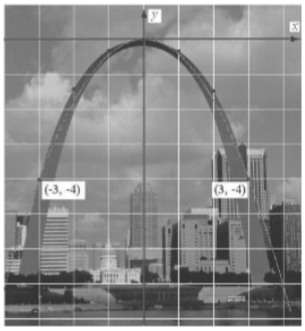
MBF 3C1 Name: _____

Understanding Problems Involving Quadratic Relations

Example 1

A grid has been superimposed on The Gateway Arch in St. Louis. Find the equation that models The Arch.



$y = a(x-h)^2 + k$

$y = a(x-0)^2 + 0$

$-4 = a(3-0)^2 + 0$

$-4 = 9a$

$-\frac{4}{9} = a$

$\therefore y = -\frac{4}{9}(x-0)^2 + 0$

Height

$y = -\frac{4}{9}x^2$ ← distance horiz.

Example 2

A football was kicked. Its path can be modelled by the relation $h = -0.1(d-8.7)^2 + 7.6$ where h is the football's height above the ground and d is the horizontal distance from where the football was kicked, both in meters.

a. What is the vertex of the parabola?

vertex = (8.7, 7.6)

b. What is the football's initial height?

at $d = 0$

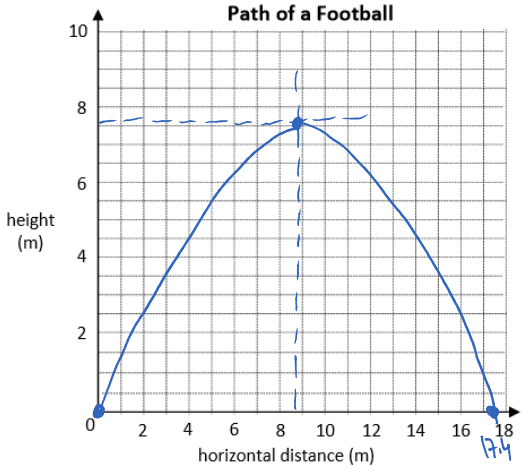
$h = -0.1(0-8.7)^2 + 7.6$

$h = -0.1(75.69) + 7.6$

$h = -7.569 + 7.6$

$h = 0.031 \sim 0$ meters

c. Graph of the football's path.



d. What does the vertex represent in terms of the football's path?

at 8.7m horizontally max height is 7.6 m

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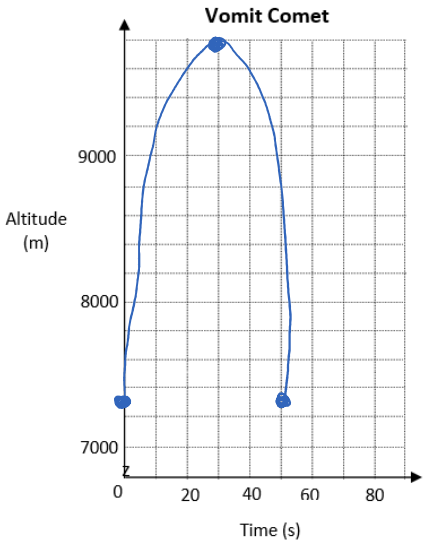
Example 3

"The Vomit Comet" is the nickname of a jet used to simulate zero gravity (0-g) for astronauts. To simulate 0-g, the jet flies in a parabolic arc, starting at an altitude of about 7300 m. After climbing for about 30 s, the jet reaches its maximum altitude at about 9800 m, where the weightlessness effect occurs, The jet descends back to an altitude of 7300 m after about 60 s and then repeats the process.

a. Sketch the parabola.

b. Write a quadratic relation to model the path of the jet. The parabola also passes through the point (31, 9799.999).



$y = a(x-h)^2 + k$

$y = a(x-30)^2 + 9800$

$9799.999 = a(31-30)^2 + 9800$

$-0.001 = a(1)^2$

$-0.001 = a$

$\therefore y = -0.001(x-30)^2 + 9800$

height ↑ time

NOTE: calculator may say -1×10^{-03} move decimal from end 3 times to the left.

c. The effects of simulated 0-g start being felt at about 20 s. What is the jet's altitude at this time?

$y = -0.001(20-30)^2 + 9800$

$y = -0.001(100) + 9800 = 9799.9$ m high.