A **Hyperbola** is the set of all points (x, y) in a plane, the difference of whose distances from two distinct fixed points, the **foci**, is a positive constant.

The graph of a hyperbola has two disconnected parts called the **branches**. The segment through the foci is the **Transverse Axis**. The mid-point of the Transverse Axis is the **Center** of the hyperbola.

The derivation of the equation for the hyperbola is similar to that of the ellipse. However, the distances from a point to each focus is not added, but they are subtracted to give a constant. The relationship between a, b, and c is also different in that $a^2 + b^2 = c^2$. In this case, it is c that is the larger of the two.
a = distance from center to each vertex = length of semi-transverse axis
b = length of the semi-conjugate axis
c = distance from center to each focus

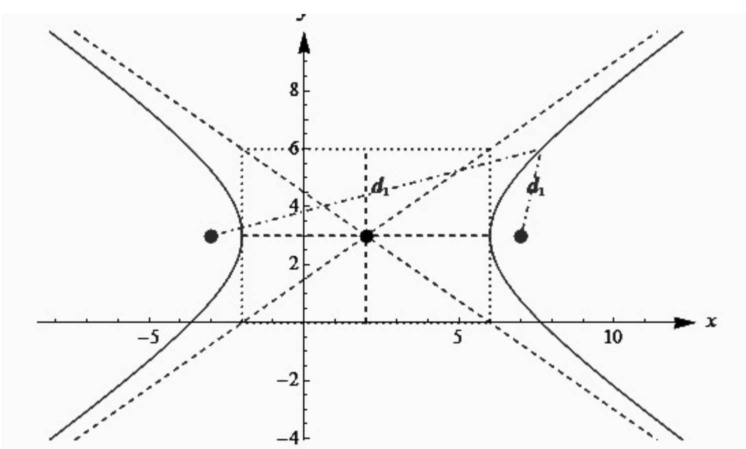
The **Standard Form Equation of a Hyperbola** with center (h, k) is:

$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$ When the Transverse axis is horizontal.

$\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1$ When the Transverse axis is vertical.

The figure below is a graph for $\frac{(x-2)^2}{16} - \frac{(y-3)^2}{9} = 1$ The dimensions of the rectangle is 2a by 2b

There are asymptotes that pass through the center (2, 3) with slopes $\pm\frac{3}{4} = \pm\frac{b}{a}$ since the transverse axis is horizontal. If the transverse axis is vertical, the slopes would be $\pm\frac{4}{3} = \pm\frac{a}{b}$.



We have h = 2, k = 3, a = 4, b = 3, and c = 5
The center is at (2, 3). Vertices are at (-2, 3) & (6, 3). The Foci are at (2 ± 5, 3)
The equations for the asymptotes above in point slope form are:

$y-3 = \frac{3}{4}(x-2)$ and $y-3 = -\frac{3}{4}(x-2)$

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Exer. 1-6: Find the vertices, the foci, and asymptotes of the hyperbola.

1. $\frac{y^2}{49} - \frac{x^2}{16} = 1$

2. $\frac{x^2}{49} - \frac{y^2}{16} = 1$

3. $y^2 - \frac{x^2}{15} = 1$

4. $\frac{(x - 3)^2}{25} - \frac{(y - 1)^2}{4} = 1$

5. $y^2 - 4x^2 - 12y - 16x + 16 = 0$

6. $4y^2 - x^2 + 40y - 4x + 60 = 0$

Exer. 8-16: From the Given Information, write the Equation of the Hyperbola in Standard Form

7. V(-2, -2), (-2, -4); F(-2, -1), (-2, -5)

8. V(0, 2), (2, 2); F(-2, 2), (4, 2)

9. F(0, ±5); Conjugate axis is 4 units

10. V(±4, 0); Contains (8, 2)

11. V(±3, 0); Asym: $y = \pm 2x$

12. F(0, ±10); Asym: $y = \pm\frac{1}{3}x$

13. x-int: ±5; Asym: $y = \pm 2x$

14. y-int: ±2; Asym: $y = \pm\frac{1}{4}x$

15. Vert Tans Axis = 10; Conj Axis = 14

16. Horiz Trans Axis = 6; Conj Axis = 2