Intro to Kinematics - 1D Kinematics

Velocity and speed are two closely related words. You might think that they are the same thing, but in physics we find that they are very different.

***Speed*** is a measure of how fast something moves. It is a ***rate***. Rates are quantities divided by time. In addition, speed is a ***scalar*** quantity.

Velocity is also a rate – the rate that displacement changes with time. The really key thing here is that velocity is a ***vector***. It has magnitude – just as speed does – but it also has a direction. When we talk about speed, we don’t care what about the direction of motion. The car went at a speed of 50 miles per hour. We don’t care if it went south, north, east, west, whatever. With velocity we do care about the direction. Velocity would be the motion of a car that is going south at 35 mph.

A ***vector*** is a quantity that has both magnitude and direction.



A toy train traveling around a circular track is moving at a constant speed. It does not have a constant velocity, however, because its direction is constantly changing.

***Distance*** is a scalar – just how far you are from some point. ***Displacement***, on the other hand, is a vector – distance and direction.

***Instantaneous*** ***velocity*** is the velocity of an object at any given instant of time. A car traveling from ***A*** to ***B*** does not always travel at a constant velocity - it stops, speeds up, slows down, etc. The speedometer on the dashboard reads out the instantaneous speed. At a stop sign it reads 0 mph, later on after the light turns green it might read 36 mph, and so on.

***Average velocity*** is the velocity for an entire trip. It is the total distance divided by the total time.

 

The symbol ***v*** is used for velocity (and is also used for speed). Some texts use , where a little bar is placed over the "v" indicating that it is a vector. We won't do that.

Average velocity is defined mathematically as:

 

 ***Δx*** means the change in ***x***, the displacement, ***Δt*** is the change in ***t***.





The subscript "***o***" means initial (it actually stands for “zero”, representing the condition that you begin with). So ***Δx***is the final displacement (or distance) minus the initial displacement. Other conventions can be used; ***t2 - t1***, ***tf – ti,*** etc.

If the initial conditions are zero, in other words, the motion started at time = 0 and at distance = 0, then the equation for average velocity can be shortened to:

  This is also used when an object has a constant velocity.

We end up with three equations for average velocity, but they’re all just variations of the same equation.

   or 

It is very common to use other letters for displacement. For example, you might use ***s*** for some general displacement. You might use ***y*** if the motion is in the ***y*** direction. ***h*** is sometimes used if the distance is a vertical distance and ***r*** might be used if we’re talking about the radius of a circle.

1. In the 1988 Summer Olympics, Florence Griffith-Joyner won the 100 m race in a time of 10.54 s. Assuming the distance was laid out to the nearest centimeter so that it was actually 100.00 m, what was her average velocity in m/s and km/h?
2. You begin a trip and record the odometer reading. It says 45 545.8 miles. You drive for 35 minutes. At the end of that time the odometer reads 45 569.8 miles. What was your average speed in miles per hour?

1. A high speed train travels from Paris to Lyons at an average speed of 227 km/h. If the trip takes 2.00 h, how far is it between the two cities?