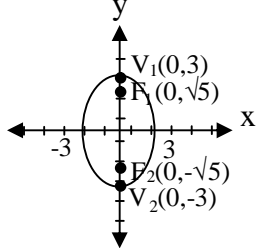
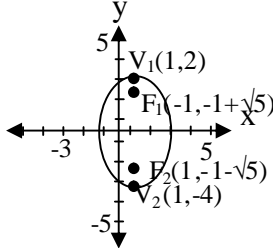
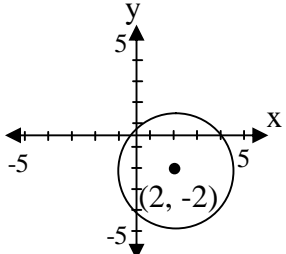
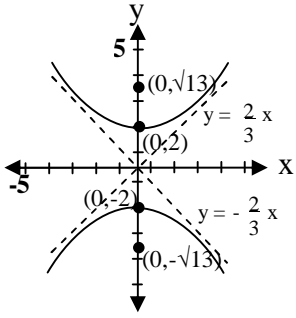
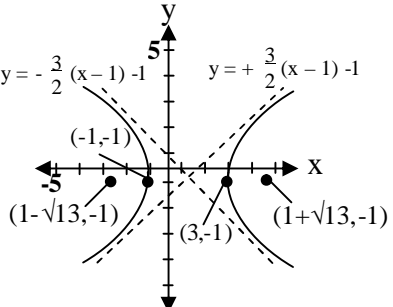


ELLIPSE, HYPERBOLA AND PARABOLA

ELLIPSE

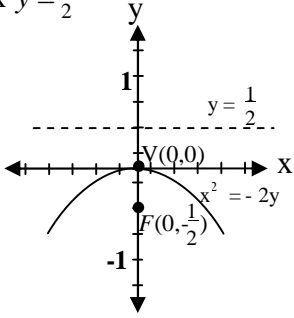
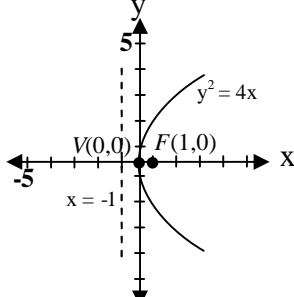
| Concept | Equation | Example |
|--|--|--|
| Ellipse with Center (0, 0) | Standard equation with $a > b > 0$ Horizontal major axis: $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ Vertical major axis: $\frac{x^2}{b^2} + \frac{y^2}{a^2} = 1$ | $\frac{x^2}{4} + \frac{y^2}{9} = 1; a = 3, b = 2$ Center (0, 0); major axis: vertical Vertices: (0, ±3); foci: (0, ±√5) ($c^2 = a^2 - b^2 = 9 - 4 = 5$, so $c = \sqrt{5}$.)  |
| Ellipse with center (h, k) | Standard equation with $a > b > 0$ Horizontal major axis: $\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$ Vertical major axis: $\frac{(x-h)^2}{b^2} + \frac{(y-k)^2}{a^2} = 1$ | $\frac{(x-1)^2}{4} + \frac{(y+1)^2}{9} = 1; a = 3, b = 2$  |
| Circle with center (h, k) and radius r | Standard equation $(x-h)^2 + (y-k)^2 = r^2$ A circle is an ellipse with $a = b = r$. | $(x-2)^2 + (y+2)^2 = 9$ Center: (2, -2); radius: $r = 3$  |
| Area inside an ellipse | $A = \pi ab$ | The area inside the ellipse given by $\frac{x^2}{49} + \frac{y^2}{9} = 1$ is $A = \pi(7)(3) = 21\pi$ square units. |

HYPERBOLA

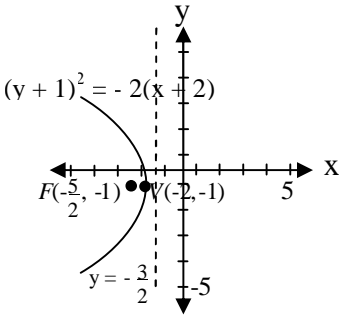
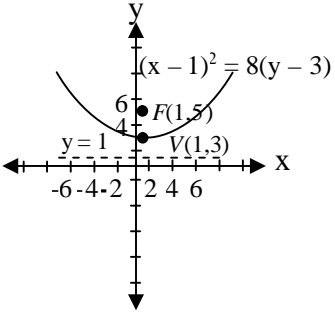
| Concept | Equation | Example |
|-------------------------------------|--|--|
| <p>Hyperbola with center (0, 0)</p> | <p>Standard equation</p> <p>Transverse axis: horizontal</p> $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ <p>Transverse axis: vertical</p> $\frac{y^2}{a^2} - \frac{x^2}{b^2} = 1$ | <p>$\frac{x^2}{4} - \frac{y^2}{9} = 1$; $a = 2$. $b = 3$</p> <p>Transverse axis: vertical</p> <p>Vertices $(0, \pm 2)$; foci: $(0, \pm\sqrt{13})$</p> <p>($c^2 = a^2 + b^2 = 4 + 9 = 13$, so $c = \sqrt{13}$.)</p> <p>Asymptotes: $y = \pm \frac{2}{3}x$</p>  |
| <p>Hyperbola with center (h, k)</p> | <p>Standard Equation</p> <p>Transverse axis: horizontal</p> $\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$ <p>Transverse axis: vertical</p> $\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1$ | <p>$\frac{(x-1)^2}{4} - \frac{(y+1)^2}{9} = 1$; $a = 2$. $b = 3$</p> <p>Transverse axis: horizontal; center (1, -1)</p> <p>Vertices $(1 \pm 2, -1)$; foci: $(1 \pm \sqrt{13}, -1)$</p> <p>($c^2 = a^2 + b^2 = 4 + 9 = 13$, so $c = \sqrt{13}$.)</p> <p>Asymptotes: $y = \pm \frac{3}{2}(x-1) - 1$</p>  |

PARABOLAS

Parabola Vertex (0, 0)

| Concept | Equation | Example |
|---|--|---|
| Parabola with vertex (0, 0) and vertical axis | $x^2 = 4py$ $p > 0$: opens upward $p < 0$: opens downward Focus: (0, p) Directrix: $y = -p$ | $x^2 = -2y$ has $4p = -2$ or $p = -\frac{1}{2}$ The parabola opens downward with vertex (0, 0), focus (0, $-\frac{1}{2}$), and directrix $y = \frac{1}{2}$  |
| Parabola with vertex (0, 0) and horizontal axis | $y^2 = 4px$ $p > 0$: opens to the right $p < 0$: opens to the left Focus: (p , 0) Directrix: $x = -p$ | $y^2 = 4x$ has $4p = 4$ or $p = 1$ The parabola opens to the right with vertex (0, 0), focus (1, 0), and directrix $x = -1$  |

Parabola Vertex (h, k)

| Concept | Equation | Example |
|---|--|--|
| Parabola with vertex (h, k) and horizontal axis | $(y - k)^2 = 4p(x - h)$ <p>$p > 0$: opens to the right</p> <p>$p < 0$: opens to the left</p> <p>Focus: (h + p, k)</p> <p>Directrix: $x = h - p$</p> | $(y + 1)^2 = -2(x + 2)$ has $p = -\frac{1}{2}$ The parabola opens to the left with vertex (-2, -1), focus $(-\frac{5}{2}, -1)$, and directrix $x = -\frac{3}{2}$  |
| Parabola with vertex (h, k) and vertical axis | $(x - h)^2 = 4p(y - k)$ <p>$p > 0$: opens upwards</p> <p>$p < 0$: opens downwards</p> <p>Focus: (h, k + p)</p> <p>Directrix: $y = k - p$</p> | $(x - 1)^2 = 8(y - 3)$ has $p = 2$. The parabola opens upward with vertex (1, 3), focus (1, 5), and directrix $y = 1$.  |