Relevant Formulas and Data

$A = \frac{1}{2}\theta r^2$ Area of parabolic section $= \frac{4}{3}\times$ Area of inscribed triangle.

$\frac{a_M^3}{T_M^2} = \frac{a_J^3}{T_J^2}$

$y = Ax^2 + Bx + C$ $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ $a = \frac{k}{2}$ and $b = \sqrt{a^2 - e^2}$.

$r = a(1 - \varepsilon\cos\beta)$ $\tan\frac{\alpha}{2} = \sqrt{\frac{1+\varepsilon}{1-\varepsilon}}\tan\frac{\beta}{2}$ $\beta - \varepsilon\sin\beta = \frac{2\pi t}{T}$

$\frac{2\pi t}{T} + \varepsilon\,(\quad)$

Orbital Data of Planets					
Planet	Semi-major axis in AUs	Period of the orbit in years	Astronomical Eccentricity	Angle of orbital plane with that of the Earth	Average speed in miles/sec
Mercury	0.3871	0.2408	0.2056	7.00°	29.6
Venus	0.7233	0.6152	0.0068	3.39°	21.7
Earth	1.0000	1.0000	0.0167	0.00°	18.5
Mars	1.5237	1.8809	0.0934	1.85°	15.0
Jupiter	5.2028	11.8622	0.0484	1.31°	8.1
Saturn	9.5388	29.4577	0.0557	2.49°	6.0

$\int_a^b f(x)\,dx = F(b) - F(a)$ $A = \int_a^b \pi f(x)^2\,dx$ $L = \int_a^b \sqrt{1 + f'(x)^2}\,dx$

$\int_a^b cx^r\,dx = \frac{c}{r+1}x^{r+1}|_a^b = \frac{c}{r+1}b^{r+1} - \frac{c}{r+1}a^{r+1}$

$x'(t) = v_0\cos\varphi_0$ and $x(t) = (v_0\cos\varphi_0)\,t$,

$y'(t) = -gt + v_0\sin\varphi_0$ and $y(t) = -\frac{g}{2}t^2 + (v_0\sin\varphi_0)\,t + y_0$

$y = \left(\frac{-g}{2v_0^2\cos^2\varphi_0}\right)x^2 + (\tan\ \varphi_0)\,x + y_0$

$\frac{1}{2g}v_0^2\sin^2\varphi_0 + y_0$ (maximal height attained by the projectile)

$$t_{\text{imp}} = \frac{v_0 \sin\varphi_0 + \sqrt{v_0^2 \sin^2\varphi_0 + 2gy_0}}{g} \text{ (time of impact)}$$

$$R = \frac{v_0^2}{2g}\sin(2\varphi_0) + \frac{v_0}{g}\sqrt{\frac{v_0^2}{4}\sin^2(2\varphi_0) + 2gy_0\cos^2\varphi_0} \quad \text{(range)}$$

$$R_{\text{max}} = \frac{v_0^2}{2g} + \frac{v_0}{g}\sqrt{\frac{v_0^2}{4} + gy_0} \text{ (maximal range)}$$

$$v(t) = \sqrt{v_0^2 + g^2t^2 - 2g\,(v_0\sin\varphi_0)\,t}$$