

## Common Student Ideas about Forces and Motion

Common Student Idea(s)	Scientific Explanation
1. If an object is moving, a force must be acting on it. Motion implies force.	Forces cause changes in motion. If an object is moving, no force is necessary to keep it moving, but a force is needed to make it stop moving or change direction.
2. Forces get things going but don't stop things. An object stops because it runs out of force or energy.	This misconception stems from common, everyday student observations, such as seeing an object coming to a stop after it has been pushed across the floor (and not seeing friction as a force acting on the object). Objects don't <i>contain</i> force, so they can't run out of force. All forces are interactions (a push or pull, a touch or tug) between two objects. A foot might interact with a soccer ball to get it moving in a certain direction. The grass the ball rolls over and the air it moves through both exert forces that push the ball in the opposite direction of the kick, causing the ball to slow down and eventually stop.
3. All objects slow down and eventually stop.	If no forces are acting on a moving object, its motion will never change or stop. In outer space, for example, no air resistance or friction is present to act on an object, so the object will keep moving in the same direction or in a straight line indefinitely. This is why a rocket in outer space needs only a short burst from the thruster to experience a change in speed or direction. Objects we're more familiar with on Earth always experience the force of some material—air, water, or a surface—pushing in the opposite direction of their motion. For that reason, objects on Earth slow down and eventually stop.
4. Force transfers from one object to another object.	Force isn't a thing that can transfer from one place or object to another. It describes an <i>interaction</i> between two objects. Students often confuse force with energy. Energy is always conserved, meaning that it can transfer from one place or object to another and can change from one form to another (such as motion, heat, light, or sound).
5. A force has to keep being applied for an object to stay in motion.	On Earth, friction is a force that resists or pushes in the opposite direction of an object's motion. Friction causes objects to slow down and stop unless additional force (pushing or pulling) is applied. But in a world without friction, such as outer space, a constant force doesn't result in constant motion; rather, it causes an increase in an object's speed. So an object in motion will continue in motion forever. This is difficult for students to understand because of their everyday experiences with friction on Earth.
6. People have the power to move things, so objects	Some students believe that inert objects can alter another object's motion, such as a wall stopping a ball thrown at it, but

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move only when people push or pull them.	they can't exert a force. However, any two objects that interact through direct or indirect contact (such as gravity or magnetism) exert force on each other. A sandwich sitting on a plate exerts a downward force on the plate, while the plate exerts an equal upward force on the sandwich. Both objects are exerting a force on each other even though neither object is a person.
7. If an object is at rest, no forces are pushing or pulling it.	Students often believe that objects at rest are in a natural state in which no forces are acting on them. They may think that air pressure, gravity, or an intervening object (like a table) keeps another object stationary. However, an object at rest usually has many forces acting on it, including the downward forces of gravity and air pressure and the upward force of the surface the object is sitting on.
8. Inanimate or inert objects (like a table or chair) don't exert force.	Some students are hesitant to believe that passive objects can exert a force, but any object that touches (pushes, pulls, twists) another object exerts a force on it.