

$(\boldsymbol{A})\ a = 25, b = 9$
$(\boldsymbol{B})\ a = 9, b = 25$
$(\boldsymbol{C})\ a = 5, b = 3$
$(\boldsymbol{D})\ a = 3, b = 5$

PRACTICE: Given the hyperbola $x^2 - \frac{y^2}{4} = 1$, find the length of the a-axis and b-axis.

$(\boldsymbol{A})\ a = 1, b = 4$
$(\boldsymbol{B})\ a = 4, b = 1$
$(\boldsymbol{C})\ a = 1, b = 2$
$(\boldsymbol{D})\ a = 2, b = 1$

TOPIC: Hyperbolas at the Origin

PRACTICE: Given the hyperbola $\frac{y^2}{100} - \frac{x^2}{139} = 1$, find the length of the a-axis and b-axis.

$(\boldsymbol{A})\ a = 100, b = 139$
$(\boldsymbol{B})\ a = 139, b = 100$
$(\boldsymbol{C})\ a = \sqrt{139}, b = 10$
$(\boldsymbol{D})\ a = 10, b = \sqrt{139}$

Circle	Ellipse	Parabola	**Hyperbola**

TOPIC: Hyperbolas at the Origin
Vertices and Foci of Hyperbolas

- Every hyperbola has 2 **Vertices** & 2 **Foci**, both located on the **[MAJOR | MINOR]** axis.
  - **Vertices** are the points on the hyperbola ___________ to the center

    Distance between center & **Vertex** = **[a | b | c]**
  - For any point on a hyperbola, the ___________ of the distances between the point & each **Focus** is a constant

    Distance between center & **Focus** = **[a | b | c]**

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

(*Horiz. Hyperbola*)

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

(*Foci of Ellipse*)

$$c^2 = a^2 \quad\quad b^2$$

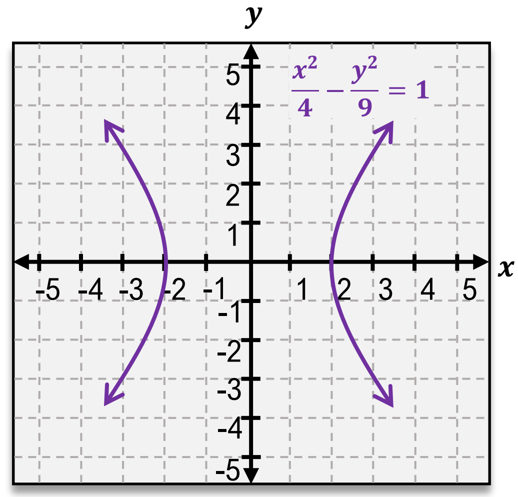
(*Foci of Hyperbola*)

EXAMPLE: Find the vertices & foci of the hyperbola in the graph.

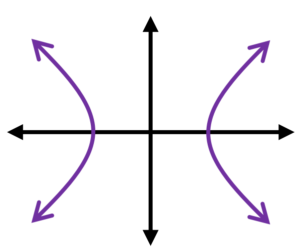
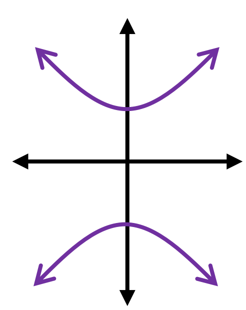
$a =$

$b =$

$c =$



- For a *vertical* hyperbola, the coordinates of vertices & foci are different

Horizontal Hyperbola	Vertical Hyperbola
	
Vertices: (___ ,0) & (___ ,0)	Vertices: (0 , ___) & (0 , ___)
Foci: (___ , 0) & (___ , 0)	Foci: (0, ___) & (0, ___)
Vertices & Foci on **[x | y]** axis	Vertices & Foci on **[x | y]** axis

TOPIC: Hyperbolas at the Origin

PRACTICE: Determine the vertices and foci of the hyperbola $\frac{y^2}{4} - x^2 = 1$.

$(\boldsymbol{A})$ Vertices: $(2,0), (-2,0)$
Foci: $(\sqrt{5}, 0), (-\sqrt{5}, 0)$

$(\boldsymbol{B})$ Vertices: $(0,2), (0,-2)$
Foci: $(0, \sqrt{5}), (0, -\sqrt{5})$

$(\boldsymbol{C})$ Vertices: $(1,0), (-1,0)$
Foci: $(5,0), (-5,0)$

$(\boldsymbol{D})$ Vertices: $(0,1), (0,-1)$
Foci: $(0,5), (0,-5)$

PRACTICE: Find the equation for a hyperbola with a center at $(0,0)$, focus at $(0,-6)$ and vertex at $(0,4)$.

$(\boldsymbol{A})\ \frac{y^2}{16} - \frac{x^2}{20} = 1$

$(\boldsymbol{B})\ \frac{y^2}{20} - \frac{x^2}{16} = 1$

$(\boldsymbol{C})\ \frac{y^2}{4} - \frac{x^2}{\sqrt{20}} = 1$

$(\boldsymbol{D})\ \frac{y^2}{\sqrt{20}} - \frac{x^2}{4} = 1$

Circle	Ellipse	Parabola	**Hyperbola**

TOPIC: Hyperbolas at the Origin

Asymptotes of Hyperbolas

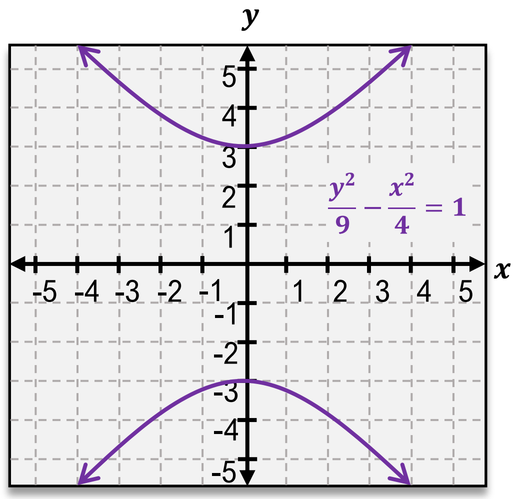
- To graph hyperbolas, you'll need asymptotes
  - The values of a & b form a ______ where the asymptotes are draw through the corners of the shape.

$$\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$$

(*Vert. Hyperbola*)

$$y = \pm \frac{\ }{\ } x$$

(Vert. *Hyperbola Asym.*)



EXAMPLE: Find & draw the asymptotes of the given hyperbola.

$a =$

$b =$

Asymptotes: $y =$ _________ & $y =$ _________

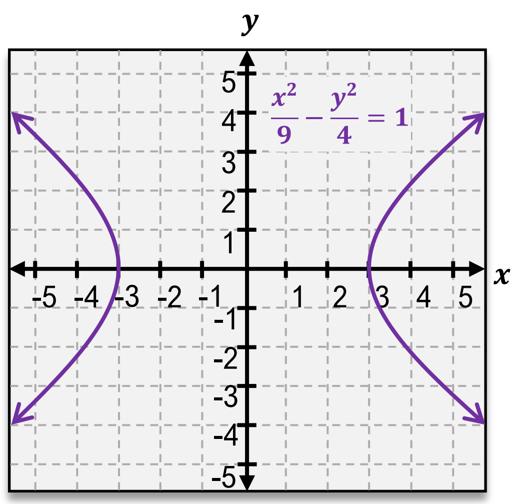
- For asymptotes of horizontal hyperbolas, just flip a & b

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

(*Horiz. Hyperbola*)

$$y = \pm \frac{\ }{\ } x$$

(Horiz. *Hyperbola Asym.*)



EXAMPLE: Find & draw the asymptotes of the given hyperbola.

$a =$

$b =$

Asymptotes: $y =$ _________ & $y =$ _________

TOPIC: Hyperbolas at the Origin

PRACTICE: Find the equations for the asymptotes of the hyperbola $\frac{x^2}{64} - \frac{y^2}{100} = 1$.

$(\boldsymbol{A})\ y = \pm\frac{4}{5}x$

$(\boldsymbol{B})\ y = \pm\frac{5}{4}x$

$(\boldsymbol{C})\ y = \pm\frac{16}{25}x$

$(\boldsymbol{D})\ y = \pm\frac{25}{16}x$

PRACTICE: Find the equations for the asymptotes of the hyperbola $\frac{y^2}{16} - \frac{x^2}{9} = 1$.

$(\boldsymbol{A})\ y = \pm\frac{9}{16}x$

$(\boldsymbol{B})\ y = \pm\frac{16}{9}x$

$(\boldsymbol{C})\ y = \pm\frac{3}{4}x$

$(\boldsymbol{D})\ y = \pm\frac{4}{3}x$

Circle	Ellipse	Parabola	**Hyperbola**

TOPIC: Hyperbolas at the Origin
Graph Hyperbolas at the Origin

EXAMPLE: Graph the hyperbola and identify the foci.

$$\frac{x^2}{9} - \frac{y^2}{64} = 1$$

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

TO GRAPH

1) Hyperbola is **[HORIZONTAL | VERTICAL]**

2) **Vertices** $(\pm a, 0)$, *OR* $(0, \pm a)$:

(__ , __) & (__ , __)

3) ***b* points** $(\pm b, 0)$, *OR* $(0, \pm b)$:

(__ , __) & (__ , __)

4) Asymptotes:

(A) draw a box through **vertices** & ***b* points**

(B) draw lines through box corners

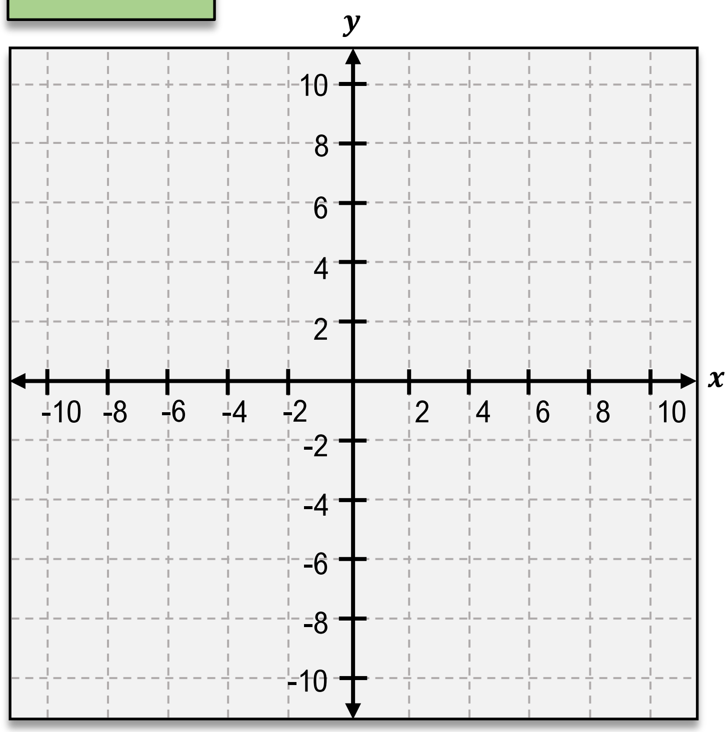
5) Draw branches at **vertices** & approaching asym.

FROM GRAPH

6) Foci $(\pm c, 0)$, *OR* $(0, \pm c)$:

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

(__ , __) & (__ , __)



TOPIC: Hyperbolas at the Origin

EXAMPLE**:** Graph the hyperbola and identify the foci.

$$\frac{x^2}{16} - \frac{y^2}{20} = 1$$

TO GRAPH

1) Hyperbola is **[** HORIZONTAL | VERTICAL **]**

2) **Vertices** $(\pm a, 0)$, *OR* $(0, \pm a)$**:**

(__ , __) & (__ , __)

3) ***b*** **points** $(\pm b, 0)$, *OR* $(0, \pm b)$**:**

(__ , __) & (__ , __)

4) Asymptotes:

(A) draw a box through **vertices** & ***b*** **points**

(B) draw lines through box corners

5) Draw branches at **vertices** & approaching asym.

FROM GRAPH

6) Foci $(\pm c, 0)$, *OR* $(0, \pm c)$**:**

(__ , __) & (__ , __)