

ECE 30

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## Agenda

- Uniformly Accelerated Motion
- Mass and Newton's First Law
- Force and Newton's Second Law
- Weight
- Equilibrium and Newton's Third Law

## Uniformly Accelerated Motion

$|v| \triangleq s$  speed is the magnitude of the velocity.

Average Acceleration is defined as

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{\Delta t}$$

Using the same limiting process we can define instantaneous acceleration to be:

$$\vec{a} = \frac{d\vec{v}}{dt}$$

Acceleration is the change in velocity over time, there are things that correspond to increasing derivatives of position but they are not usually relevant.

If we plot the components of velocity rather than position we are in what is called a "Phase Space". Any depiction of the state of a system which does not correspond to the literal space it occupies is a "Phase Space".

We also get an equation from this.

$$\vec{v}_f = \vec{a}\Delta t + \vec{v}_0$$

For most situations Acceleration is taken to be constant. This is true for gravitational acceleration, in a grounded reference frame. It is not true for things like orbits or the movements of celestial bodies.

Constant acceleration produces parabolic motion. This arises from integrating acceleration twice to get position against time.

$$\vec{x} = \frac{1}{2}\vec{a}t^2 + \vec{v}_0t + \vec{x}_0$$

This also gives the equations:

$$\vec{v} - \vec{v}_0 = \vec{a}t$$

$$\vec{v}^2 = \vec{v}_0^2 + 2\vec{a}\Delta x$$

$$\Delta x = \vec{v}_0t + \frac{1}{2}\vec{a}t^2$$

$$\Delta x = \frac{1}{2}(\vec{v}_0 + \vec{v})t$$

$$\Delta x = \vec{v}t - \frac{1}{2}\vec{a}t^2$$

Note:  
For these equations everything is component wise. These are technically vector quantities but they act as scalars in this case.

## Mass and Newton's First Law

Mass is a property of matter which is constant. In SI units it is measured with kg.

Mass has a property called *inertia* which resists acceleration. We can thus deduce that a body's velocity will not change unless acted upon. This is Newton's First law.

Things like Gravity and Friction are considered external actors which is why things on earth slow down or stop.