

## Acceleration



<http://www.glenbrook.k12.il.us/gbssci/phys/Class/1DKin/U1L1e.html>

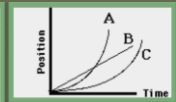
- Sports announcers will occasionally say that a person is accelerating if he/she is moving fast. Yet acceleration has nothing to do with going fast. A person can be moving very fast and still not be accelerating. Acceleration has to do with changing how fast an object is moving. If an object is not changing its velocity, then the object is not accelerating.



- The data at the right are representative of a northward-moving accelerating object. The velocity is changing over the course of time. In fact, the velocity is changing by a constant amount - 10 m/s - in each second of time. Anytime an object's velocity is changing, the object is said to be accelerating; it has an acceleration.

Time	Velocity
0 s	0 m/s, No
1 s	10 m/s, No
2 s	20 m/s, No
3 s	30 m/s, No
4 s	40 m/s, No
5 s	50 m/s, No

## Acceleration Animation



1. Which car or cars (red, green, and/or blue) are undergoing an acceleration? Study each car individually in order to determine the answer.
2. Consider the position-time graph at the right. Each one of the three lines on the position-time graph corresponds to the motion of one of the three cars. Match the appropriate line to the particular color of car.

## Definition

- **Acceleration** is a **vector quantity** which is defined as the rate at which an object changes its **velocity**. An object is accelerating if it is changing its velocity.



Since acceleration is a velocity change over a time, the units on acceleration are velocity units divided by time units - thus (m/s)/s or (mi/hr)/s. The (m/s)/s unit can be mathematically simplified to  $m/s^2$ .



$$\text{Ave. acceleration} = \frac{\Delta \text{velocity}}{\text{time}} = \frac{v_f - v_i}{t}$$

$$a = \frac{\Delta \text{velocity}}{\text{time}}$$

A car going 50km/hour accelerates to pass a truck. Five seconds later the car is going 80 km/h. Calculate the acceleration of the car.

You are driving down the road at 65 kilometers per hour when you apply the brakes to avoid an accident. Ten seconds later you have brought the car to a stop. What was your acceleration?

Constant acceleration – velocity is changing by the same amount each second.

An object with a constant acceleration should not be confused with an object with a constant velocity. Don't be fooled! If an object is changing its velocity -whether by a constant amount or a varying amount - then it is an accelerating object. And an object with a constant velocity is not accelerating.

**Accelerating Objects are Changing Their Velocity**

...by a constant amount each second ...by a changing amount each second ...

Time (s)	Velocity (m/s)
0	0
1	4
2	8
3	12
4	16

...in which case, it is referred to as a constant acceleration.

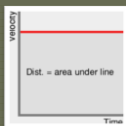
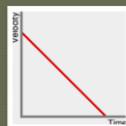
Time (s)	Velocity (m/s)
0	0
1	1
2	4
3	9
4	16

...in which case, it is referred to as a non-constant acceleration.

velocity increasing at a steady rate example: car accelerating from 0 to 60 mph

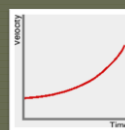
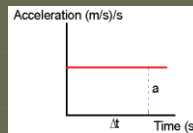


Moving with constant negative acceleration - velocity decreasing at a steady rate example: car braking



Moving at a constant velocity.

If an object moves in a circle it is accelerating



Acceleration increasing - velocity increasing at an increasing rate example: rocket accelerating away from lift off - constant thrust but burning fuel means that rocket weighs less - so accelerates at a greater rate

### Check your understanding:

You ride a bike on a straight path to school at a velocity of 4 m/s. As you get closer, you hear the school bell. In 3 s, you speed up to 10 m/s. Calculate your acceleration.

While walking to school, you approach an intersection and slow down from 2 m/s to a stop in 3 seconds. What was your acceleration during this time interval?

Calculate the rate of acceleration for each of the following data tables.

Time (s)	Velocity (m/s)	Time (s)	Velocity (m/s)
0	0	0	8
1	2	1	6
2	4	2	4
3	6	3	2
4	8	4	0

The graph shows the acceleration of an object. Using the graph, describe the object's motion.

