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Hyperbolas

A **hyperbola** is a set of points in a plane such that the difference of the distances from points on the hyperbola to fixed points, called the **foci**, is constant.

- A hyperbola contains two symmetrical parts called **branches**.
- A hyperbola also has two axes of symmetry.
  - The **transverse axis** contains the vertices and, if it were extended, the foci of the hyperbola.
  - The **conjugate axis** separates the two branches of the hyperbola.
    - The transverse axis is NOT ALWAYS longer than the conjugate axis.
- The **vertices of a hyperbola** are the endpoints of the transverse axis.
- The **co-vertices of a hyperbola** are the endpoints of the conjugate axis.

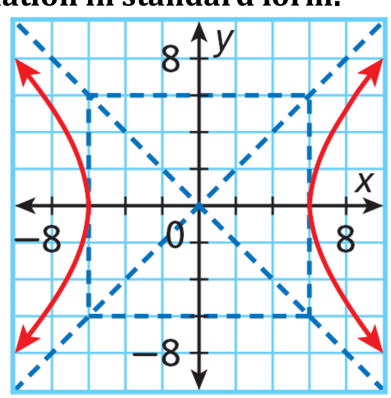
Assume $c = \sqrt{a^2 + b^2}$

** a does not have to be larger than b

Standard Form for the Equation of a Hyperbola Center at (0, 0)

TRANSVERSE AXIS	HORIZONTAL	VERTICAL
Equation	$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$	$\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$
Vertices	$(a, 0), (-a, 0)$	$(0, a), (0, -a)$
Foci	$(c, 0), (-c, 0)$	$(0, c), (0, -c)$
Co-vertices	$(0, b), (0, -b)$	$(b, 0), (-b, 0)$
Asymptotes	$y = \pm\frac{b}{a}x$	$y = \pm\frac{a}{b}x$

Example #2: **Write the equation in standard form.**



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Example #3:
Write the equation in standard form of the hyperbola with center at the origin, vertex (4, 0), and focus (10, 0).

You try: **Vertex (0, 9), co-vertex (7, 0), Center at origin.**

Example #4: **Find the vertices, co-vertices, foci, and asymptotes of the hyperbola, and then graph.**

$$\frac{x^2}{16} - \frac{y^2}{36} = 1$$

Standard form of a hyperbola:

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

Example #5: **Identify the center, vertices, co-vertices the length of transverse axis, and the length of conjugate axis.**

$$\frac{(x-3)^2}{9} - \frac{(y+5)^2}{49} = 1$$

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Example #6: **Find the center, vertices, co-vertices, foci, and asymptotes of the hyperbola. Then graph.**

$$\frac{(y+5)^2}{1} - \frac{(x-1)^2}{9} = 1$$

	Horizontal	**Vertical**
Asymptotes	$y - k = \pm\frac{b}{a}(x - h)$	$y - k = \pm\frac{a}{b}(x - h)$

- Notice how the asymptote equations look like point-slope form when the center shifts

You try: **Find the center, vertices, co-vertices, foci, and asymptotes of the hyperbola. Then graph.**

$$\frac{(y-2)^2}{16} - \frac{(x+2)^2}{25} = 1$$