SYNOPSIS:

Sir Isaac Newton defined the Laws of Motion that apply to all moving objects. These laws say that when the forces acting on a moving body are balanced, the body will travel at a constant speed. But, if these forces become unbalanced, the object will change its speed.

This program looks at the forces that act on racing bikes, skydivers, airplanes, and racing cars. We learn about the force of gravity, friction, and air resistance, and we also see how gravity is countered by lift to make airplanes fly.

CURRICULUM UNITS:

Engineering
General Science
Physics

CAREER OPPORTUNITIES:

Aircraft Designer
Athlete
Engineer
Pilot

PROGRAM OVERVIEW:

Newton's Laws of Motion date back to the 1600s, and they are still valid. The automobile, motorcycle, and modern day jet are examples of inventions that apply to Newton's laws. The program opens with the examination of the forces acting on a skydiver. The force of gravity causes the jumper to accelerate at a rate of nine and three-quarters kilometers per second. But the faster the diver falls, the stronger is the air resistance that slows him down. When the force of gravity is balanced by drag, the skydiver falls at a constant rate. The terminal velocity is about 193 kilometers per hour. However, when the ripcord is pulled and the parachute opens, there is a great increase in air resistance which slows the diver's fall to a safe rate of about five meters per second.

While air resistance is very useful for a skydiver, a bicyclist depends on drag to slow a bike down. Although a constant force applied to the pedals produces forward motion, the bike can accelerate only until the forces produced by friction and air resistance equal the pedal force. At that point, the bike maintains a constant speed. To go faster, the cyclist has to pedal faster, causing the force of acceleration to be greater than the force of airresistance.

Although man's early attempts to fly were a failure, today we know how forces are applied to the wing to produce flight. The simple experiment of blowing air over a slip of paper shows us how air moving over an airfoil produces lift. In a wind tunnel, we see that the shape of the wing determines whether lift is produced. When a wing with a symmetrical shape is placed in the tunnel, nothing happens. The wing produces no lift. But when an asymmetrically shaped wing is tested, we see that it rises up. Lift is created because of the difference in air pressure between the top and the bottom wing.

Since Newton first defined how forces act on moving bodies, scientists and engineers have been putting that knowledge to work creating tools and machines that improve our lives. By using these forces we are able to travel on land, on the water, in the air, and even into space.

ISSUES AND CRITICAL THINKING:

After viewing the program, ask your students the following:
What is air resistance?
What happens when opposing forces are in balance?
What is friction?
Why don't skydivers crash into the earth?
How does an airplane wing produce lift?

Discuss the effects of streamlining on cars and airplanes
Discuss some of the things that engineers do to reduce friction.
Discuss the forces at work on watercraft.
Talk about the design of airplane wings and how they have changed since the Wright Brothers' first airplane took off.
Have students research wing structures, then design paper airplanes and have a contest to see which design gets the most lift.
Have students demonstrate lift by blowing across a piece of paper.

GLOSSARY:

ACCELERATE- to increase velocity or speed.
AIRFOIL- a surface designed to provide lift or thrust when in motion through the air.
AIR RESISTANCE- the drag experienced by a body passing through air.
ASYMMETRICAL- not having a similar form on either side of a dividing line or plane.
DECELERATE- to decrease velocity or speed.
DRAG- the force opposing motion encountered by a body moving.
FORCE- any external agent that causes a change in the motion of a free body.
FRICTION- a force that opposes the relative motion of two surfaces that are in contact with one another.
MOMENTUM- the force which a moving body has because of its weight and motion.
SYMMETRICAL- having similar form on wither side of a dividing line or plane.
TERMINAL VELOCITY- the constant velocity of a falling body.
VACUUM- a totally empty space.
WIND TUNNEL- apparatus in which a high speed movement of air or other gas is generate, often by a fan.

TMW *MEDIA GROUP*
2321 Abbot Kinney Blvd., Venice, CA 90291
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