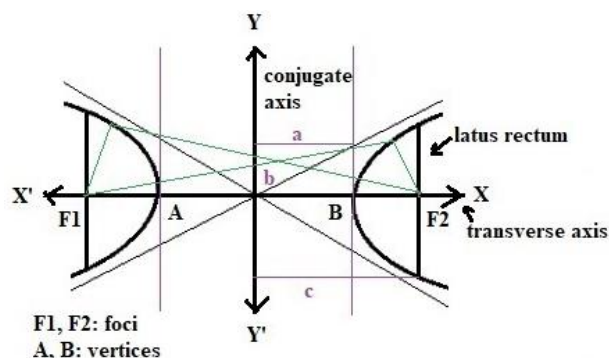


Conic Sections: Hyperbola

A **conic section** is the intersection of a right circular cone and a plane parallel to an element of the cone. By changing the angle and the site where the plane slices the cone, you get circles, ellipses, parabolas and hyperbolae.



A **hyperbola** is the locus of all points the difference of whose distances from two fixed points, called the **foci**, is a constant. The line segment through the foci of a hyperbola is called the **transverse axis**. It intersects the hyperbola at the **vertices**. Halfway between the foci is the **center** of the hyperbola. The line segment passing through the center, perpendicular to the transverse axis, is the **conjugate axis**. The two **latus recti** pass through the foci, perpendicular to the transverse axis.

The **standard equations of a hyperbola** are $(x-h)^2/a^2 - (y-k)^2/b^2 = 1$ and $(y-p)^2/a^2 - (x-q)^2/b^2 = 1$. The **centers** of these two types of hyperbolae are **(h, k)** and **(p, q)**, respectively. The distance between the foci is **2c**. Lengths of transverse and conjugate axes are **2a** and **2b**, respectively. **c** is **squareroot of $(a^2 + b^2)$** . $(x-h)^2/a^2 - (y-k)^2/b^2 = 1$ has a **horizontal transverse axis** and **vertical conjugate axis**. $(y-p)^2/a^2 - (x-q)^2/b^2 = 1$ has a **vertical transverse axis** and a **horizontal conjugate axis**. Let's look at some real life examples and applications of hyperbolae.

Spacecrafts that use the “**gravitational slingshot**” technique by using the gravity of a planet to alter their paths and propel them at high speed away from the planet into space, have hyperbolic paths.

Many **bridges** and **Dulles airport** in Virginia, USA, near the capital, are hyperbolic.

Hyperboloid-shaped gears, whose axes of symmetry coincide with skew axles, can be rotated through rotation of a straight line skew to the axle so that these lines act as gear teeth in constant contact with each other, creating a smooth and efficient **transmission**.

Cooling towers are made hyperbolic. They have to be sufficiently tall and wide enough at the top to allow for rapid mixing of hot vapors with atmospheric air and consequently, efficient cooling. The narrowing of the middle increases the speed of hot vapors, which rise inside the tower as they are less dense than cool air. A wide base gives strength to the entire structure and a lot of space for installation of machinery. The shape allows for the use of a lattice of straight beams to erect the tower so that the structure is more resistant to external natural forces.