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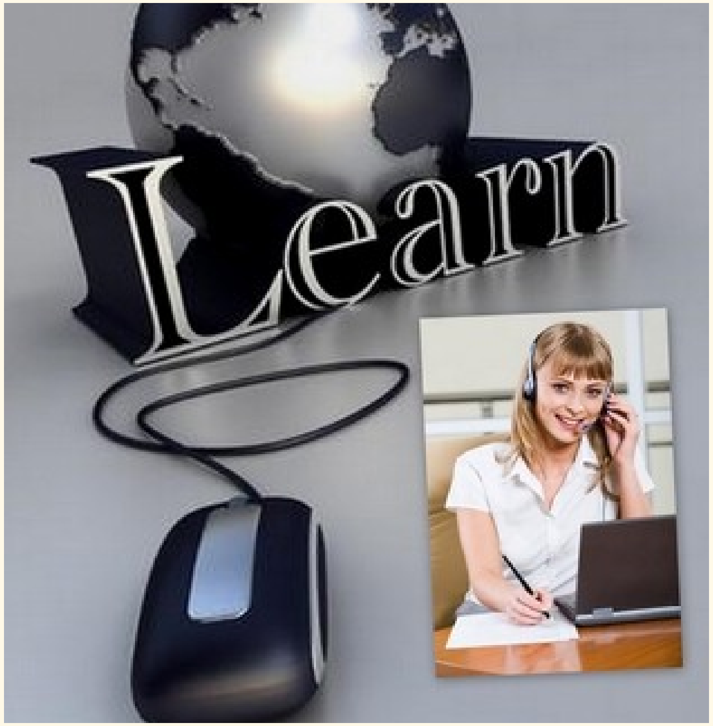

Coordinate Geometry II

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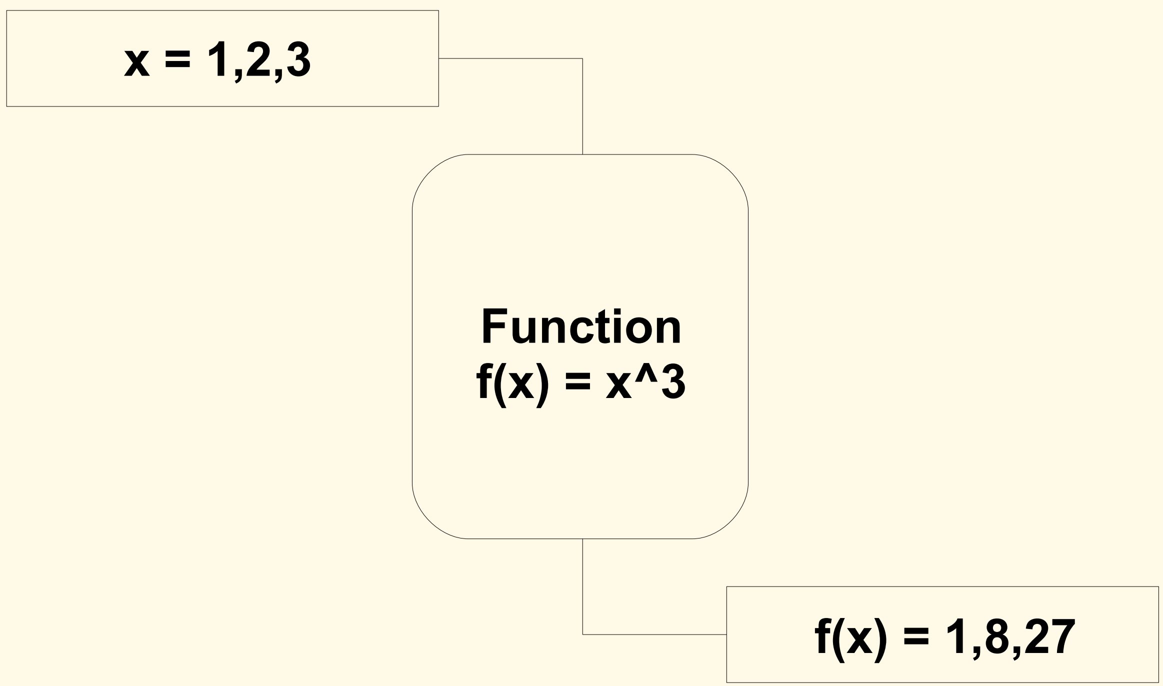
Function

A **Function** ***f*** is a mathematical expression which takes input 'x' and produce corresponding output ***f(x)***. For any function, each input ***x*** gives exactly one output ***f(x)***.



Function Notation

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Let us consider the function,

$$y = f(x)$$

where x is the independent variable and y is the dependent variable.

We generally write functions as ***f(x)*** and read this as ***"function f of x"***.

We can use other notations for functions, like ***g(x) or h(x)***.

Domain

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The set of all inputs that a function accepts is called **domain.**

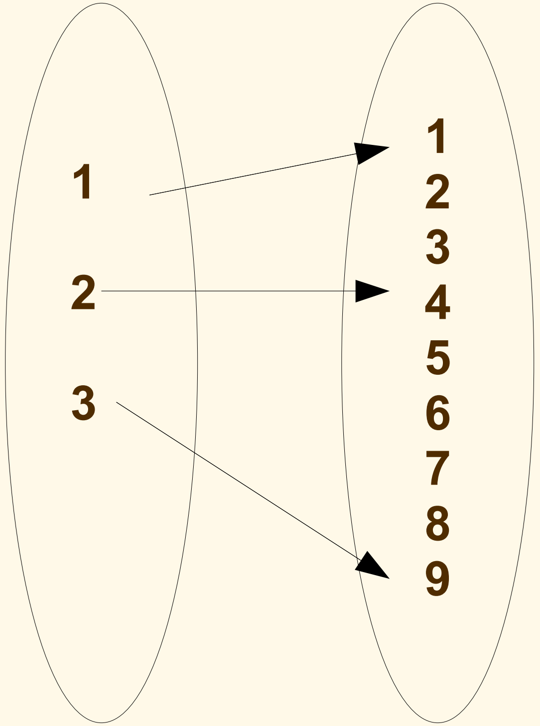
Example

If for a function ***f(x)***,

x takes the value from {1,2,3,..}

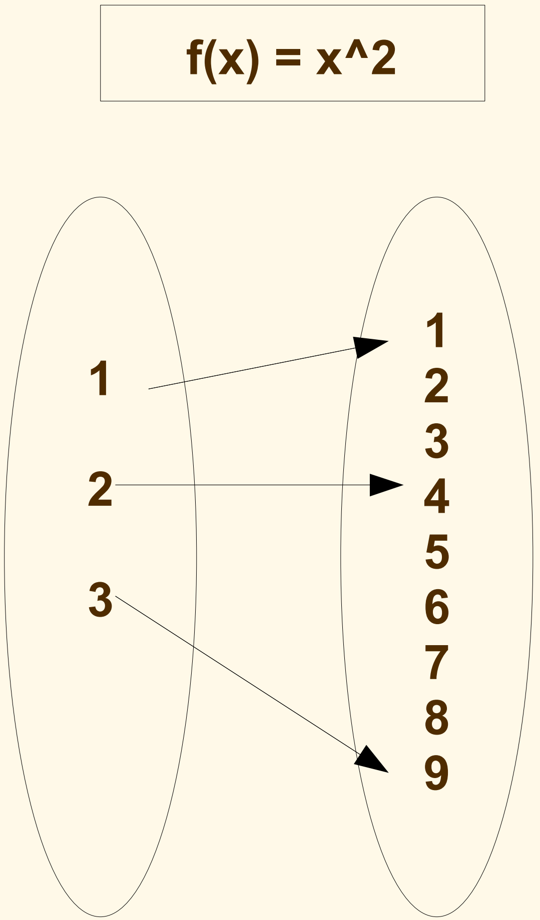
Then the domain will be {1,2,3,..}

$f(x) = x^2$



Range

The set of all output values of a function is called as **range.**



Example

If for the function $\boldsymbol{f(x) = x^2}$ **,** values of $x = \{1,2,3,...\}$ then its range will be $\boldsymbol{x^2} = \{1,4,9,...\}$

Example

Find the domain and range for the function

$$f(x) = x^2 + 2.$$

Can You Answer this?

Solution

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The function ***$f(x) = x^2 + 2$*** is defined for all real values of x (because there are no restrictions on the value of x).

[**Note:** The set of real numbers includes all integers, positive and negative; all fractions; and the irrational numbers.]

Hence, the domain of f(x) is "all real values of x"

Since ***x^2*** is never negative, ***$x^2 + 2$*** is never less than 2

Hence, the range of f(x) is "all real numbers ***$f(x) \geq 2$***".

Parabola

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A quadratic equation of the form $y = ax^2 + bx + c$

where a, b, c are constant

- If $a \neq 0$ then graph of the equation will be a parabola.
- If $a > 0$ then parabola opens upward
- If $a < 0$ then parabola opens downward

Note: The point of intersection of X axis and parabola will give the solution of equation of parabola.

Vertex

The **vertex** of a parabola is the high point or low point of the graph.

Ways to find the vertex of the parabola

- x coordinate of vertex = ***-(b/2a)***

- y coordinate of vertex can obtained by substituting the above the x value in the equation.

Hence the coordinate of the vertex is given by (x,y).

Different types of parabola

- Upward Parabola
- Downward Parabola

Upward Parabola

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If a > 0 then parabola opens upward

Let us draw the graph of the equation

$$y = (x-1)^2 + 1$$

Let us have the equation,

$y = (x-1)^2 + 1$

$y = x^2 + 1 - 2x + 1$

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

Example

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If we compare the above equation with the general form

$$y = ax^2 + bx + c$$

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

We have, $a = 1$, $b = -2$ and $c = 2$

Then the vertex is ,

$x = -(b/2a) = -(-2/2(1)) = 1$

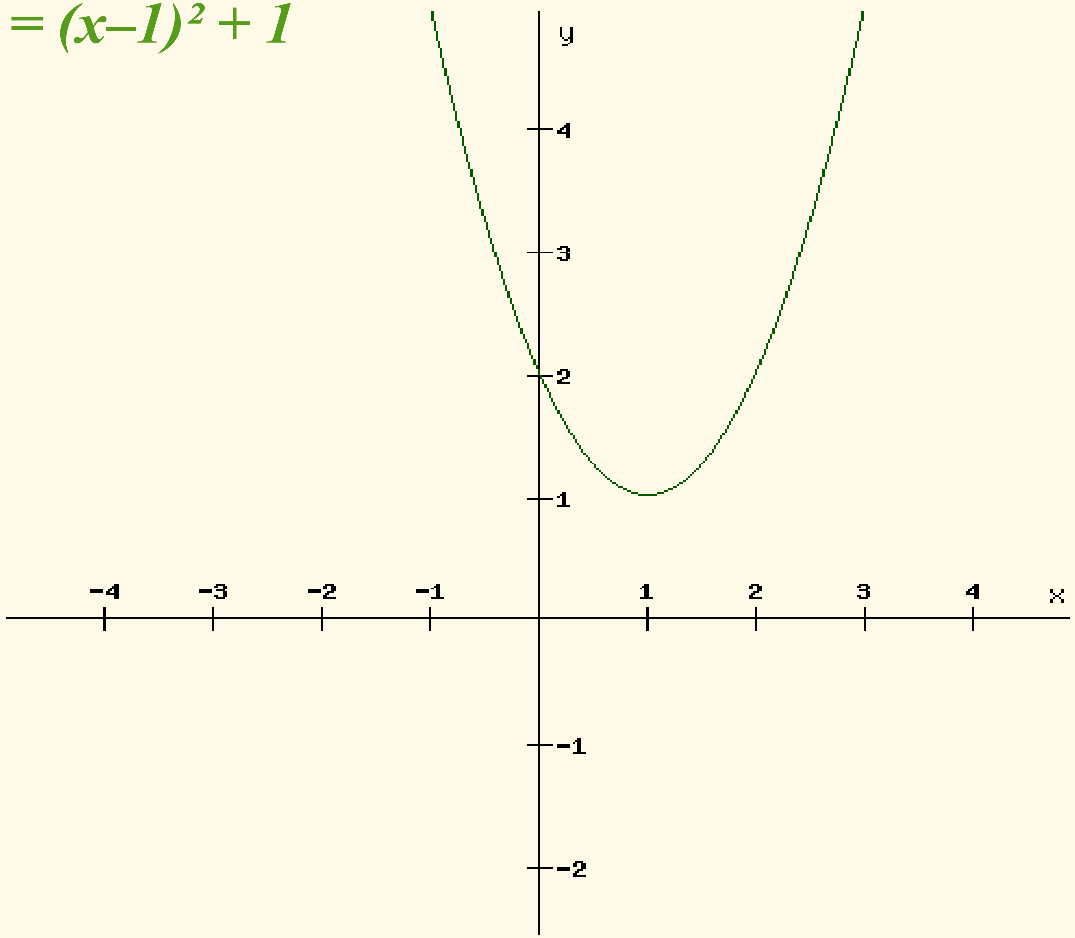
and $y = 1 - 2 + 2 = 1$.

Hence the vertex is (1,1). Domain is x can take all the real values. And the range will be $y >= 1$.

Example

x	0	1	2
y	2	1	2

$y = (x–1)^2 + 1$



Downward Parabola

If a < 0 then parabola opens downward

Let us draw the graph of the equation

$$y = 2 - x^2$$

Example

If we compare the above equation with the general form

$$y = ax^2 + bx + c$$

We have,

$a = -1$, $b = 0$ and $c = 2$

Then the vertex is ,

$x = -(b/2a) = -(0/2(-1)) = 0$

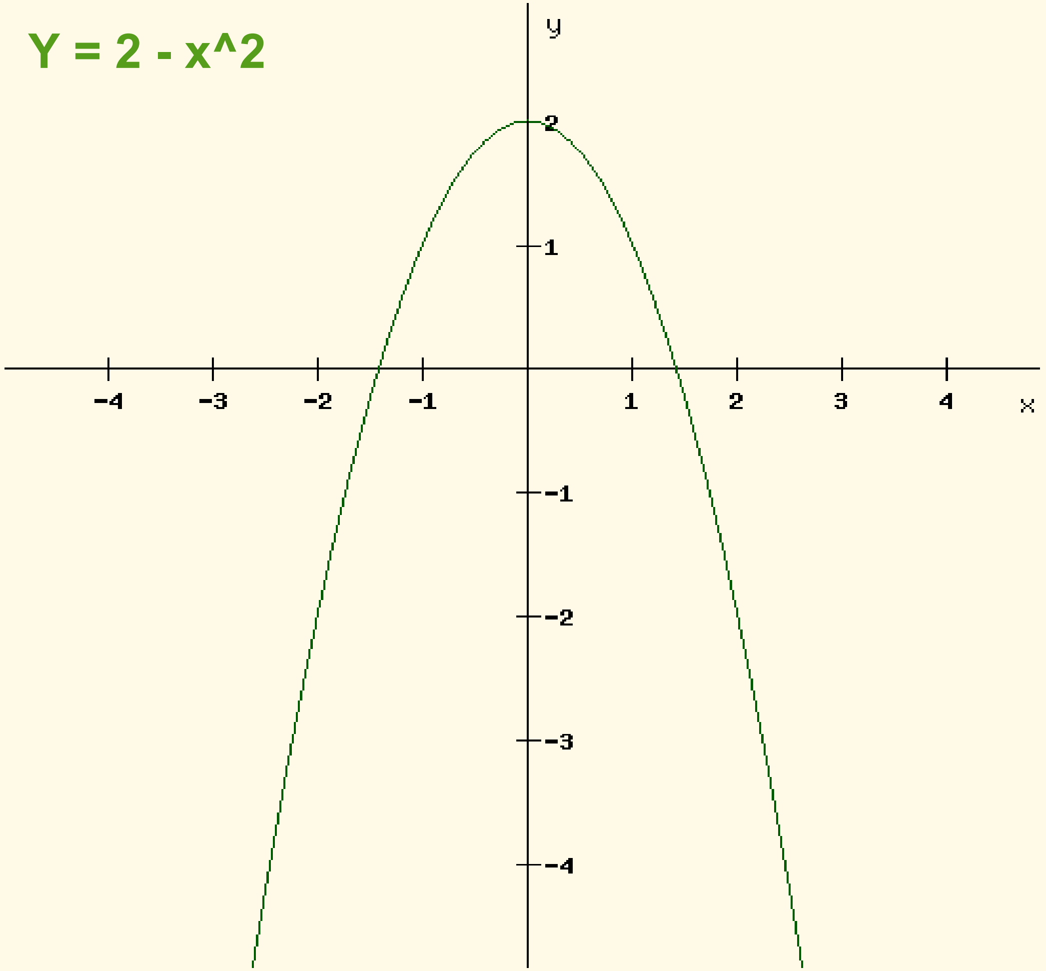
and $y = 2-0 = 2$.

Hence the vertex is (0,2). Domain is x can take all the real values. And the range will be $y <= 2$

Example

x	-1	0	1
y	1	2	1

$Y = 2 - x^2$



Equation of a Circle

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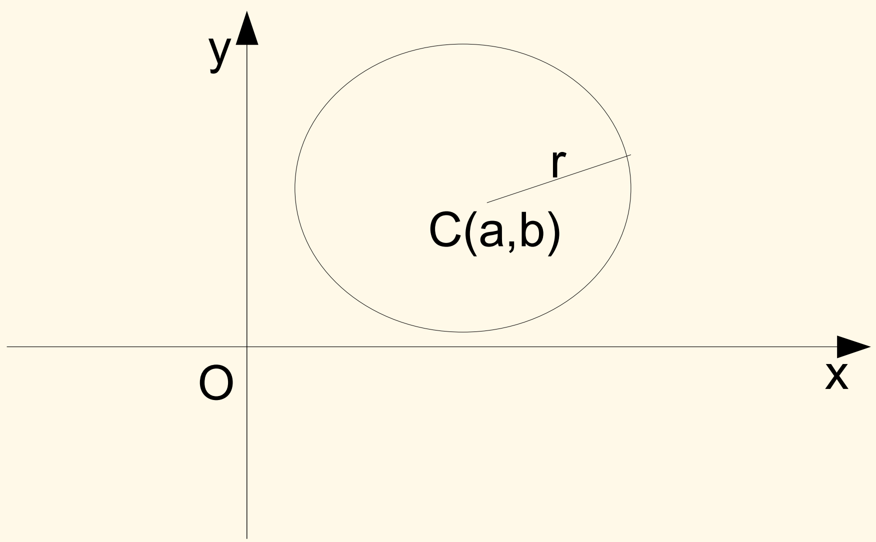
Standard form of equation of a Circle

The graph of an equation of the form

$$(x - a)^2 + (y - b)^2 = r^2$$

is a circle with its center at the point (a , b) and with radius r.



Example

For the equation of the circle

$$(y-3)^2+(x-1)^2 = 9$$

Find the center and radius of the circle.

Solution

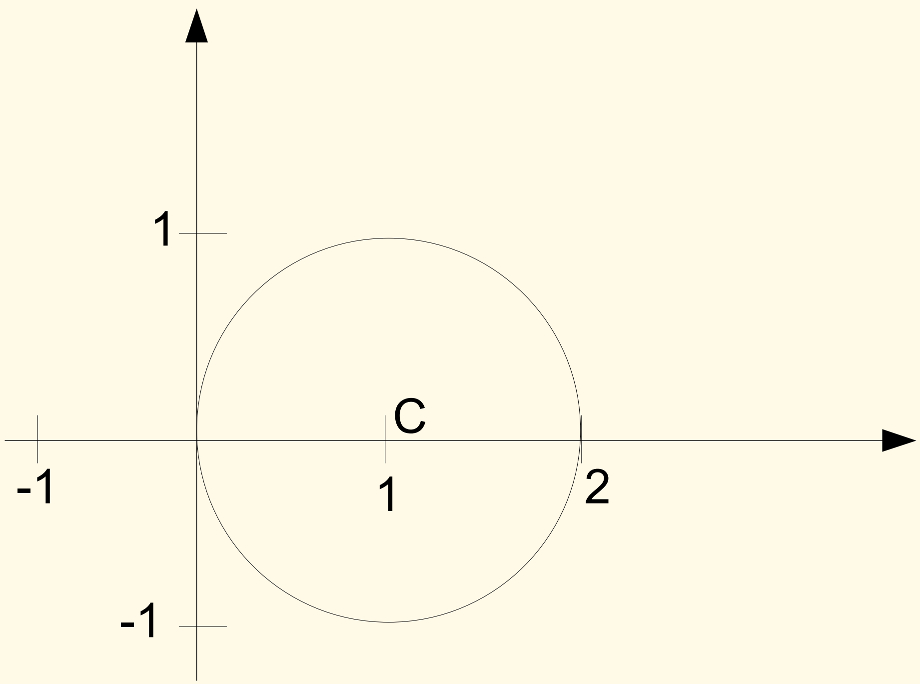
The given equation of circle is (y-3)^2+(x-1)^2 =9
Compare these with (x - a)^2 + (y - b)^2 = r^2

a = 1, b = 3, r^2 = 9,
r = 3

Hence the Center of the circle is (1,3) and radius 3 unit

Example

Look at the graph below, can you express the equation of the circle in standard form?



Solution

Since the radius of this this circle is 1, and its center is (1,0) , this circle's equation is

$$(x - a)^2 + (y - b)^2 = r^2$$
$$(x – 1)^2 + (y – 0)^2 = 1^2$$
$$(x – 1)^2 + y^2 = 1$$

Hence the equation of the circle is $(x – 1)^2 + y^2 = 1$

Graphing and plotting of function

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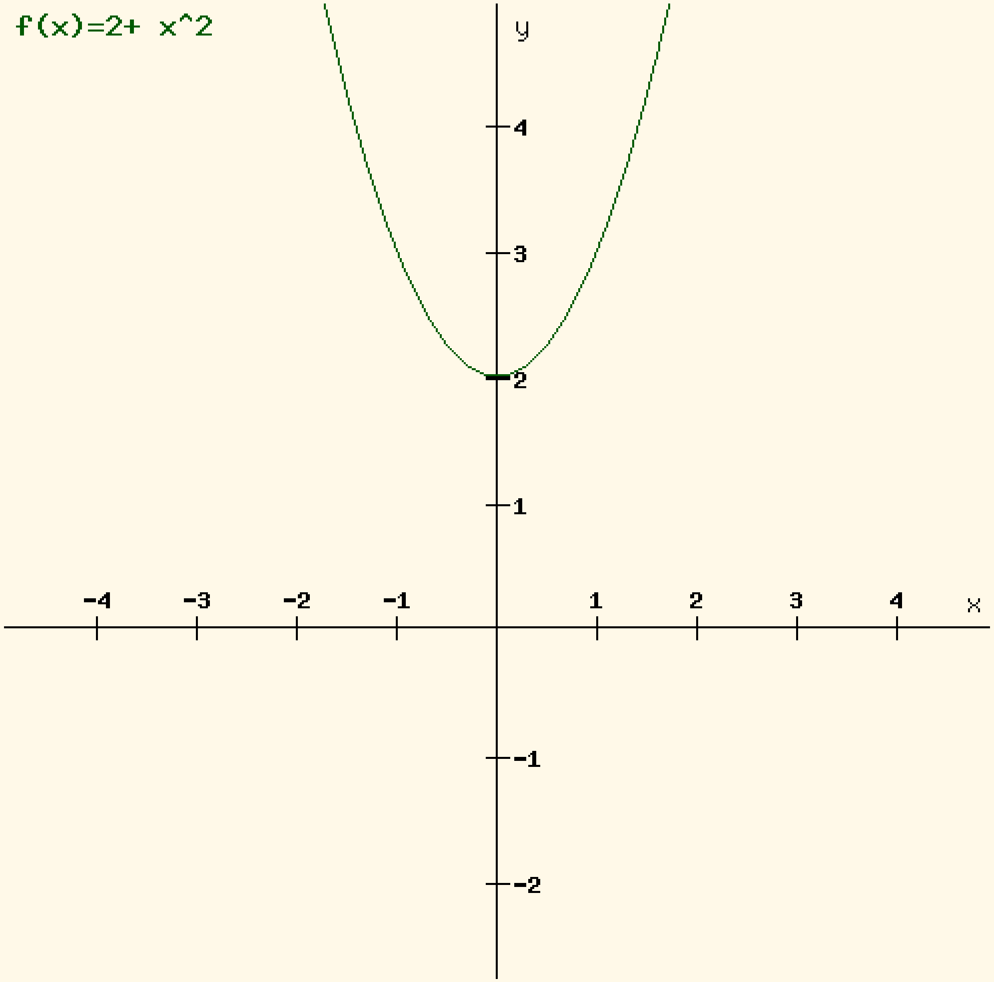
Plot the Graph of the function
f(x) = x^2 + 2

To Plot the graph let us find some of the *f(x)* values by having the values of *x* = **.... , -2, -1, 0, 1, 2, …**

x	-2	-1	0	1	2
f(x) = x^+2	(-2)^2+2 = 6	(-1)^2+2 = 3	0+2 = 2	(1)^2+2 = 3	(2)^2 +2 = 6

Graph



We can see that x can take any value in the graph, but the resulting ***f(x)*** values are greater than or equal to 2.

Square Root

The formal definition of a square root.

$$Sqrt(a) = x$$

Squaring on both sides we get,

$$x^2=a, \text{ for } x >= 0.$$

That is, x is the non-negative number whose square is a.

Example

sqrt(0.09) = 0.3
since (0.3)^2 = 0.09.

The expression is defined only when ***a >= 0***, and so an expression like ***sqrt(2-3x)*** makes sense only if ***2-3x >= 0.***

Example

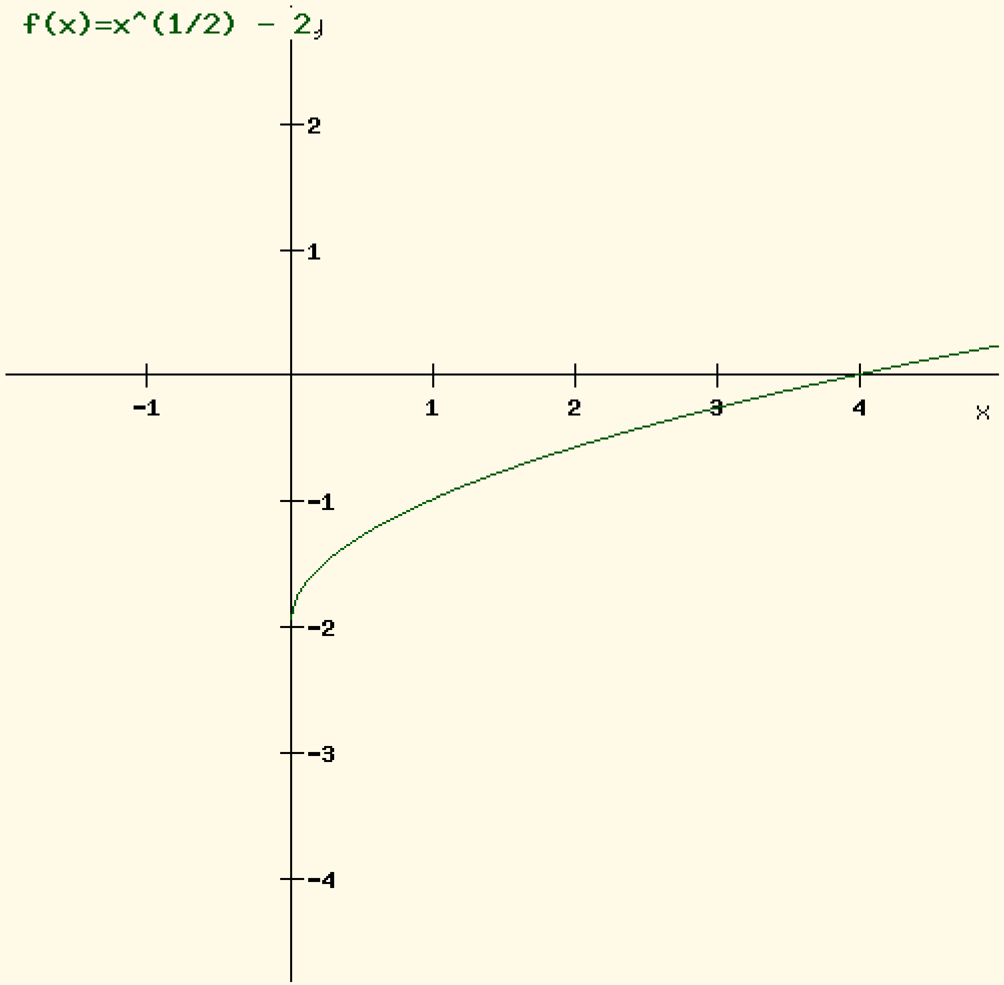
Plot the graph for the function *f(x) = sqrt(x) - 2*

Solution

Here x can take only the non negative real number. Negative values are not possible for sqrt. Then the domain is,
x > = 0. Range will be,
When x = 0, f(x) = 0-2. Therefore the range is f(x) > = -2

x	f(x) = sqrt(x) - 2
0	0 - 2 = - 2
1	1 - 2 = - 1
2	Sqrt(2) – 2 = - 0.6
3	Sqrt(3) - 2 = - 0.3
4	Sqrt(4)-2 = 0

Graph



This is the graph for f(x) = sqrt(x) -2

Example

Plot the Graph for the function,

$$f(x) = \sqrt{x - 3}$$

and find the domain and range of f.

Solution

First find the domain of the square root function given above by stating that the expression under the square root must be positive or equal to zero

$x - 3 \geq 0$

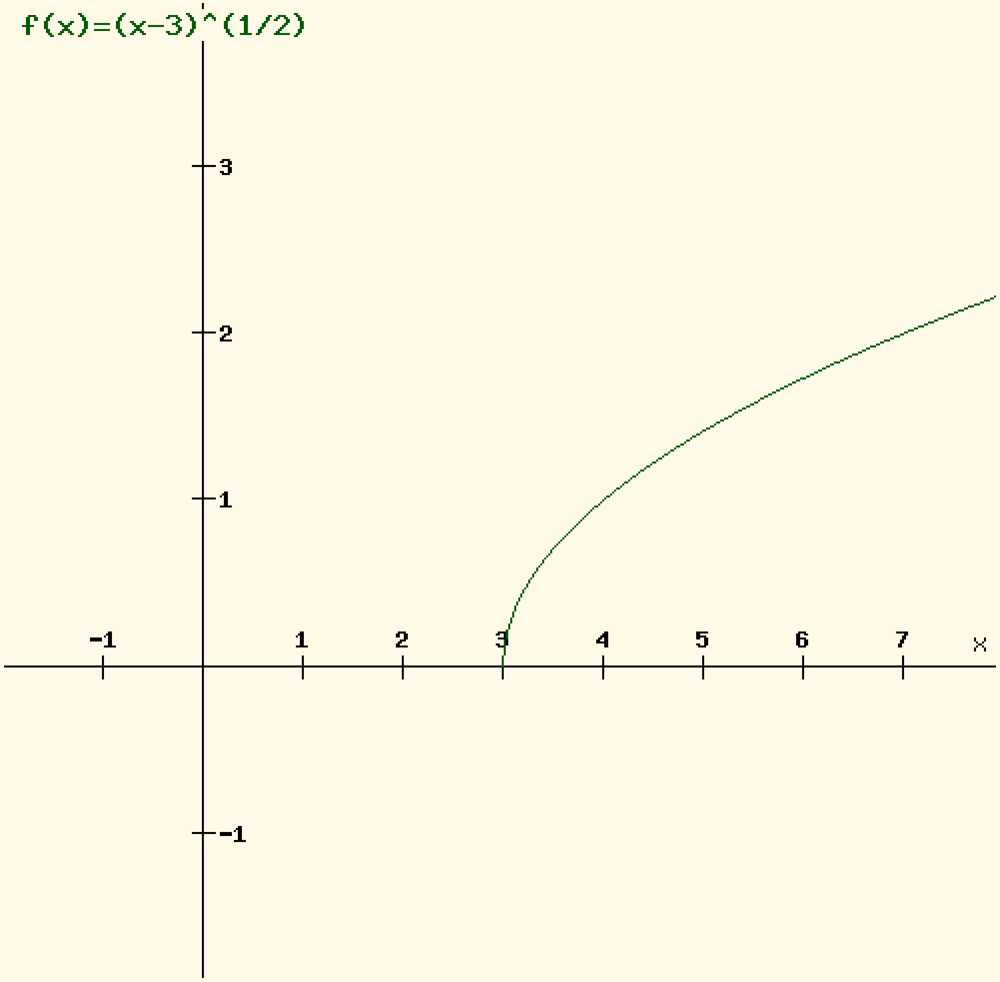
Solve the above inequality to obtain the domain of f as the set of all real values such that

$x \geq 3$

Example

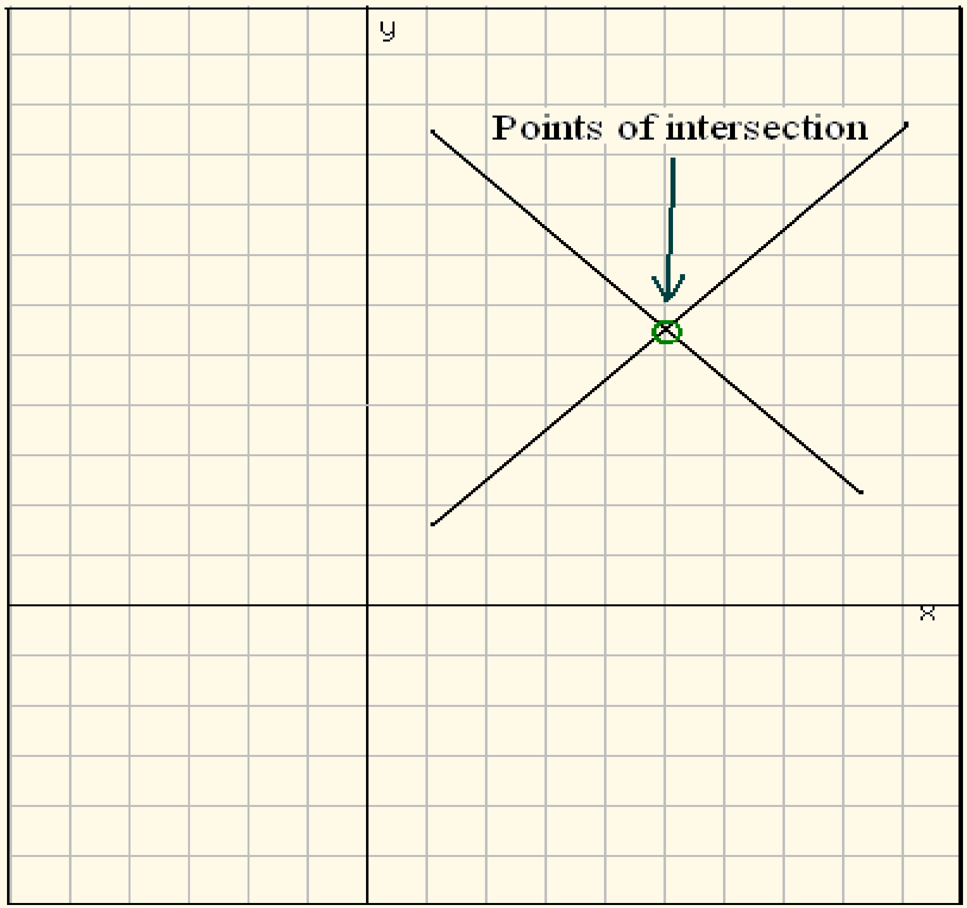
We now select values of x in the domain to construct a table of values. The interval [0 , +infinity) ie, f(x) > = 0represents the range of f.

x	f(x) = sqrt(x-3)
3	Sqrt(3-3) = 0
4	Sqrt(4-3) = 1
7	Sqrt(7-3) = 2
12	Sqrt(12-3) = 3



Point of Intersection

When both graphs pass through the same point, point of intersection occurs.



Example

Find the number of point of intersection given

$$f(x) = 3x + 2 \text{ and } g(x) = 2x - 1$$

Solution

To Find the number of point of intersection we need to equate the given function,

$$f(x) = 3x + 2 \text{ and } g(x) = 2x - 1$$

Equating we get,

$$3x + 2 = 2x - 1$$

$$3x - 2x = -3$$

$$x = -3$$

Example

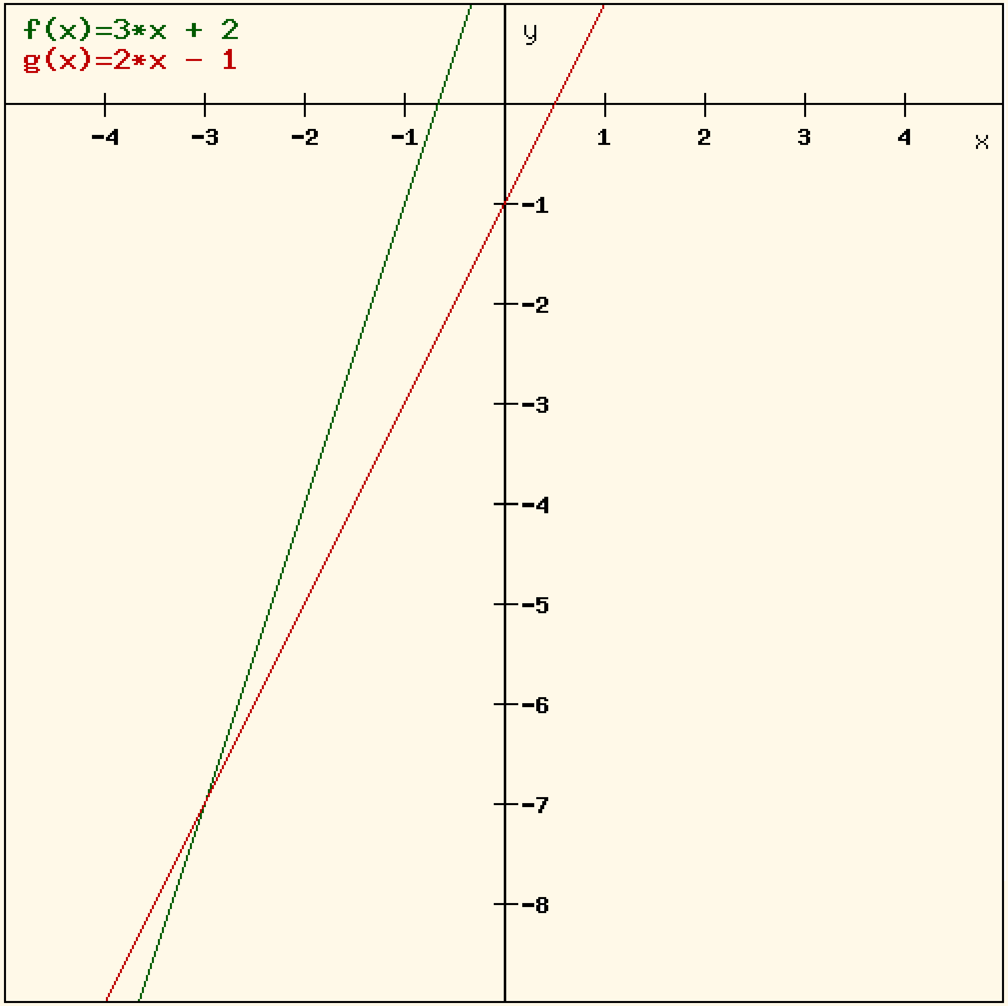
To Find the point of intersection

If we substitute the value of x = -3 in any of the equation we can find the point of intersection.

$$f(-3) = 3(-3) + 2 = -9 + 2 = -7$$
$$g(-3) = 2(-3) - 1 = -6 - 1 = -7$$

Here point of intersection is $(x, f(x)) = (-3,-7) = (x, g(x))$.

Graph



Example

Given the functions

$$f(x) = x^2 - 8x + 20 \text{ and } g(x) = -x^2 + 4x + 2$$

Find the number of point of intersection.

Solution

Equating these two functions we get,

$$x^2 - 8x + 20 = -x^2 + 4x + 2$$
$$x^2 + x^2 - 8x - 4x + 20 - 2 = 0$$
$$2x^2 - 12x + 18 = 0$$

Formula

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Let ***ax^2 + bx + c = 0*** be the quadratic equation. Then the roots are given by,

$$x = \frac{[-b \pm \sqrt{(b^2 - 4ac)}]}{2a}$$

Example

We have,

2x^2 – 12 x +18 = 0

Here a = 2, b = -12 and c = 18

$$x = \frac{[-(-12) \pm \sqrt{((-12)^2 - 4(2)(18))}]}{4}$$

$$x = \frac{[12 \pm \sqrt{(144-144)}]}{4}$$

Then x = 3.

Here then number of point of intersection is one.

Example

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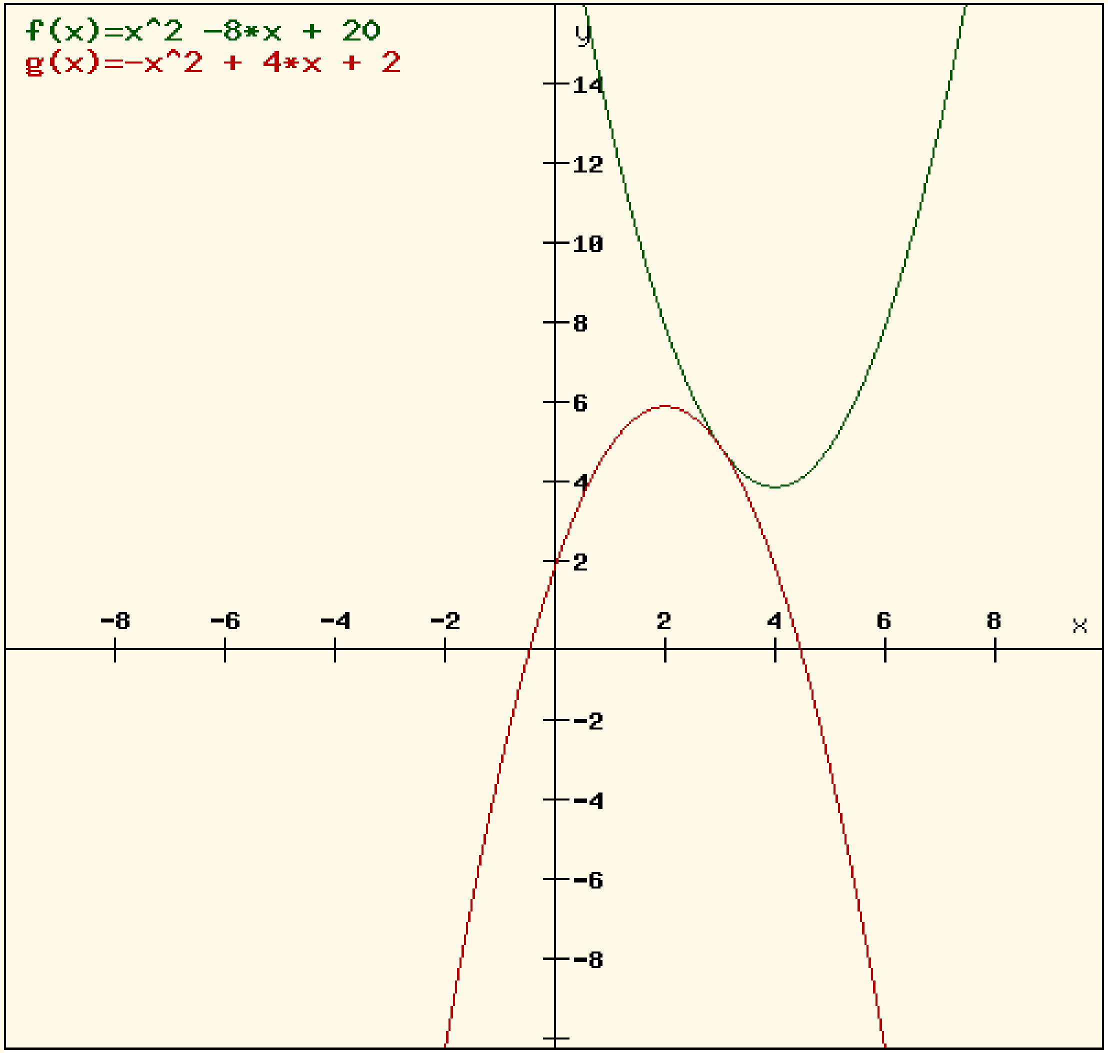
If we substitute the value of $x = 3$ in any of the equation we can find the point of intersection.

$$f(3) = x^2 - 8x + 20 = (3^2) - 8(3) + 20 = 5$$
$$g(3) = -x^2 + 4x + 2 = -(3^2) + 4(3) + 2 = 5$$

Here point of intersection is $(x, f(x)) = (3,5) = (x, g(x))$.

Graph

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