# Designing a Parabolic Solar Energy Collector

Task: Develop a function relation between the coefficient (a) of $x^2$ in the equation for a parabola and the focal distance (p). Use a parabola with vertex at the origin as shown below. The equation of a parabola with vertex at origin: $y = ax^2$

The locus definition of a parabola is the set of all points equidistant from a given point and a given line. In the case of a parabola the given point is called the *focus*, and the given line is the *directrix*.

The basic strategy for this problem is to use the locus definition to create an equation. Express the distance from the focus to a general point on the parabola, (x,y) using the distance formula and the distance from the general point to the directrix using your knowledge of the coordinate grid. Equate them, and manipulate the equation into the form of a general parabola (solve for y). You can then establish a simple relation between the coefficient of x, (a), and the focal distance, (p). When actually building a collector, you may want to determine a good focal distance to accomodate any hardware, equipment, etc. at the focus, so the equation of the parabola will be determined from your chosen focal distance, hence the answer should be in the form of $a = f(p)$

$AB = \sqrt{x^2 + (y-p)^2}$

$BC = y + p$

$\boxed{y + p = \sqrt{x^2 + (y-p)^2}}$

$y^2 + 2yp + p^2 = x^2 + y^2 - 2yp + p^2$

$4yp = x^2$

$y = \frac{1}{4p} x^2$

$\boxed{a = \frac{1}{4p}}$

$\boxed{y = ax^2}$