Newtons 1ˢᵗ Law

INERTIA
Your truck has brakes...the massive hunk of stone doesn't

Outcomes:

S2-3-04 Outline the historical development of the concepts of force and "natural" motion. *Include: Aristotle, Galileo, Newton's 1ˢᵗ Law.*

S2-3-05 Experiment to illustrate the effects of inertia in car collisions. *Include: distance travelled is proportional to velocity squared.*

History of Forces & "Natural Motion"

We define a **FORCE** as a **PUSH** or a **PULL** on any object. But where did the idea of force and motion begin?

Aristotle (384-322 B.C.)

- Said that everything on earth had a **NATURAL MOTION** toward the **CENTER** of the **UNIVERSE** (the **EARTH** at that time).
- In order for something to have a **DIFFERENT** motion, some **EXTERNAL FORCE** must be applied.
- To **KEEP** an object **MOVING**, you must apply a **CONTINUOUS** force.

History of Forces & "Natural Motion"

Galileo (1564-1642)

- Challenged Aristotle's physics, said motion is more complex.
- The **NATURAL MOTION** of an object is to **CIRCLE** the earth.
- **THOUGHT EXPERIMENT**:
  - Release an object **DOWN** a **RAMP**, it will **SPEED** up.
  - Push an object **UP** the **RAMP** it **SLOWS** down.
  - Therefore, if the motion is **HORIZONTAL**, it will **KEEP** going at **CONSTANT SPEED**.
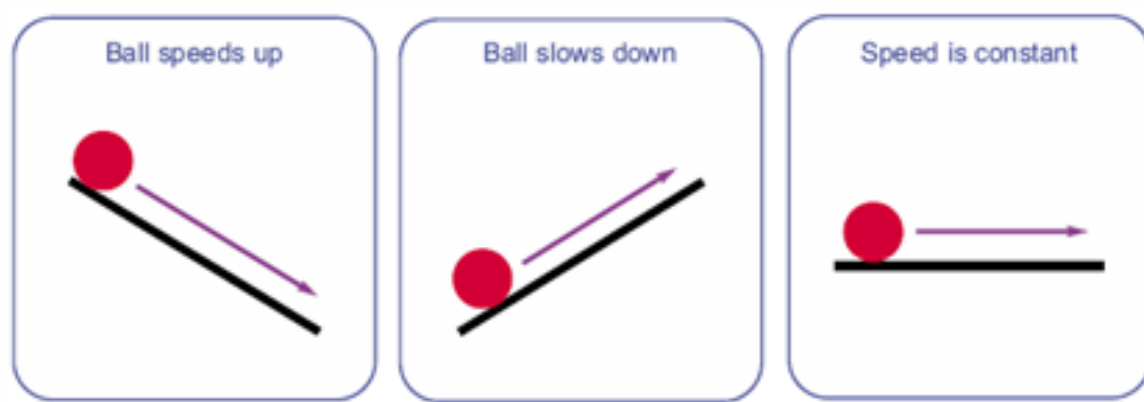
- In the **ABSENCE** of another **FORCE**, an object **CONTINUES** in motion.
- Said that another force called **FRICTION** is what brings objects to **REST**.

Sir Isaac Newton (1642-1727)

Developed 3 laws of motion involving **FORCES**
→ The unit of force is called a **NEWTON (N)**

Newton's First Law

Also known as the Law of Inertia:

*An object in motion will remain in motion, at the same speed
and direction unless acted upon by an outside (unbalanced) force.*

*An object at rest will remain at rest, unless acted upon by an outside
(unbalanced) force.*

This characteristic of matter to **RESIST CHANGES IN MOTION** is called
INERTIA.

Forces…

We know that a force is a push or a pull on an object, but what are balanced and unbalanced forces?

Balanced Forces:

- **TWO** forces acting on the same object that are **EQUAL** but **OPPOSITE**.
  - Balanced forces **CANCEL EACH OTHER OUT**.
  - Result is **CONSTANT MOTION** or **REST**.

Example:

There are balanced forces acting on the car below, as a result it **STAYS** at the **SAME** speed/velocity (including at **REST**).

Force "A"   Force "B"

Forces...

Unbalanced Forces

- A force that is acting on an object and is **NOT** opposed by another force with the same size acting in the **OPPOSITE** direction.

- Forces that **DO NOT CANCEL OUT** (one is **BIGGER** than the other)

- Result is a **CHANGE IN MOTION** (**ACCELERATION**)

Example:

There are unbalanced forces acting on the car below, as a result, it moves with **INCREASING VELOCITY** in the positive direction (the minivan is **ACCELERATING**).

Force "A"   Force "B"

Effects of Inertia…

The Effects of Inertia in Car Collisions

- In car crashes there are 2 collisions:
  - car colliding with an object represents the **FIRST COLLISION**.
  - A **PASSENGER** in the car colliding with a **PART OF THE CAR** is the **SECOND COLLISION**.

- It is the **SECOND COLLISION** that **INJURES** the passenger.

- **INERTIA** plays an important role in car crashes.
  - If the car stops suddenly, the passenger **CONTINUES TO MOVE** with the **SAME VELOCITY** (speed & direction) as he/she had just before the crash.

Effects of Inertia…

The Effects of Inertia in Car Collisions

- The **FASTER** the car is traveling the **FARTHER** a passenger will be thrown according to the relationship:

  α ← "proportional to"

  $$d \propto v^2$$

- This means that the distance thrown varies with the **SQUARE OF THE VELOCITY**.

  - If the speed of the car is **DOUBLED**, the passenger is thrown = **FOUR** times as far.

  - If the speed is **TRIPLED** the passenger is thrown = **NINE** times as far.

Distance of Passenger