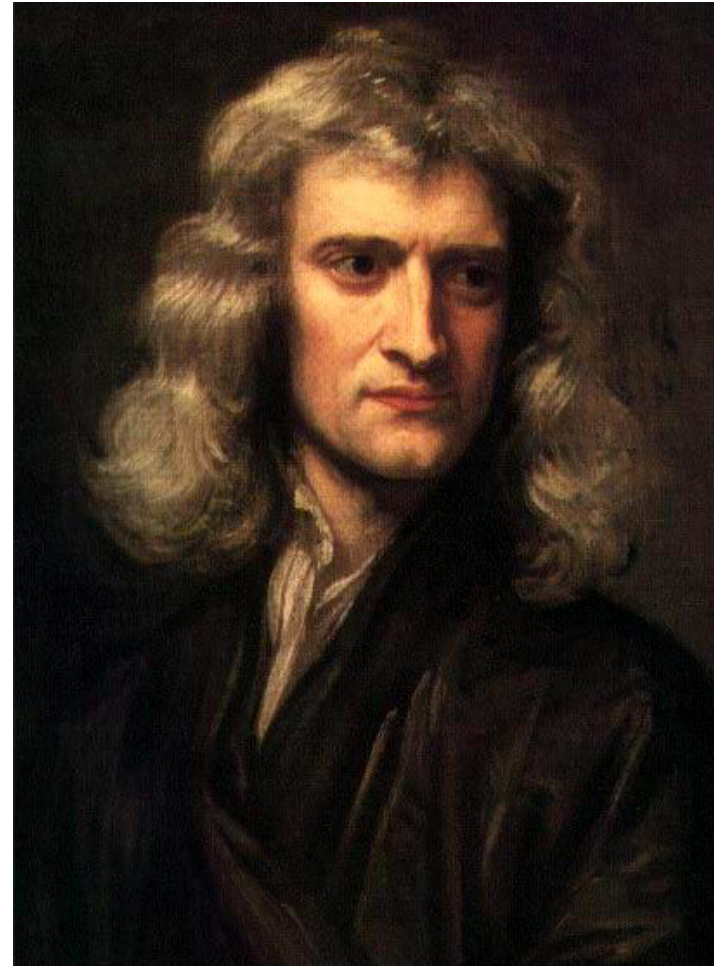


# Sir Isaac Newton

- 1642-1727
- Scientist/Mathematician
- 3 Laws of Motion
  - The physical laws that show how bodies, motion, and forces interact



# Newton's First Law of Motion



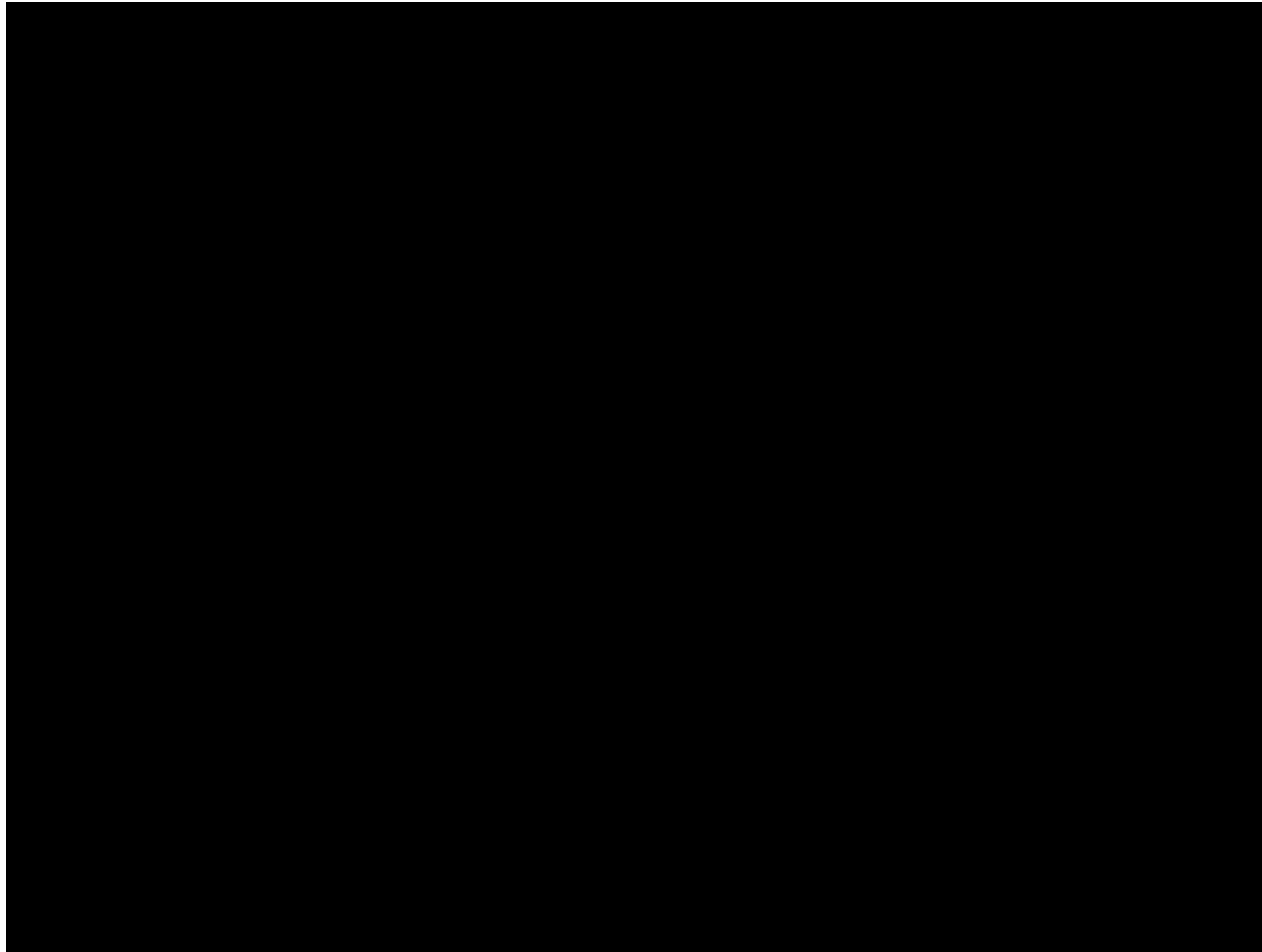
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# First Law of Motion: Inertia

- Every object continues in a state of rest or constant motion unless acted on by a nonzero net force
- Basically:
  1. Objects at rest will stay at rest unless a non-zero net force of is applied
  2. Objects in motion will stay in motion unless a non-zero net force is applied

# Newton's First Law Applied by NASA



# Newton's Second Law of Motion



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# Key Units

Term	Definition	Unit
Velocity	Speed and direction of an object	m/s
Acceleration	How fast an object “speeds up” (and direction)	m/s <sup>2</sup>
Force	“push or pull” on an object to make it have change in velocity	N
Mass	Amount of matter in an object	g

# Metric System

- Metric System:

- Mega -  $\times 10^6$
- Kilo -  $\times 10^3$
- Hecto -  $\times 10^2$
- Deca -  $\times 10^1$
- Deci -  $\times 10^{-1}$
- Centi -  $\times 10^{-2}$
- Milli -  $\times 10^{-3}$
- Micro -  $\times 10^{-6}$

# Second Law of Motion: Formal Definition

The acceleration of an object is directly proportional and in the same direction to the net force acting on it AND inversely proportional to the mass of the object.

$$\mathbf{a} = \frac{\mathbf{F}}{m}$$

# Second Law of Motion: What it really means...

An object accelerates when a force act on it.

$$\mathbf{a} = \frac{\mathbf{F}}{\mathbf{m}}$$

Rewrite this equation:

$$\mathbf{F} = \mathbf{m} \times \mathbf{a}$$

## Second Law Examples

(NO friction and NO air resistance)

If a car has a mass of 2000 kg and a force of 4000 N acts on it, what will the acceleration be?

## Second Law Examples (NO friction and NO air resistance)

If you drop a 5 kg ball off the table, what force will it exert on the floor when it hits the floor?

# Second Law Examples

## (NO friction and NO air resistance)

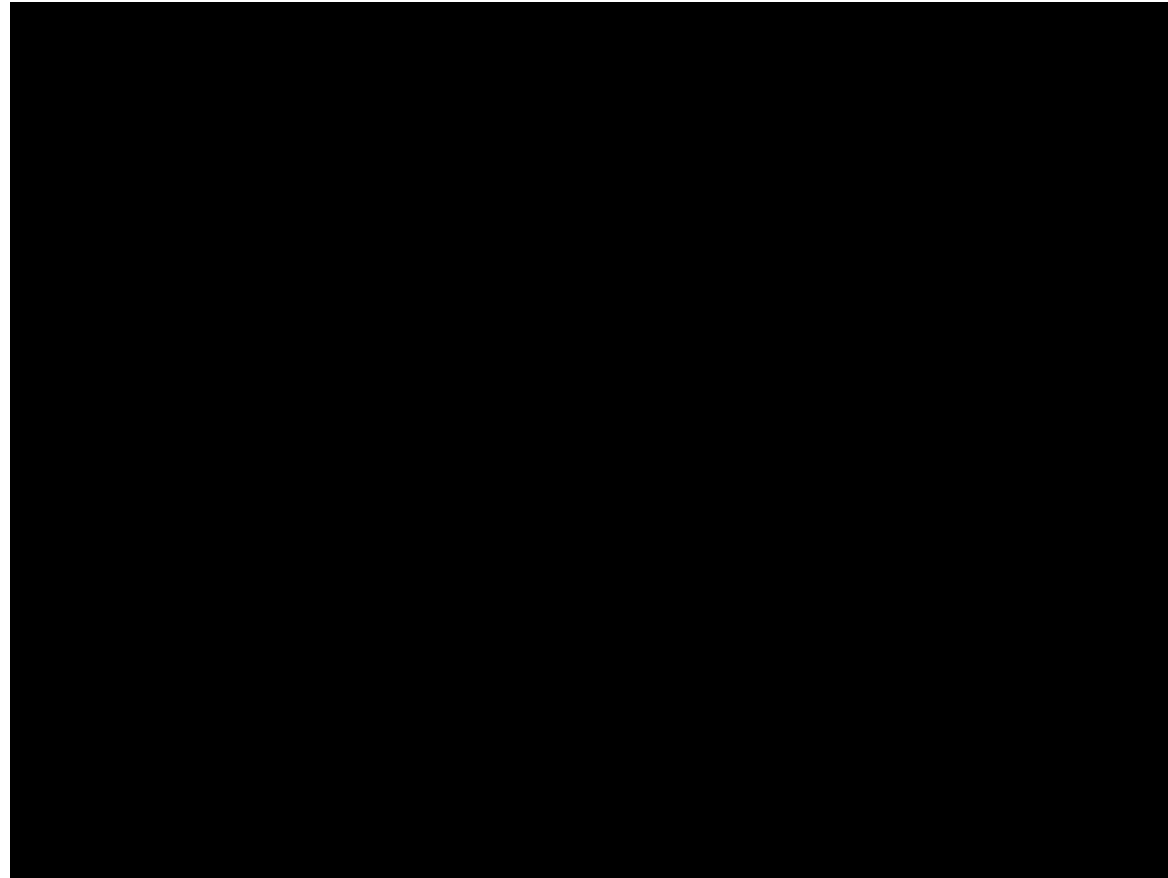
A 12 N force is applied to a 100 mg block of mass resting on a frictionless flat surface. What is the resulting acceleration of the block?

# Second Law and Rockets

Does this law apply to rockets?

**NO!**

# Newton's Second Law Applied by NASA



# Newton's Third Law of Motion



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# Third Law of Motion

- When one body exerts a force on another body, the second body simultaneously exerts an equal force on the first body.

**Every action has an equal and opposite reaction**

# Action-Reaction Pairs Examples

Example:

When you kick a soccer ball, what is the action-reaction pair?

Answer:

Your foot exerts a force on the ball and the ball exerts an equal and opposite force on your foot.

# Action-Reaction Pairs Examples

Example:

How can fish swimming be explained by Newton's 3<sup>rd</sup> law?

Answer:

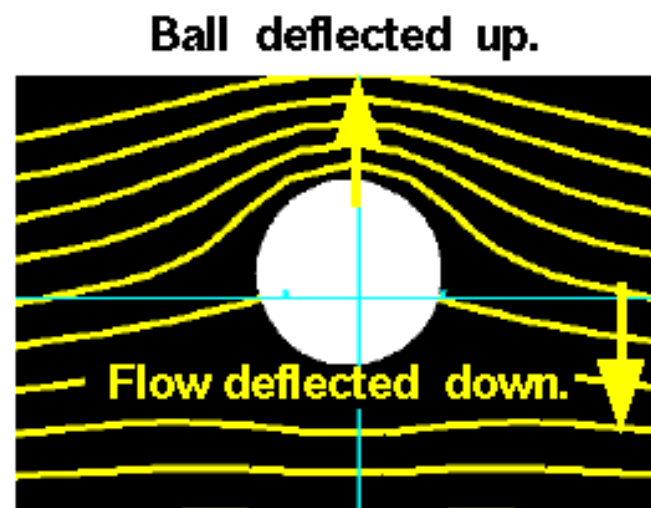
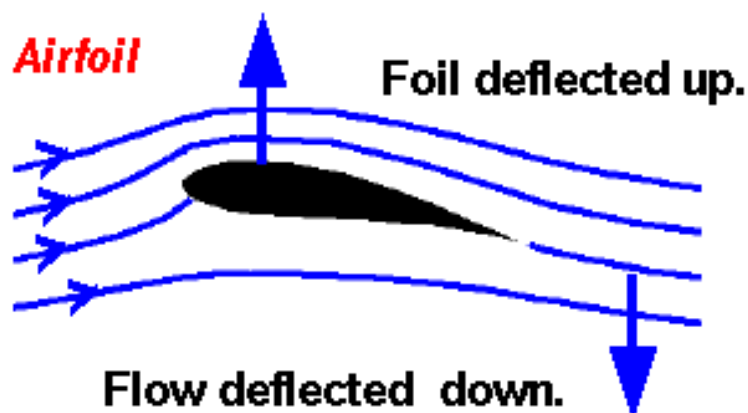
Fish flap their tails and exert a force on the water in a certain direction. The water exerts an opposite and equal force on the fish causing the fish to move forward!



# Newton's Third Law Applied to Aerodynamics

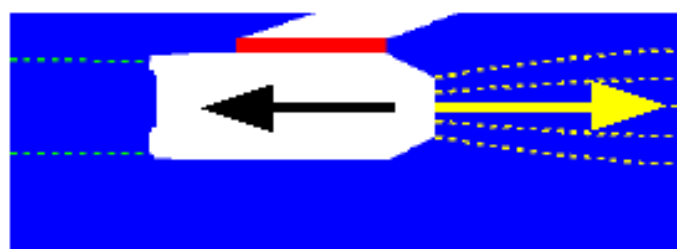
Glenn  
Research  
Center

For every action, there is an equal and opposite re-action.



**Spinning Ball**

Engine pushed forward.



Flow pushed backward.

**Jet Engine**

# Newton's laws of Motion

- Newton's third law video

