Acceleration

- Constant and Instantaneous Acceleration
- Determining Velocities and Displacements based on Acceleration
- Gravitational Acceleration

Acceleration

If an object is not going a constant speed or stopped, it is accelerating.

An object increasing speed has a positive acceleration. An object slowing down will have a negative acceleration.

Acceleration is the change in velocity over a certain period of time.

$$a = \frac{\Delta v}{\Delta t}$$

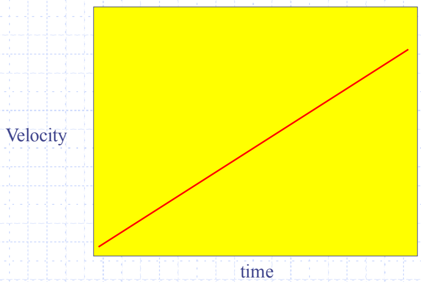
The unit for acceleration is m/s^2

Graphing Acceleration

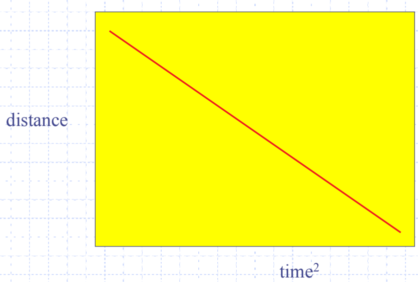
There are two ways to graph acceleration so that the slope of the best-fit line gives you acceleration:

- Speed vs. time
- Distance vs. time squared

Positive Acceleration

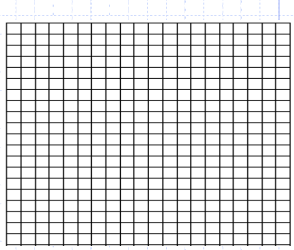


Negative Acceleration



Graphing Acceleration

Distance (m)	Time (s)
0.0	0.00
25.0	4.01
50.0	5.72
75.0	6.90
100.0	7.86
125.0	8.75



Types of Acceleration

- Average Acceleration, the average change in velocity, is the slope of the best-fit line of a velocity vs. time graph.
- Constant Acceleration occurs when an object changes velocity the same amount every second.
- Instantaneous Acceleration, the amount of velocity change right now, is determined by the slope of the tangent of a velocity vs. time curve

Determining Final Velocity

- If an object undergoes constant acceleration over a period of time, the final velocity can be calculated by using the following equation:

$$v_f = v_i + at$$

Acceleration and Displacement

- Displacement is much easier to measure than velocity, so it is helpful to have relationships between displacement and constant acceleration.
- As we have seen before: $d = v_{(average)} * t$
- Since $v_{(average)}$ is simply 1/2 $(v_f + v_i)$, by mathematical manipulation, we can derive the formula:

$$d = 1/2\ (v_f + v_i)t$$

Displacement, Time and Acceleration

When the acceleration is constant, and we know the initial velocity and the time the acceleration occurs, the equations

$d = 1/2\ (v_f + v_i)t$ and $v_f = v_i + at$

Can be easily changed into:

$d = v_i t + 1/2at^2$

For an object that starts at rest, the equation is simply $d=1/2at^2$

But what if you don't know time?

By taking the equations we have developed so far, it is possible to find displacement if the time is not known.

By using $v_f = v_i + at$ and $d = 1/2\ (v_f - v_i)t$ together, the following equation can be developed:

$v_f^2 = v_i^2 + 2ad$

Gravitational Acceleration

All objects will fall with the same acceleration if air resistance can be ignored.

The acceleration varies slightly from place to place on the Earth. We will therefore use a the following gravitational value:

$g = -9.8\ m/s^2$

The negative is to indicate that the acceleration pulls down. The letter g can replace a in all of our acceleration equations.

Transforming Graphs