The Parabola Formulas

The standard formula of a parabola

1. \[ y^2 = 2px \]

Parametric equations of the parabola:

2. \[ x = 2pt^2 \]
   \[ y = 2pt \]

Tangent line in a point \( D(x_0, y_0) \) of a parabola \( y^2 = 2px \) is:

3. \[ y_0 y = p(x + x_0) \]

Tangent line with a given slope \( m \):

4. \[ y = mx + \frac{p}{2m} \]

Tangent lines from a given point

Take a fixed point \( P(x_0, y_0) \). The equations of the tangent lines are:

\[ y - y_0 = m_1(x - x_0) \]
\[ y - y_0 = m_2(x - x_0) \]

5. \[ m_1 = \frac{y_0 + \sqrt{y_0^2 - 2px_0}}{2x_0} \]
\[ m_2 = \frac{y_0 - \sqrt{y_0^2 - 2px_0}}{2x_0} \]

The Ellipse Formulas

The set of all points in the plane, the sum of whose distances from two fixed points, called the foci, is a constant.

The standard formula of a ellipse:

6. \[ \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \]

Parametric equations of the ellipse:

7. \[ x = a \cos t \]
   \[ y = b \sin t \]

Tangent line in a point \( D(x_0, y_0) \) of a ellipse:

8. \[ \frac{x_0 x}{a^2} + \frac{y_0 y}{b^2} = 1 \]

Eccentricity of the ellipse:

9. \[ e = \frac{\sqrt{a^2 - b^2}}{a} \]

Foci of the ellipse:
10.  
   if $a \geq b \implies F_1(-\sqrt{a^2 - b^2}, 0) \quad F_2(\sqrt{a^2 - b^2}, 0)$
   if $a < b \implies F_1(0, -\sqrt{b^2 - a^2}) \quad F_2(0, \sqrt{b^2 - a^2})$

   Area of the ellipse:

11.  
   $A = \pi \cdot a \cdot b$

The Hyperbola Formulas

The set of all points in the plane, the difference of whose distances from two fixed points, called the foci, remains constant.

The standard formula of a hyperbola:

12.  
   $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

Parametric equations of the Hyperbola:

13.  
   $x = \frac{a}{\sin t}$
   $y = \frac{b}{\cos t}$

Tangent line in a point $D(x_0, y_0)$ of a Hyperbola:

14.  
   $\frac{x_0x}{a^2} - \frac{y_0y}{b^2} = 1$

Foci:

15.  
   if $a \geq b \implies F_1(-\sqrt{a^2 + b^2}, 0) \quad F_2(\sqrt{a^2 + b^2}, 0)$
   if $a < b \implies F_1(0, -\sqrt{a^2 + b^2}) \quad F_2(0, \sqrt{a^2 + b^2})$

Asymptotes:

16.  
   if $a \geq b \implies y = \frac{b}{a}x$ and $y = -\frac{b}{a}x$
   if $a < b \implies y = \frac{a}{b}x$ and $y = -\frac{a}{b}x$