Lesson 23: Newton's First Law (Inertia)

Newton's Laws of Motion, as written in his book the ***Principia***, are actually very difficult to read.

- At the time, Newton didn't care too much about the "readability" of his book. He just wanted to get the stuff put down on paper.
- As a result, the way we state his laws today, and the formulas we use, are in some ways different from the way he originally wrote them. They still mean the same thing.

He actually wrote the laws in a specific order for a specific reason.

- As we go through the laws, you should realize that he builds one on top of the other.

The First Law (The Law of Inertia)

"**Every body continues in a state of rest or uniform velocity in a straight line, unless an external force acts on it.**"

"**Every body**…"
Means ***any*** physical object in the universe that has mass. It can be here on the Earth, on the moon, floating in space, wherever.

"…**continues in a state of rest or uniform velocity in a straight line**…"
If it is sitting still, it will stay that way. If it is moving, it will keep on moving forever at that velocity in a straight line.

"…**unless an external force acts on it.**"
Unless something else pushes it.

It is important that you understand the idea of "**external forces**."

- Let's say your car is stuck in a snow drift, so you ask your friend sitting in the passenger seat to push you out.
- He agrees and starts pushing as hard as he can on the dashboard…. the car doesn't move!
- Your friend is an ***internal*** force. He would have to get out of the car and push from out there to be an ***external*** force to cause your car to move.

An object resisting a change in its "state of motion" (stopped or moving in a straight line) is something that Newton called **inertia**.

- That's why this law is sometimes called the **Law of Inertia**.
- Basically, the idea of inertia is that however an object is moving right now, it will keep on moving that way.
- In day to day experience you don't necessarily see this because of the effects of friction.
    - If you roll a ball across the floor it will slow down and eventually stop.
    - This is not because it is violating inertia, but because there is an external force acting on it... friction.

We will basically say that as long as the net force on the object is zero, we will not see a change in its velocity.

$$\text{If } F_{NET} = 0, \text{ then } \Delta v = 0$$

Example 1: **Describe** the motion of a hockey puck that is shot down the ice.

A hockey puck will keep moving in the same direction at (almost) the same speed unless someone stops it or changes its direction. This would be done by applying a external force. The effect of friction on the puck will be quite small.

Example 2: **Describe** the motion of a book sitting on a desk.

A book sitting on a desk won't start to move all on its own. A force needs to be applied to it. Since it is in a state of rest, it will stay that way.

Example 3: Use Newton's First Law to **explain** why people are injured in car accidents when they do not wear seat belts. Assume the person was in a head on collision.

During the collision the car is rapidly brought to rest by a force acting against it. In the car the person still has inertia, so the person will continue to move forward at the same speed as the car was originally traveling at until a force acts against him. This force will be supplied by the steering wheel, dashboard, or windshield as they hit it. It is this force that causes injuries to his body.

Newton's First Law goes against what Aristotle said, but is basically what Galileo had said a few years earlier.

- Aristotle had said that if you stop pushing an object, it will come to rest.
  - He believed that "at rest" was the natural state for any object.
- Galileo told us to ignore friction and basically came up with Newton's First Law.
  - It is called Newton's First Law because he was the one that formally published it and had the mathematical proofs to back it up.

Homework

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