Conic Sections - General Equations

These general formulae govern all types of orbital motion in the gravitational two body problem, including both bound and unbound conics. More specialized formulae, valid only for certain types of orbits, can be derived from these.

Specific Energy	Specific Angular Momentum	Distance	Speed	Pericenter Distance
$C = -\frac{GM}{2a}$	$h = \sqrt{GMa(1-e^2)}$	$r = \frac{a(1-e^2)}{1+e\cos f}$	$v = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$	$q = a(1-e)$

Conic Sections - Equations for Specific Orbits

Energy determines whether an orbit is bound or not. Circles and ellipses are the only bound orbits; parabolas and hyperbolas are the only unbound ones. Note that rectilinear or purely radial orbits, which always have $e = 1$, may be elliptical, parabolic, or hyperbolic.

	Bound Orbits ($C < 0$)		Unbound Orbits ($C \geq 0$)	
	Circle	Ellipse	Parabola	Hyperbola
Semimajor Axis:	$a = r$	$a > 0$	$a \to \pm\infty$	$a < 0$
Eccentricity:	$e = 0$	$0 < e \leq 1$	$e = 1$	$e \geq 1$
Distance:	$r = a$	$r \geq a(1-e)$ $r \leq a(1+e)$	$r \geq a(1-e)$ $r \to \infty$	$r \geq a(1-e)$ $r \to \infty$
Speed:	$v = \sqrt{\frac{GM}{a}}$	$v \leq \sqrt{\frac{GM(1+e)}{a(1-e)}}$ $v \geq \sqrt{\frac{GM(1-e)}{a(1+e)}}$	$v = \sqrt{\frac{2GM}{r}}$ $v(r \to \infty) = 0$	$v \leq \sqrt{\frac{GM(1+e)}{a(1-e)}}$ $v(r \to \infty) \to \sqrt{\frac{-GM}{a}}$