



Science

Rockets in Motion

STEP 1

LEARN (15 minutes)

Objectives

- Students will explain Newton's First Law of Motion.
- To understand how Newton's First Law of Motion works, students will make and launch a model rocket.
- Students will describe how Newton's First Law of Motion applies to the launch of a model rocket.

Materials

1. Firestreak SST™ Rocket Lab Pack™ (24 pack) - 1 or more
2. Rocket Engine Lab Pack™ (24 pack) - 1 or more
3. Electron Beam® Launch Controller - 1 or more
4. Porta-Pad® II Launch Pad - 1 or more

Time

One class session

Background

Sir Isaac Newton

What is known about rocketry today can be traced back to the time of Sir Isaac Newton (1642-1727). Newton described the motion of objects falling to the Earth in his book *Philosophiae Naturalis Principia Mathematica* where he outlined three laws of motion. Although Newton was merely describing principles of nature, Newton's Laws apply to the physics of rocketry. His laws are simple statements regarding the physics governing motion and can be used to provide precise explanations of rocket flight.

Newton's First Law of Motion

Objects at rest will stay at rest and objects in motion will stay in motion in a straight line unless acted upon by an unbalanced force.

NATIONAL STANDARD

Standard B
Physical Science

Standard 10
Understands forces and motion

Benchmark 4
Understands effects of balanced and unbalanced forces on an object's motion

Benchmark 5
Knows that an object that is not being subjected to a force will continue to move at a constant speed and in a straight line



During a model rocket flight, forces become balanced and unbalanced all the time. A rocket on the launch pad is in a state of rest. It is balanced all the time. It is balanced because the surface of the pad pushes the rocket up while the force of gravity tries to pull it down. An unbalanced force must be exerted for a rocket to lift off from a launch pad. A rocket blasting off the launch pad changes from a state of rest to a state of motion. It will keep moving in a straight line at the same speed unless it is acted upon by an unbalanced force (drag and gravity).

There are four forces (drag, gravity, thrust, lift) that act on all objects that travel through the air. Drag and gravity are the two unbalanced forces that act on a model rocket. Drag is the resistance or frictional force between the surface of a moving object and air. Drag increases with speed. Gravity is the force pulling an object back to the surface of the Earth. The amount of this force is proportional to the mass of the object.

When the rocket lifts off the launch pad it is guided by the launch rod in a straight line upward. The unbalanced forces (drag and gravity) cause it to arch and fall to the ground. The Firestreak SST™ has a streamer that is activated so the rocket will be recovered safely to be launched again.

The Rest of the Story

Newton's First Law of Motion isn't a quantifiable law. There are no numbers to prove it accurate or not. It is simply a statement of truth or untruth. If the rocket stays on the pad before it is launched, and the force from the engine changes that, it is proved true.

KEY WORDS

balanced force
drag
First Law of Motion
forces
frictional force
gravity
motion
physics
resistance
Sir Isaac Newton
unbalanced force

Activity

1. Assemble and display a teacher's demonstration Firestreak SST™ rocket on an Estes Porta-Pad® II Launch Pad in a prominent place in your classroom. Discuss Sir Isaac Newton and how his First Law of Motion explains how a rocket on a launch pad can change from a state of rest (Firestreak SST™ on the launch pad) to a state of motion in a straight line until affected by an unbalanced force (drag and gravity).
2. Using a textbook, demonstrate Newton's First Law of Motion. The book sitting on a desk is an object at rest just like the rocket on the launch pad. As long as no unbalanced force acts on the book to move it, the book will stay where it is and so will the rocket on the pad. Direct students to put a text book on their desk and observe an object rest. Ask students if they can think



of a way to move the book (unbalanced force). Any force applied to the book in great enough quantity will cause the book to move. Forces great enough to move it could include picking up the book, pushing it along the desk with a finger or hitting the book hard enough to knock it off the desk. Ask students to explain what unbalanced force will move the rocket off the launch pad.

2 STEP BUILD (15 minutes)

Activity

1. To demonstrate, observe and validate Newton's First Law of Motion, students will make and launch a model rocket.
2. Build the Firestreak SST™ together with students, using step-by-step procedures. This is a snap together rocket that needs no gluing or cutting.

3 STEP LAUNCH (30 minutes)

Activity

1. Assign and post launch jobs for students. Launch jobs are in the *Estes Educator Guide for Teachers & Youth Group Leaders*.
2. Prepare rockets for launching in your classroom before going outside to launch. Follow the Engine Preparation steps located in the Firestreak SST™ Instructions.
3. Launch rockets outside at a soccer field, football field, baseball field, green grass area or blacktop area.

Wrap Up - Touch Down & Recovery

1. Students will write a detailed observation on Newton's First Law of Motion and model rockets. This works well as a journal entry in a science notebook.
2. Students will discuss other examples to show Newton's First Law of Motion.

Extensions

1. Students can use a ball to demonstrate Newton's First Law of Motion. When they hold a ball in their hand without moving it, the ball is at rest. As the



ball is held there, it is being acted upon by forces. The force of gravity is pulling the ball downward. Their hands are pushing against the ball to hold it up. The forces acting on the ball are balanced. When the ball stays at rest with no unbalanced forces to act on it is called static inertia. When students let the ball go or move their hand upward, the ball changes from a state of rest acted upon by balanced forces to a state of motion acted upon by unbalanced forces. An object at rest takes an unbalanced force to make it move. Once the object is in motion, it will continue in motion in a straight line until an unbalanced force stops it or changes its direction or speed.

2. There are many examples of Newton's First Law in sports. Describe a sport that has an object at rest, is set into motion and stays in motion until it is stopped. What is this object? Students will write or orally explain the description of this sport and its object as a sportscaster.

Evaluation/Assessment

- Students will use a textbook to demonstrate Newton's First Law of Motion.
- Students will assemble and launch the Firesteak SST™ to observe how Newton's first law applies to model rockets.
- Students will write a detailed observation on Newton's First Law of Motion and model rockets.

References

- *Estes Educator™ - Guide for Teachers and Youth Group Leaders*
- *Estes Educator™ - Newton's Laws of Motion and Model Rocketry*
- *Estes Educator™ Website - www.esteseducator.com*