04/05/22 Cartesian Coordinates

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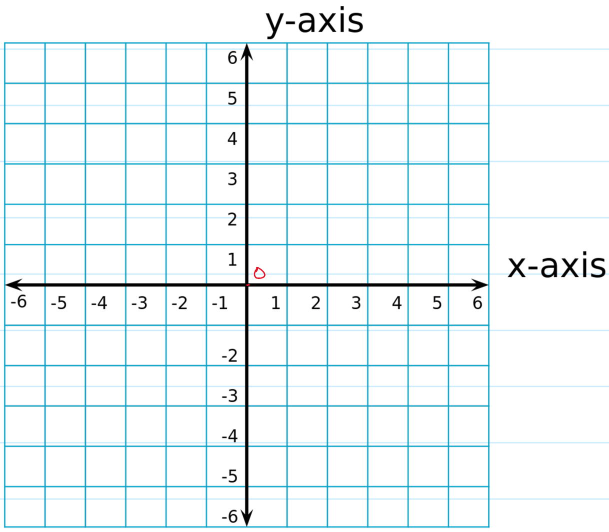
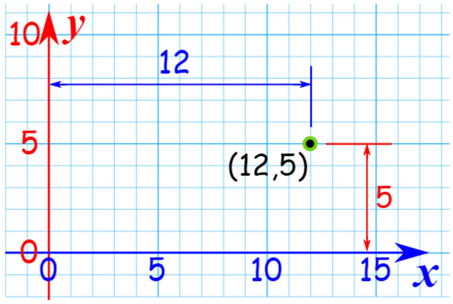
Cartesian Coordinates



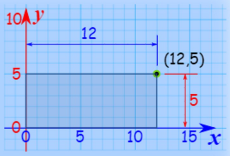
Using Cartesian Coordinates we mark a point on a graph by **how far along** and **how far up** it is:



absolute coordinate

The point **(12,5)** is 12 units along, and 5 units up.

They are also called **Rectangular Coordinates** because it is like we are forming a rectangle.

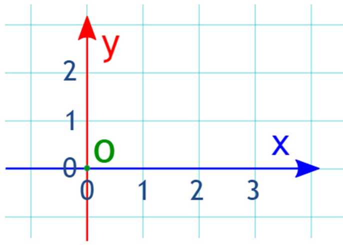


X and Y Axis

The *left-right* (**horizontal**) direction is commonly called **X**.

The *up-down* (**vertical**) direction is commonly called **Y**.

Put them together on a graph ...

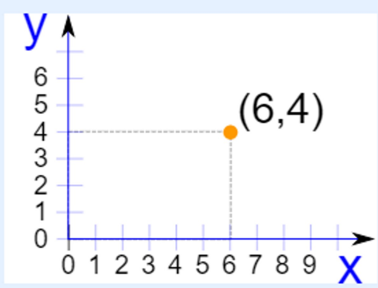


... and we are ready to go

Where they cross over is the "0" point, (a.k.a origin)
we measure everything from there.

- The **X Axis** runs horizontally through zero
- The **Y Axis** runs vertically through zero

Example:



Point **(6,4)** is

6 units across (in the **x** direction), and

4 units up (in the **y** direction)

So **(6,4)** means:

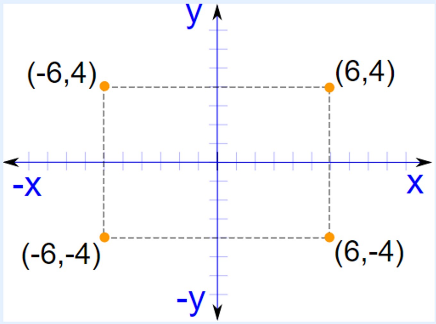
Go along 6 and then go up 4 then "plot the dot".

They are called *Cartesian* because the idea was developed by the mathematician and philosopher **Rene Descartes** who was also known as ***Cartesius***.

He is also famous for saying *"I think, therefore I am"*.

Negative: start at zero and **head in the opposite direction**:

- Negative x goes **to the left**
- Negative y goes **down**



So, for a negative number:

- go backwards for x
- go down for y

For example **(-6,4)** means:
go **back** along the x axis 6 then go up 4.

And **(-6,-4)** means:
go **back** along the x axis 6 then go **down 4.**

Why Study Cartesian Systems?

- All CNC machine tools follow the same standard for motion nomenclature and the same coordinate system.
- This is defined as the EIA 267-C standard.
- The standard defines a machine coordinate system and machine movements so that a programmer can describe machining operations without worrying about whether a tool approaches a workpiece or a workpiece approaches a tool.

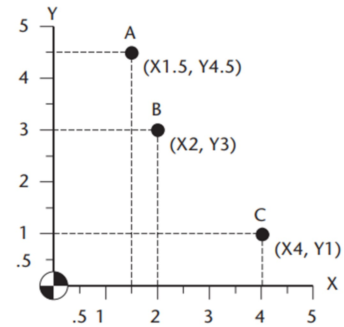
- Different machine tools have different machine motions, but they always use the same coordinate system.
- When describing a machine operation, the programmer always calculates tool movements relative to the coordinate system of the stationary workpiece. For example, you may have a CNC machine on which the tool is always stationary; however, the workpiece will move in various directions to achieve a finished part. In this example, when describing the tool motion or coordinate system, you describe the tool moving relative to the workpiece.

The machine coordinate system is described by the **rectangular Cartesian system**.

Absolute Coordinates

- All CNC machine tools require a reference point from which to base all coordinates.
- There are two main reference points on a CNC machine from which to base all coordinates.
  - The machine reference zero (MRZ) is a point on the actual machine.
  - The part reference zero (PRZ) is a point on the actual part or workpiece.

Absolute coordinates use the **origin point** as the reference point. This means that any point on the Cartesian graph can be plotted accurately by measuring the distance from the origin to the point, first in the X direction and then in the Y direction.



Observe from Fig. 2.11 the following.

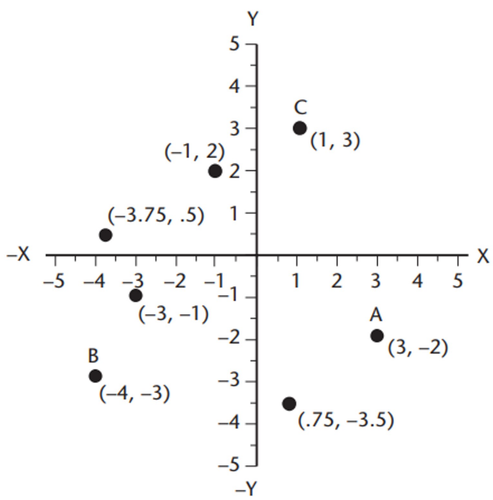
Point A: This point is 1.5 units along the X axis from the origin and 4.5 units along the Y axis from the origin. It is at (X1.5, Y4.5).

Point B: This point is 2 units along the X axis and 3 units along the Y axis from the origin. It is at (X2.0, Y3.0).

Point C: Point C is 4 units along the X axis and 1 unit from the Y axis. It is at (X4.0, Y1.0).

With absolute coordinates, keep in mind that all coordinates are measured from (X0, Y0) to the point in question, first in the X direction, then in the Y direction.

Example A: From the origin, point A is 3 units along the +X axis and then down 2 units along the –Y axis. Therefore (X3.0, Y–2.0).



Example B: From the origin, point B is 4 units along the –X axis and then down 3 units along the –Y axis. Therefore (X–4.0, Y–3.0).

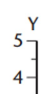
Example C: From the origin, point C is 1 unit along the +X axis and then up 3 units along the +Y axis. Therefore (X1.0, Y3.0).

Incremental Coordinates

Incremental coordinates use the **present position** as the reference point for the next movement.

This means that any point in the Cartesian graph can be plotted accurately by measuring the distance between points, generally starting at the origin. It is important to remember that incremental coordinates are measured from point to point, always starting from a known reference point such as (0, 0).

Figure 2.13
In this graph, point 1 is 1 unit in the +X direction from the origin

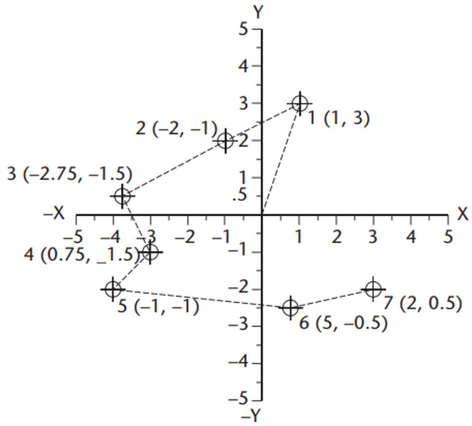


Example: From Fig. 2.13, the incremental coordinates for points 3, 4, 5, 6, and 7 are as follows:

Point 3 is (X–2.75, Y–1.5) units from the previous point (point 2).

FIGURE 2.13

In this graph, point 1 is 1 unit in the +X direction from the origin and up 3 units in the +Y direction. Thus the incremental coordinates for point 1 are (X+1, Y+3). Point 2 is 2 units in the –X direction and down 1 unit in the –Y direction. Thus the incremental coordinates for point 2 are (X–2, Y–1).

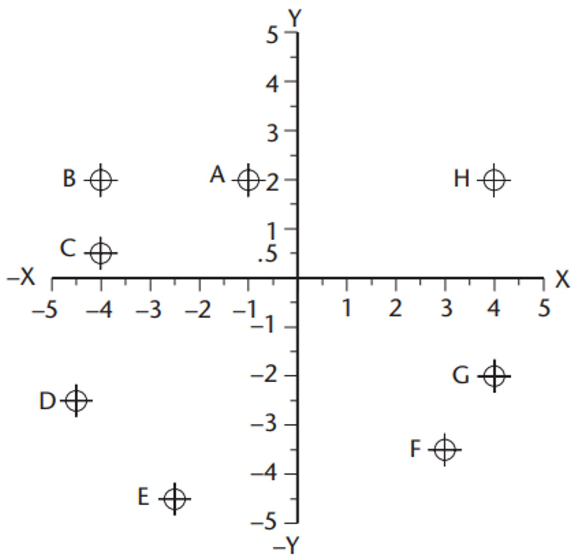


EXAMPLE: From Fig. 2.13, the incremental coordinates for points 3, 4, 5, 6, and 7 are as follows:

Point 3 is (X–2.75, Y–1.5) units from the previous point (point 2).
Point 4 is (X+.75, Y–1.5) units from the previous point (point 3).
Point 5 is (X–1.0, Y–1.0) units from the previous point (point 4).
Point 6 is (X+5, Y–.5) units from the previous point (point 5).
Point 7 is (X+2.0, Y+.5) units from the previous point (point 6).

You generally use incremental coordinates when plotting a large series of points that are clustered around a reference point. In this way, you can use absolute coordinates to pinpoint the reference point (for example, a corner in a milled pocket or center of a bolt hole) and then use incremental coordinates to plot the points around it.

Exercise:



EXERCISE 1: Absolute Coordinates

Fill in the X and Y blanks with the appropriate absolute coordinates for points A through H.

A: X -1, Y 2 B: X -4, Y 2
C: X -4, Y 0.5 D: X -4.5, Y -2.5
E: X -2.5, Y -4.5 F: X 3, Y -3.5
G: X 4, Y -2 H: X 4, Y 2

-2.5 -0.5

EXERCISE 2: Incremental Coordinates

Fill in the X and Y blanks with the appropriate incremental coordinates for points A through H.

A: X -1, Y 2 B: X -3, Y 0
C: X 0, Y -1.5 D: X 0.5, Y -3
E: X 2, Y -2 F: X 5.5, Y 1
G: X 1, Y 1.5 H: X 0, Y 4

CNC Mill Programming Exercise