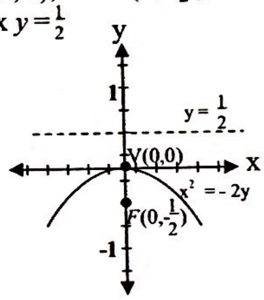
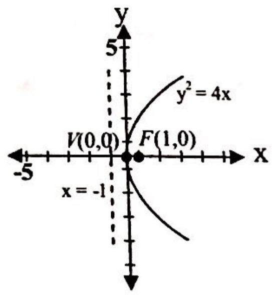
PARABOLAS

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 he right with vertex (0, 0), focus (1, 0), and directrix $x = -1$ 

Parabola Vertex (h, k)

X

<table>
<tr><th>Concept</th><th>Equation</th><th>Example</th></tr>
<tr>
<td>Parabola with vertex (h, k) and horizontal axis</td>
<td>$(y-k)^2 = 4p(x-h)$

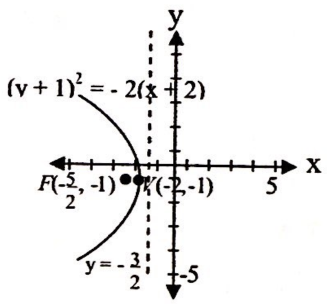
$p > 0$: opens to the right

$p < 0$: opens to the left

Focus: $(h + p, k)$

Directrix: $x = h - p$</td>
<td>$(y+1)^2 = -2(x+2)$ has $p = -\frac{1}{2}$

The parabola opens to the left with vertex (-2, - 1), focus $(-\frac{5}{2}, -1)$, and directrix $x = -\frac{3}{2}$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<tr>
<td>Parabola with vertex (h, k) and vertical axis</td>
<td>$(x-h)^2 = 4p(y-k)$

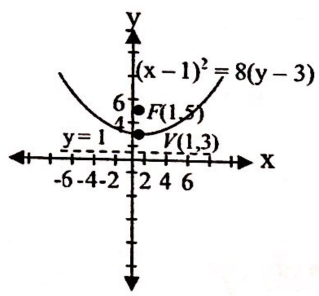
$p > 0$: opens upwards

$p < 0$: opens downwards

Focus: $(h, k + p)$

Directrix: $y = k - p$</td>
<td>$(x-1)^2 = 8(y-3)$ has $p = 2$.

The parabola opens upward with vertex (1, 3), focus (1, 5), and directrix $y = 1$.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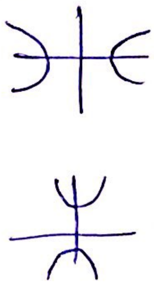
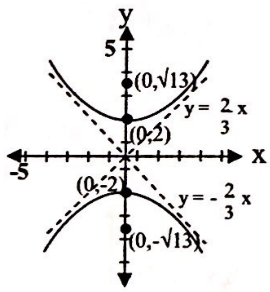
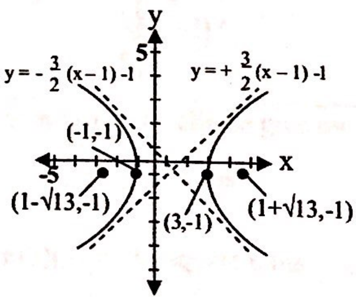
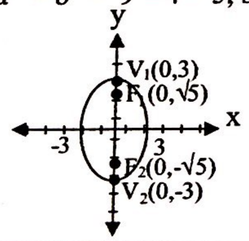
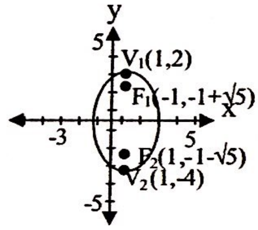
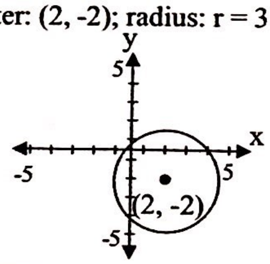
HYPERBOLA

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

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: $(0, \pm 3)$; foci: $(0, \pm\sqrt{5})$ $(c^2 = a^2 - b^2 = 9 - 4 = 5$, 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 give by $\frac{x^2}{49} + \frac{y^2}{9} = 1$ is $A = \pi(7)(3) = 21\pi$ square units.