

I'm not robot!

Return to the Lessons Index | Do the Lessons in Order | Print-friendly page Conics: Parabolas: Word Problems & Calculators (page 4 of 4) Sections: Introduction, Finding information from the equation, Finding the equation from information, Word problems & Calculators An arch in a memorial park, having a parabolic shape, has a height of 25 feet and a base width of 30 feet. Find an equation which models this shape, using the x-axis to represent the ground. State the focus and directrix. For simplicity, I'll center the curve for the arch on the y-axis, so the vertex will be at (h, k) = (0, 25). Since the width is thirty, then the x-intercepts must be at x = -15 and x = +15. Obviously, this is a regular (vertical) but upside-down parabola, so the x part is squared and I'll have a negative leading coefficient. Working backwards from the x-intercepts, the equation has to be of the form  $y = a(x - 15)(x + 15)$ . Plugging in the known vertex value, I get:  $25 = a(0 - 15)(0 + 15) = -225a$  Then  $a = -1/9$ . With a being the leading coefficient from the regular quadratic equation  $y = ax^2 + bx + c$ , I also know that the value of  $1/a$  is the same as the value of  $4p$ , so  $1/(-1/9) = -9 = 4p$ , and thus  $p = -9/4$ . The focus is  $9/4$  units below the vertex; the directrix is the horizontal line  $9/4$  units above the vertex:  $4p(y - k) = (x - h)^2 4(-9/4)(y - 25) = (x - 0)^2 -9(y - 25) = x^2$  focus: (0, 91/4), directrix:  $y = 109/4$  You could also work directly from the conics form of the parabola equation: plugging in the vertex and an x-intercept, to find the value of p:  $4p(y - 25) = (x - 0)^2 4p(0 - 25) = (15 - 0)^2 4p(-25) = 225 4p = -225/25 = -9 p = -9/4$  Copyright © Elizabeth Stapel 2010-2011 All Rights Reserved You may encounter an exercise of this sort regarding the Gateway Arch in Saint Louis, Missouri. In fact, that Arch is in the shape of an "inverted catenary" curve; in particular, a hyperbolic cosine curve. But its shape is close enough to that of a parabola for the purposes of the exercise. (If you ever visit Saint Louis, you should definitely try to visit the Arch. You can watch a movie down in the basement describing the design and construction of the Arch, and then you ride the tram up to the top of the Arch. The view is fabulous!) A radio telescope has a parabolic dish with a diameter of 100 meters. The collected radio signals are reflected to one collection point, called the "focal" point, being the focus of the parabola. If the focal length is 45 meters, find the depth of the dish, rounded to one decimal place. To simplify my computations, I'll put the vertex of my parabola (that is, the base of the dish) at the origin, so (h, k) = (0, 0). Since the focal length is 45, then  $p = 45$  and the equation is:  $4py = x^2 4(45)y = x^2 180y = x^2$  This parabola extends forever in either direction, but I only care about the part of the curve that models the dish. Since the dish has a diameter of a hundred meters, then I only care about the part of the curve from  $x = -50$  to  $x = +50$ . The height of the edge of the dish (and thus the depth of the dish) will be the y-value of the equation at the "ends" of the modelling curve. The height of the parabola will be the same at either x-value, since they're each the same distance from the vertex, so it doesn't matter which value I use. I prefer positive values, so I'll plug  $x = 50$  into my modelling equation:  $180y = (50)^2 180y = 2500 y = 2500/18 ...$ or about 13.9 meters. If you need to graph a sideways parabola in your graphing calculator (to check your work, for instance), you'll need to solve the equation for its two halves, and then graph the two halves as two separate functions. For instance, to view the graph of  $(y + 2)^2 = -4(x - 1)$ , you'd solve and graph as: Don't expect the two halves of the graph to "meet in the middle" on your calculator screen; that's a higher degree of accuracy than the calculator can handle. In my experience, it is easier to remember the relationships between the vertex, focus, axis of symmetry, directrix, and the value of p, than to try to memorize the (often very long) list of formulas they give you. Do enough practice exercises that you have a good grasp of how these elements are related, and you should be successful with parabolas.

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