

ECE 30

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Agenda

- Newton's Laws
- Hooke's Law and Oscillatory Motion
- Young's Modulus
- Three point beam springs

Newton's Laws

1. A Body in Motion Will Stay in Motion

Frames of reference mean that constant velocity is interchangeable with being at rest.

A definition of Mass:

That property of an object which specifies how much resistance an object has to its velocity being changed.

In other words:

Mass is a measure of inertia, or resistance to acceleration.

Force is defined as:

$$F = ma$$

Or in other words:

Force is what changes the motion of an object.

2. Body subjected to multiple forces is accelerated in the direction of the resultant force.

This implies the relationship

$$F \propto m$$

And it implies:

$$F \propto a$$

Therefore, force can be written as:

$$\vec{F} = m\vec{a}$$

As a sidenote: Force is an arbitrary unit. Its one of those units we made up to explain things.

$$\vec{F} = \sum_{i=1}^N \vec{F}_i$$

These are vector sums which also means that the final sum can be decomposed into component wise sums.

What Units is Force in?

Mass is measured in kg, and acceleration in m/s^2 , Force must be measured in $kg \frac{m}{s^2}$. This unit is known as a Newton.

Weight vs Mass

Weight is defined as the force exerted on a body via gravity, which is equal to the force a body exerts on the planet. This means the units for weight is actually Newtons. Weight is only measured in kg because the gravitational acceleration is reasonably constant on Earth.

$$W = mg$$

Equilibrium:

This is the state where the net force is zero.

$$\sum_{i=1}^N \vec{F}_i = 0$$

When the above equation is not true, that is known as Non-Equilibrium.

3. Every Action has an Equal and Opposite Reaction

If a body acts on another, both bodies experience force in opposite directions from the point of contact.

Hooke's Law

The force a spring exerts is proportional to how much it is stretched or compressed.

$$F \propto -x$$

Where x is the displacement of the length of a spring from its resting length.

Further investigation revealed that F is equal to the displacement multiplied by some constant.

The force of a spring is equal to a constant times the displacement of the spring from its resting length.

$$F = kx$$

The spring constant k has units, N/m which is required for the total equation to have correct units.

Harmonic Oscillation

$$p(t) = x_0 \cos\left(t \frac{2\pi}{T}\right) \quad (1)$$

Where T is the time between peaks.