$f(x) = ax^2 + bx + c$

axis of symmetry: $\frac{-b}{2a}$
y-intercept: c
vertex: (h, k)

vertex form: $y = (x-h)^2 + k$

ex: $a=1$

$y = x^2 + 2x + 6$ ← ? is half of b squared $\left(\frac{b}{2}\right)^2$
$y = (x^2 + 2x + ?) + 6$
$y = (x^2 + 2x + 1) + 6 - 1$
$y = (x+1)^2 + 5$

ex: $a>1$

$y = 2x^2 - 12x + 3$ → $\left(\frac{6}{2}\right)^2 = 9$, 9×2
$y = 2(x^2 - 6x + 9) + 3 - 18$
$y = 2(x-3)^2 - 15$

discriminant $= b^2 - 4ac$

0 = 1 solution
positive = 2 solutions
negative = ∅ no solution

Parabolas

$(x-h)^2 = 4p(y-k)$

p>0 p<0

vertex: (h, k)
focus: $(h, k+p)$
axis of symmetry: $x = h$
directrix d: $y = k - p$

$(y-k)^2 = 4p(x-h)$

p>0 p<0

vertex: (h, k)
focus: $(h+p, k)$
axis of symmetry: $y = k$
directrix d: $x = h - p$

hyperbolas

$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$

center: (h, k)
verticies: $(h \pm a, k)$
foci: $(h \pm c, k)$
transverse axis: $y = k$
conjugate axis: $x = h$
asymtotes: $y - k = \pm \frac{b}{a}(x-h)$

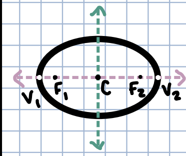
$c = \sqrt{a^2 + b^2}$

$\frac{(y-k)^2}{a^2} - \frac{(x-h)^2}{b^2} = 1$

center: (h, k)
verticies: $(h, k \pm a)$
foci: $(h, k \pm c)$
transverse axis: $x = h$
conjugate axis: $y = k$
asymtotes: $y - k = \pm \frac{a}{b}(x-h)$

a is always the first, not largest

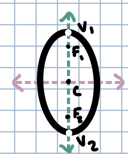
ellipses



$\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$

center: (h, k) major axis: $y = k$
foci: $(h \pm c, k)$ minor axis: $x = h$
vertices: $(h \pm a, k)$
co-vertices: $(h, k \pm b)$

↑ $c^2 = a^2 - b^2$ or $c = \sqrt{a^2 - b^2}$ ↓



$\frac{(x-h)^2}{b^2} + \frac{(y-k)^2}{a^2} = 1$

center: (h, k) major axis: $x = h$
foci: $(h, k \pm c)$ minor axis: $y = k$
vertices: $(h, k \pm a)$
co-vertices: $(h \pm b, k)$

the equations above need to equal 1 to be in standard form

eccentricity: $e = \frac{c}{a}$
↑ determines how 'circular' or 'stretched' it is
↑ always between 0 and 1

larger denomenator is a
a is half the length of the major axis
b is half the length of the minor axis

circles

$(x-h)^2 + (y-k)^2 = r^2$
r = radius center = (h, k)

classifying conics using discriminant

$Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$

circle: $B^2 - 4AC < 0$; $B = 0$, $A = C$
ellipse: $B^2 - 4AC < 0$; $B \neq 0$, $A \neq C$
parabola: $B^2 - 4AC = 0$
hyperbola: $B^2 - 4AC > 0$