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The Force Lecture

- Galileo Galilei: inventor of the telescope
    - Died in 1642
- Isaac Newton:
    - Born in 1643
- Reminder: ALL MOTION IS RELATIVE
- All moving frames of reference moving at a constant velocity

Newton's First Law of Motion: Law of Inertia

> "An object in motion will continue to move at that speed in that direction unless acted upon by an external force"
>
> $$\Sigma F = 0 \Leftrightarrow a = 0$$

- Galileo's Idea: An object will remain at rest or in uniform motion in a straight line unless acted on by an external force
    - Newton essentially copied this from Galileo
- Example Scenario: Ball on the floor of a bus moving at a constant velocity
    - If the ball is still on the floor of the bus, it means the bus is moving at a constant velocity
    - If the ball starts moving, that means the bus is accelerating, or going in a different direction
        - Nothing is pushing the ball, but the ball remains in a state of constant velocity as the environment around it (the bus) accelerates.
- Inertial Frame of Reference: studying physics in a **non-accelerating** frame of reference

Newton's Second Law of Motion: Law of Acceleration

> "A force will accelerate a mass"
>
> $$\Sigma F = ma$$

Newton's Third Law of Motion: Law of Action & Reaction

> "For every action (force) in nature there is an equal and opposite reaction"
>
> $$F_{A\ on\ B} = -F_{B\ on\ A}$$

Common Misconceptions About Motion:

- Misconception: "If an object is moving, there must be a force acting on it."
    - Reality: According to Newton's first law, an object in motion will continue moving at a constant velocity unless acted upon by an external force. If no net force is acting on it (such as friction or air resistance), it will keep moving indefinitely. People often confuse constant velocity with the need for a continuous force.

- Misconception: "If an object is accelerating, there must be an increasing force."
    - Reality: The force does not have to increase for constant acceleration. For example, if an object is sliding down frictionless incline, it accelerates at a constant rate under the constant force of gravity

- Misconception: "Force and acceleration are always in the same direction as motion."
    - Reality: Force and acceleration determine the change in motion, For instance, if you throw a ball upward, the force of gravity, (downward) is opposite to the motion (upward), and this causes the ball to slow down, stop, and eventually fall.

- Misconception: "If two objects exert equal and opposite forces on each other, they cancel out, so no motion occurs."
    - Reality: Newton's third law states that forces come in equal and opposite pairs, but these forces act on different objects, not on the same object, so they don't cancel each other out. For example, when you push on a wall, the wall pushes back on you with equal force, but if one of you is free to move (like you on a skateboard), you'll experience motion

- Misconception: "The bigger object exerts a larger force on the smaller object."
    - Reality: According to Newton's third law, the forces are always equal and opposite. A truck and a car collide with the same force on each other, but the car experiences greater acceleration due to its smaller mass, which often gives the impression of unequal forces.

- Misconception: "Weight and mass are the same thing."

- Reality: Mass is the amount of matter in an object, while weight is the force of gravity acting on that mass. Weight can change depending on the gravitational field, but mass remains constant.