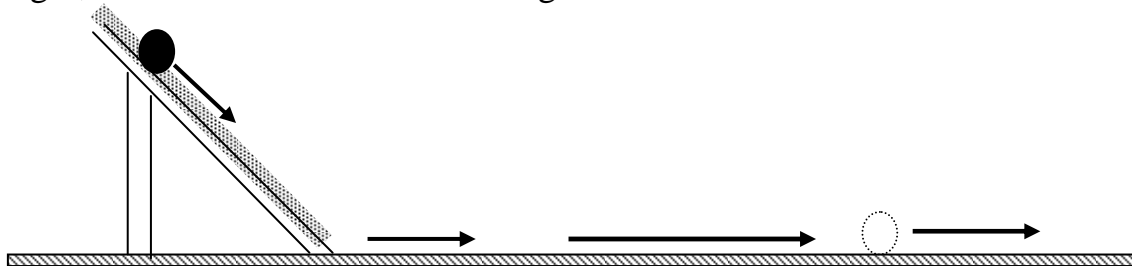# Newton's Laws

I. Newton's First Law
A. Galileo's Work

In the early 1600's, the Italian Physicist Galileo Galilee made one of the most important discoveries in history. Galileo discovered that when he rolled a ball down a smooth wooden ramp that the ball would continue rolling until it rolled up a second wooden ramp to the ball's initial height regardless of the second ramp's angle of inclination.
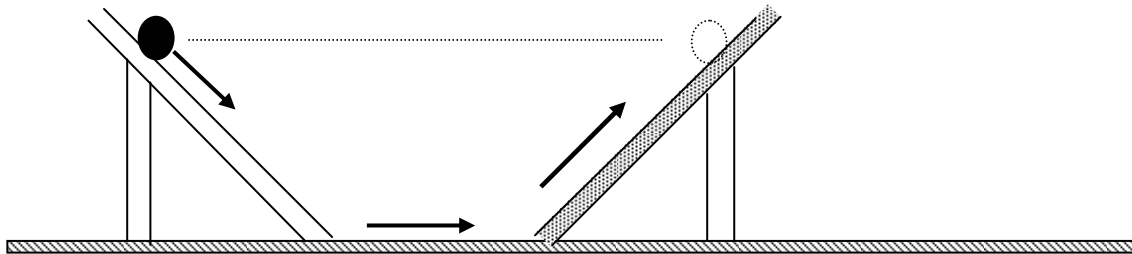
Galileo's Inclined Plane Experiment

Galileo further realized that the floor could be considered as a ramp with a zero angle of inclination (flat). Since the ball would never reach its original height, the ball would continue rolling forever!!

Ball Never Stops!!

B. Newton's First law of Motion

In his First Law of Motion, the great English physicist Isaac Newton summarized the work of Galileo and the French Physicist Rene Descart:

Newton's First Law of Motion (Galileo's Law of Inertia)

A particle will continue to **move** in a **straight line** at **constant speed** unless the particle is acted upon by a **net external force**.

C. **What Does Newton I Tell Us?**

Newton's 1st Law of Motion tells us three important things:

1) The natural motion of an object is a _____

_____ at _____

_____. Rest is a special case!!

2) When an object is _____ or _____

_____

3) The _____ of _____

Newton I gives us important information about **how to attack a problem and the nature of motion!**

Newton I is **NOT USED** to <u>find numerical results</u>!! This is the job of Newton II!

II. **Forces**

A. From everyday experience, we know that a force is a

_____ or _____ on an object.

B. Fundamental Types of Forces

At everyday temperatures, we see _____ different types of forces.

Force	Properties	Application

Using particle accelerators, we now know that _____ of

these forces are actually different aspects of a _____

_____ in the same way that intelligence, humor, sadness,

etc. are different aspects of your _____.

Physicists believe that we will eventually combine all forces into a single force. This is called the UNIFIED FIELD THEORY!! We believe that the basic laws of nature are very simple and that we just have a flawed view of them like a child watching their first chess game.

C. Units

Newton was such a powerful influence on the field of physics that they named the   unit of force after him!

1 Newton =

D. Alternative Classifications of Forces

In working problems, we sometimes find it convenient to classify forces based upon   properties other than their type!

Internal Forces - These are forces inside a particle. We can consider them to be the forces between the atoms making up a bridge or the beams of a bridge.

Newton I says that you **don't** have to **know** the **Internal Forces** to predict the **motion** of a bridge!

Alternatively, **Newton I** says that a **particle can't** change its own motion! It must be acted upon by an **outside influence** (another particle)!

External Forces - These are forces that originate outside of a particle. The car pushing on the bridge or the pull of the Earth upon the bridge!

E. Special Forces in Mechanics

A. Weight

On Earth, a body's _____ is the _____

pull of the _____ upon the _____.

Direction: _____ the _____ of the

_____

Magnitude: W =

B. Normal Force

This is a _____ of _____ between

_____ _____. The force is always

_____ to the _____ of

_____.

There is **NO GENERAL EQUATION** to find the **MAGNITUDE** of the

NORMAL FORCE. You must **SOLVE NEWTON II.**

C. Tension – T

Tension is the force of a string or a cable upon an object.

The force arrow starts at the point on the object in which the force is applied and is directed along the cable or string. Remember that strings can only pull. They can't push.

D. Friction

The only friction force which we discuss in PHYS104 is sliding friction. This is due to the relative motion or attempted relative motion between two surfaces. We will discuss this in more detail in a later lesson.

E. Applied

These forces include spring forces or constant forces that are given in the problem, but whose origin is not explained. For instance the problem might say that a horizontal 10 N force is applied to a block. We don't know who/what applied the force. In PHYS105, you will study electric and magnetic forces which fall into the applied force category.

II. Newton's 2nd Law

Newton's 2nd Law is one of the major laws used in solving mechanics problems. It is always true!!

$$\sum \vec{F}_{external} = m\vec{A}$$

It says that the acceleration of an object is proportional to the magnitude of the net external force applied to the object and in the direction of the net external force.

III. Mass

We know from experience that it takes a force of greater magnitude to accelerate a bolder than a raisin!!

This property of an object to resist acceleration (i.e. its desire to travel at a constant speed in a straight line) is called **inertia**.

The measure of an object's inertia is its mass. It is the proportionality constant, **m**, in Newton's 2nd Law Mass and has the units of kilograms. No one really knows why object's have inertia. We just know that they want to travel in straight lines at constant speeds so stay out of the way of moving cars.

IV. Newton's 3rd Law

If body A applies a force of some type upon body B then body B must apply the same type of force upon body A that is equal in magnitude but opposite in direction.