

Cartesian coordinate system

A **Cartesian coordinate system** is a coordinate system that specifies each point uniquely in a plane by a pair of numerical **coordinates**, which are the signed distances from the point to two fixed perpendicular directed lines, measured in the same unit of length. Each reference line is called a *coordinate axis* or just *axis* of the system, and the point where they meet is its *origin*, usually at ordered pair $(0, 0)$. The coordinates can also be defined as the positions of the perpendicular projections of the point onto the two axes, expressed as signed distances from the origin.

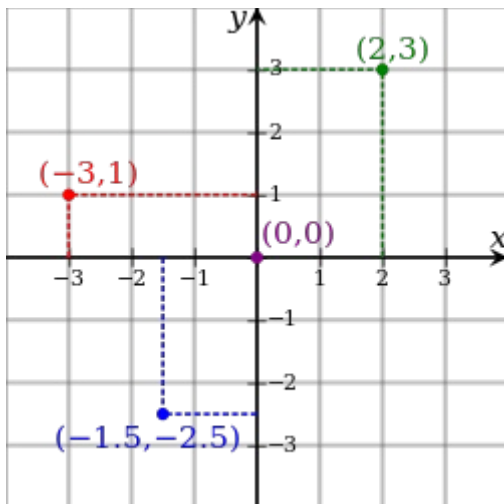
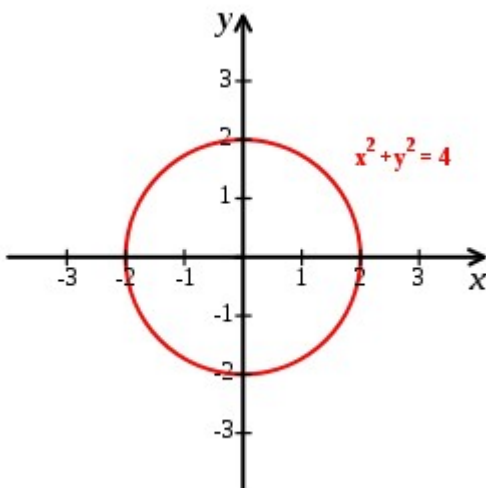


Illustration of a Cartesian coordinate plane. Four points are marked and labeled with their coordinates: $(2, 3)$ in green, $(-3, 1)$ in red, $(-1.5, -2.5)$ in blue, and the origin $(0, 0)$ in purple.



Cartesian coordinate system with a circle of radius 2 centered at the origin marked in red. The equation of a circle is $(x - a)^2 + (y - b)^2 = r^2$ where a and b are the coordinates of the center (a, b) and r is the radius.

Distance between two points

The Euclidean distance between two points of the plane with Cartesian coordinates (x_1, y_1) and (x_2, y_2) is

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}.$$

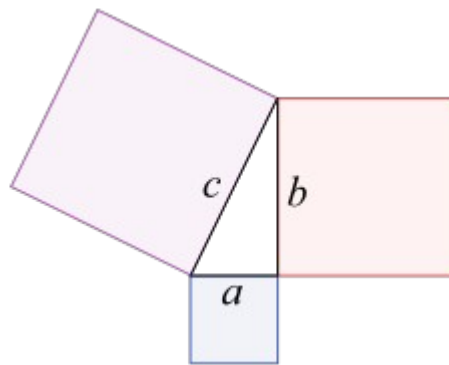
This is the Cartesian version of Pythagoras's theorem. In three-dimensional space, the distance between points (x_1, y_1, z_1) and (x_2, y_2, z_2) is

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2},$$

which can be obtained by two consecutive applications of Pythagoras' theorem.

To draw a circle using Cartesian coordinate system

1.



Considering two points x and y on the x -axis and y -axis which meet at (x, y) , this produces a right angle triangle with base of length x and height y . Here we could implement **Pythagorean theorem** which states ; The sum of the areas of the two squares on the legs (a and b) equals the area of the square on the hypotenuse (c). now applying to the above fig we get.

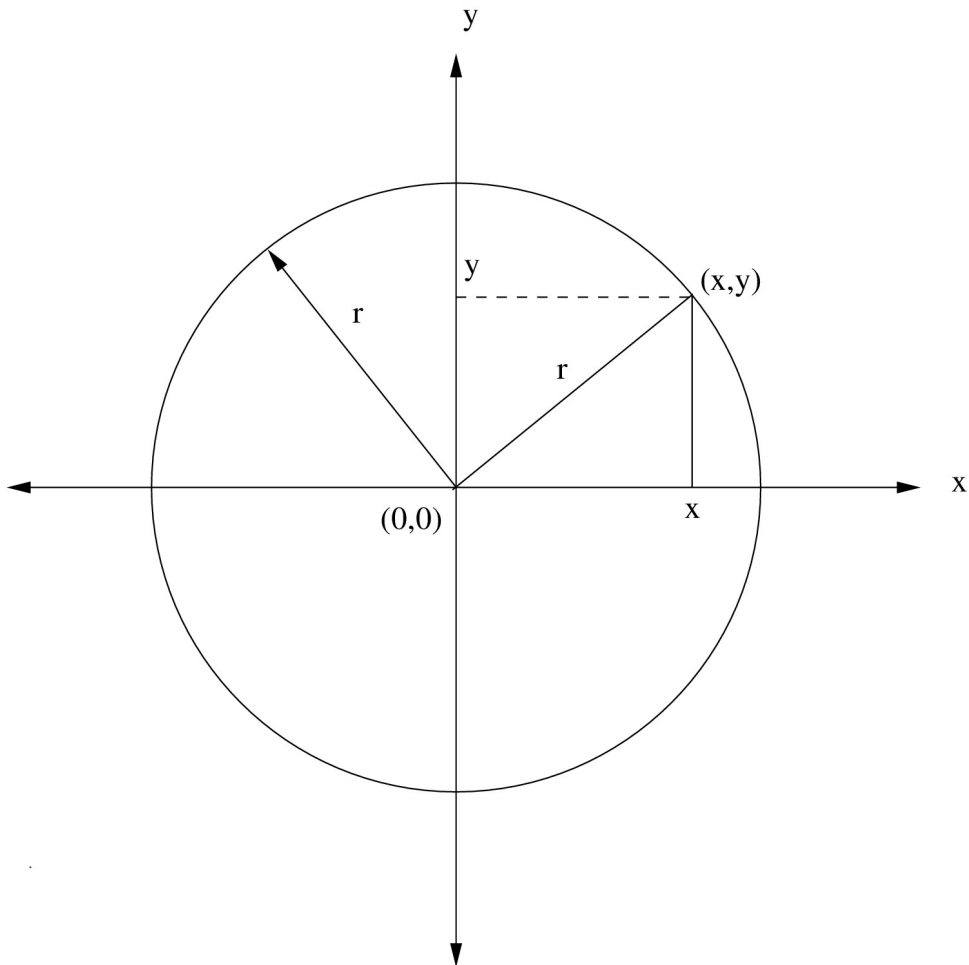
$$x^2 + y^2 = r^2$$

$$x = \sqrt{r^2 - y^2}$$

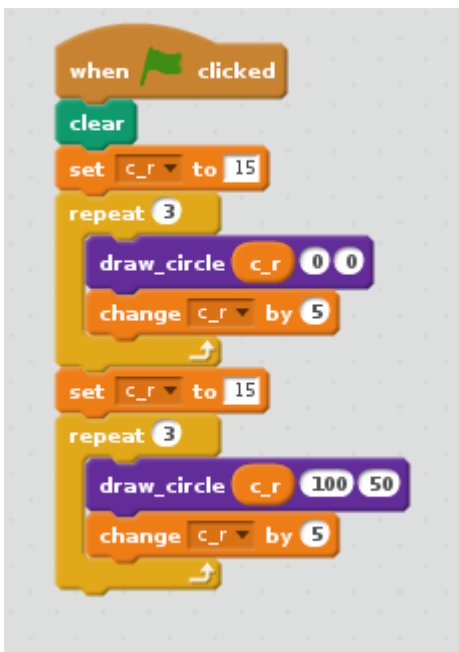
If we sweep y we can get each corresponding value of x . We can similarly write an equation for calculating y in terms of x .

In this circle the center is at $(0,0)$. If the center needs to be (x_{cent}, y_{cent}) then x needs to move by x_{cent} and each y needs to move by y_{cent} and understand the x and y represent the difference from center:

To plot we use $(x+x_{cent}, y+y_{cent})$

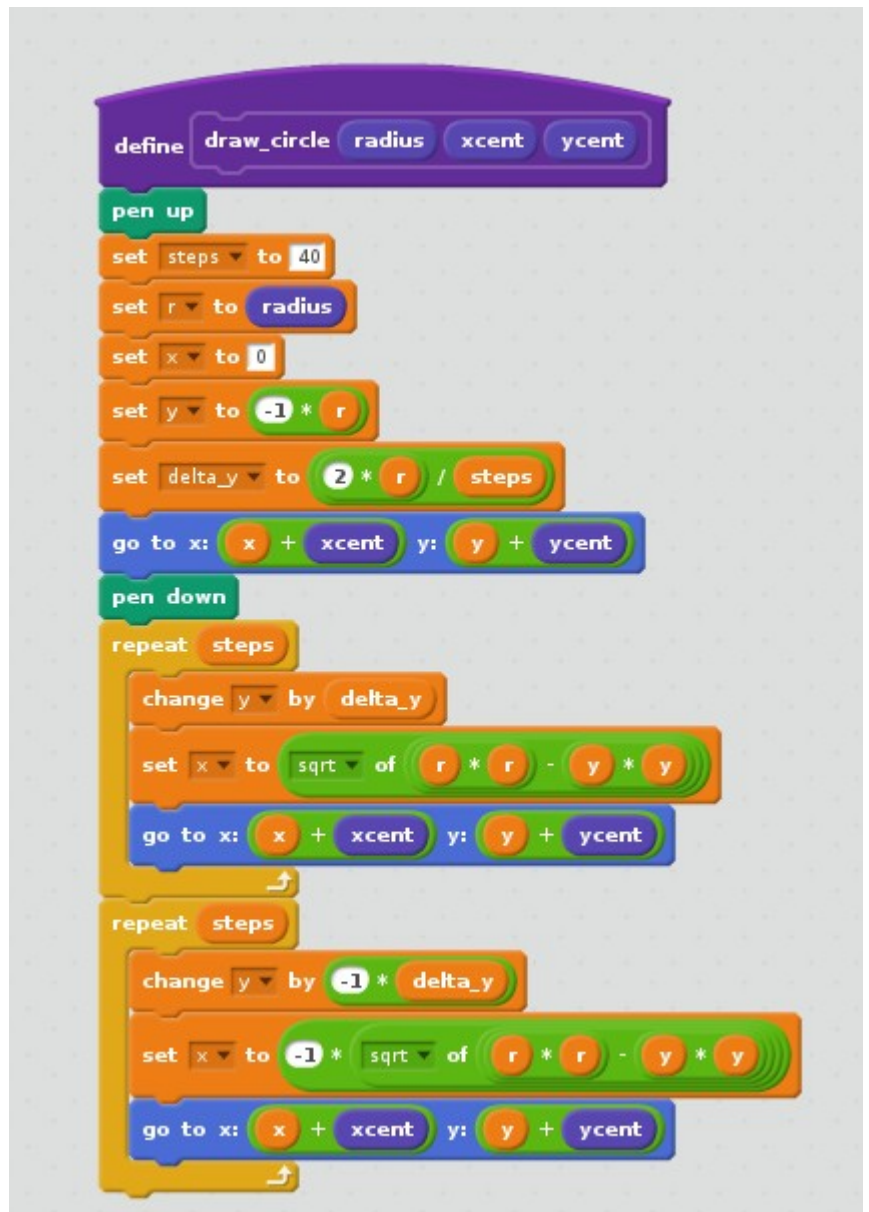


To run the script ;



```
when green flag clicked
  clear
  set c_r to 15
  repeat 3
    draw_circle c_r 0 0
    change c_r by 5
  set c_r to 15
  repeat 3
    draw_circle c_r 100 50
    change c_r by 5
```

Script ;



```
define draw_circle radius xcent ycent
  pen up
  set steps to 40
  set r to radius
  set x to 0
  set y to -1 * r
  set delta_y to 2 * r / steps
  go to x: x + xcent y: y + ycent
  pen down
  repeat steps
    change y by delta_y
    set x to sqrt of r * r - y * y
    go to x: x + xcent y: y + ycent
  repeat steps
    change y by -1 * delta_y
    set x to -1 * sqrt of r * r - y * y
    go to x: x + xcent y: y + ycent
```

- the step are defined to 40.
- setting radius of the circle to r
- defining x position to 0
- defining y position to -r (ie. To start the circle from the point (0,-r))
- determines the center of x and y.

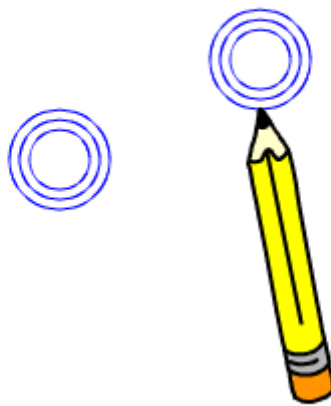
Pen down starts to draw

- the first loop repeats for the number of steps ie.40
- y value is changed with respect to delta of y .
- x is set to the modified equation of circle ie. $x = \sqrt{(r * r) - (y * y)}$
- this draws only a semi circle starting from the point **(0 +xcent,-r + ycent)** to the point **(0 +xcent, r +ycent)**
- hence we require a second loop to draw the other half of the semi circle.

- the second loop repeats for the number of steps ie.40
- y value is changed with respect to delta of - **y**.
- y is set to the modified equation of circle ie. $x = -\sqrt{(r * r) - (y * y)}$
- this draws only a semi circle starting from the point **(0+xcent,r+ycent)** to the point **(0 + xcent,-r + ycent)**
- hence the other half of the semi circle is dawn.

Now this whole script is user defined to perform 3 concentric circles around each points (0,0) and (100,50)

The Drawn Circles;



reference : <http://en.wikipedia.org> - Page 1,2