Example: A baseball is struck at a height of $1.1m$ above the ground. Three seconds later, it reaches its maximum height of $45.2m$. The height of the ball's trajectory is a second degree function of time.

x: time
y: height

need
- vertex (h, k)
- point (x, y)

Standard

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

We know:

1. Vertex $V(3,45.2)$ (h, k)

2. Point $P(0,1.1)$ (x, y)

Can find: Equation

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

$$f(t) = a(x-3)^2 + 45.2$$

$$1.1 = a(0-3)^2 + 45.2$$

$$1.1 = a(-3)^2 + 45.2$$

$$1.1 = 9a + 45.2$$

$$-45.2 \qquad -45.2$$

$$-44.1 = 9a$$

$$\frac{-44.1}{9} = \frac{9a}{9}$$

$$-4.9 = a$$

$$\therefore f(t) = -4.9(t-3)^2 + 45.2$$

a) What is the ball's height (y) after 2^x seconds?

$$f(t) = -4.9(t-3)^2 + 45.2$$

let $t = 2$

$$f(2) = -4.9(2-3)^2 + 45.2$$

$$f(2) = -4.9(-1)^2 + 45.2$$

$$f(2) = -4.9 + 45.2$$

$$f(2) = 40.3$$

The ball's height is $40.3m$.

b) At what time would a player catch the ball 2.2m above the ground ?

$$f(t) = -4.9(t-3)^2 + 45.2$$

let $y = 2.2$

$$2.2 = -4.9(t-3)^2 + 45.2$$

$$-43 = -4.9(t-3)^2$$

$$8.78 \approx (t-3)^2$$

$$\pm 2.96 \approx t - 3$$

1) $2.96 = t - 3$

$$5.96 = t$$

2) $-2.96 = t - 3$

$$0.04 = t$$

The player catches the ball after 5.96 seconds.

c) If no one catches the ball, when will it hit the ground?

height = 0 zeros

$f(t) = -4.9(t-3)^2 + 45.2$

let $y = 0$

$0 = -4.9(t-3)^2 + 45.2$

$-45.2 = -4.9(t-3)^2$

$9.22 \approx (t-3)^2$

$\pm 3.04 \approx t - 3$

$x = h \pm \sqrt{\frac{k}{a}}$

$t = 3 \pm \sqrt{\frac{-45.2}{-4.9}}$

$3 \pm \sqrt{9.224}$

3 ± 3.04

1) ~~$3.04 = t - 3$~~ $6.04 = t$

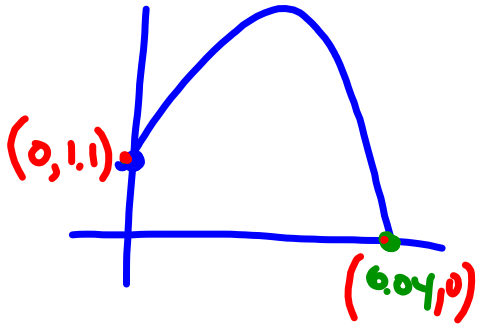
2) ~~$-3.04 = t - 3$~~ $-0.04 = t$ reject

The ball hits the ground after approximately $6.04\ s$.

d) What is the domain and range of this situation?

Domain: $[0, 6.04]$

Range: $[0, 45.2]$



Word Problems

1. A company's profits and losses R can be represented by the equation $R(x) = x^2 - 10x + 21$ where x is the number of months since the start of the year. For how many months did the company incur losses?

to negative

$$R(x) = x^2 - 10x + 21$$

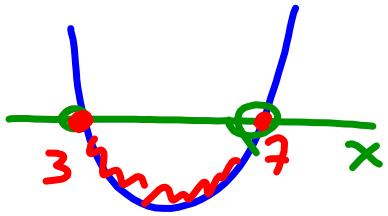
let $y = 0$

$0 = x^2 - 10x + 21$

$0 = (x-7)(x-3)$

$x - 7 = 0$ or $x - 3 = 0$

$x = 7$ $x = 3$



~~[3,7]~~

$7 - 3 =$ 4 months