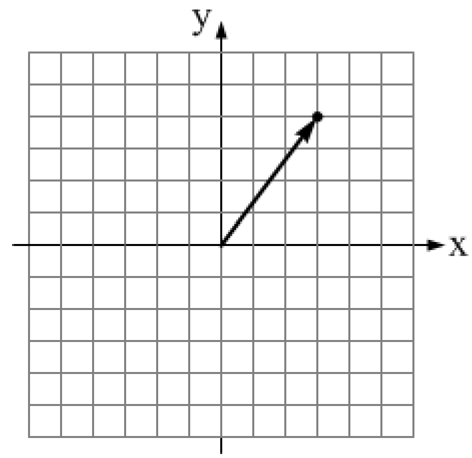
Coordinate System and Graphical Representations

Let's begin by talking about coordinate systems, and representing position and motion.



First, consider a typical x-y coordinate system in which an object is located at a position x = +3 m, y = +4 m. According to you, at least.

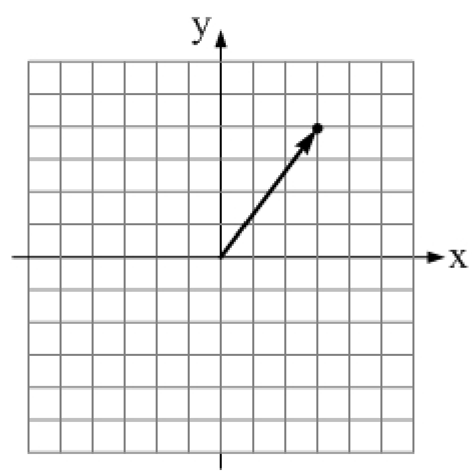
You and your friends all agree on where the origin is but you all disagree on exactly how the coordinate axes should be oriented. According to Anna the object is located on the x-axis. Where does she think it is?

According to Bill the object is located on the y-axis. Where?

According to Cindy the object has an x-coordinate of x = +1 m. What is the object's y coordinate, according to Cindy?

Do you and your three friends agree on anything? In other words, is there anything that you would agree is ***invariant***, no matter how the coordinate axes are oriented?

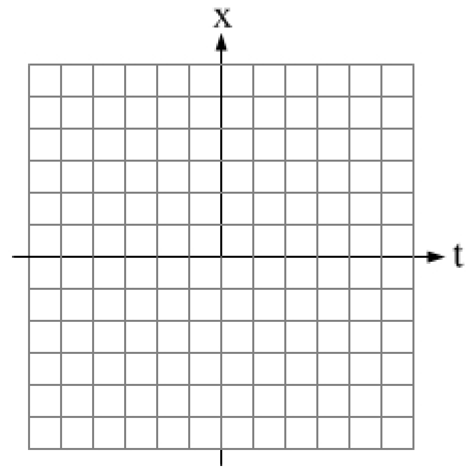
Your friend Dan introduces a new complication, in which the units on the x-axis are meters but the units on the y-axis are inches. Now you say that the object is located at x = +3 m, y = +157.48 inches. Each box on the graph measures 1 m wide by 40 inches high. Dan says the object is on his y-axis. Where does Dan say it is?



Eliza says the object is on her x-axis. Where?

Do you, Dan, and Eliza agree on any invariant quantity now?

Let's review how to plot the motion of an object. Let's say the motion is one dimensional, in which all objects move along the x-axis. Plot the position of the following objects as a function of time.

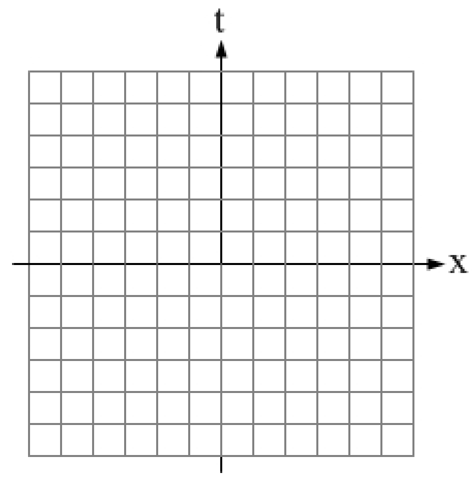


Object 1: It remains at rest at x = + 2 m.

Object 2: Starting from the origin at t = 0, object 2 has a constant velocity of +2.0 m/s.

Object 3: Starting from the origin at t = 0, object 3 has a constant velocity of -1.0 m/s.

Repeat the exercise above, but this time we'll reverse the axes so time is on the y-axis and the position is on the x-axis.



Now we'll be a bit more radical, and set up our coordinate axes with units of meters on both axes. We can do this by multiplying the time axis by a constant we'll call *b*, where *b* has a value of +1 m/s. This results in what we call a **spacetime diagram**, with a spatial dimension on the x-axis and a time dimension, converted to spatial units, on the y-axis. The boxes on the graph measure 1 m wide by 1 m high. Once again repeat the exercise above. An object's path on a spacetime diagram is known as its **worldline**.