Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2003 Volume IV: Physics in Everyday Life

Physics and Me

Curriculum Unit 03.04.06
by Mary Elizabeth Jones

This unit is designed to be taught to 6th grade inner city students. The age level is 10 - 13. A large number of our students come to 6th grade science class having no prior exposure to physical science. Most have never completed a science fair project. This will be a hands-on unit that will show students how science is present in their everyday life. Students will also learn how ordinary household products can be used to conduct experiments.

Our sixth grade science curriculum is an integrated curriculum that includes physical science. This unit will focus on force and motion. The theme of the unit is "scale." The narrative will examine four areas of force and motion: motion, gravity, measuring motion and forces in pairs. Objectives will be stated for each area. The hands-on section will include examples of activities that support each objective.

Objectives (motion)

- Collect, record and interpret data about movement
- Investigate how distance and direction can describe motion
- Identify how the variables of distance and time are used to determine speed
- Measure correctly using the metric system
- Observe and explore the changes in speed of a moving object
- Predict how the motion of an object can affect a second object
- Investigate acceleration and deceleration

Objectives (getting a grip on gravity)

- Investigate gravity
- Infer how mass affects the force of gravity
- Analyze how the force of gravity changes as distance increases
- Predict, observe and record the rate at which objects with different masses fall
- Interpret data on a graph to determine information about time and distance of a falling object
- Investigate how shape affects an object's falling rate
- Observe and infer the use of air resistance to slow an object's falling rate

Objectives (measuring motion)

- Observe and predict movement of objects
- Experiment with the use of safety devices and infer which devices are most effective
- Explain Newton's first law and apply it to everyday life
- Infer relationships between strength and direction of forces and the behavior of objects.
- Explain how Newton's second law is applied to everyday life.
- Observe how much friction different surfaces have
- Observe how wheels reduce friction
- Investigate helpful and harmful effects of friction

Objectives (forces in pairs)

- Observe how momentum is transferred from one object to another
- Investigate how mass and velocity affects momentum
- Observe the forces that affect bouncing balls

- Experiment with action and reaction forces
- Describe Newton's Third Law of Motion
- Observe the effects of action-reaction forces
- Collect data about the development of the wheel
- Investigate how action-reaction forces propel swimmers.

Motion

The terms up, down, backward, forward, left and right all describe directions in which an object can move. To determine how fast an object is moving in any direction you need a unit of measure. Today the most popular unit of measurement in the developed world (excluding the U.S.) is the Metric System. This unit of measurement is a base 10 unit, which makes it easy to go from one unit to another. Throughout history, many different systems of measurement have been developed. Until the late 18th century systems of measurement were very confusing. Every nation and sometimes every town or village had its own unique system of measurement. If you moved from one country to another you had to learn a whole new system of measurement. Also, a unit of measurement did not always mean the same thing to everyone within the same country.

> To solve this problem, in the 1790's the French National Assembly ordered the development of a new system of measurement, which has come to be known as the Metric System. As previously stated, this system is based on the number 10 and multiples 0f 10. The units of measure in the metric system includes the meter, kilometer, centimeter, liter, gram and kilogram. These units are based on standards that do not vary. So regardless of whether you are in France, Mexico, or Japan, if you are given directions to go south for 10 km, you can be sure that you know exactly how far to move. [1]
> Sir Isaac Newton's First Law of motion deals with the nature of motion. Prior to his first Law of Motion- which states that objects at rest tend to stay at rest; objects in motion tend to stay in motion- scientists thought that a constant force was needed to keep an object in motion It seemed obvious to them that if a force stopped acting on an object, the object would slow down and eventually stop. [2]

Inertia

The tendency of an object to remain at rest or to remain in motion is called inertia. We expect a rock to remain sitting at the top of a hill. Similarly, a ball rolling across a table top might be expected to continue rolling in the same direction; no force is needed to keep it in motion. A change in conditions could influence an object's motion. For example, suppose that the rock starts falling down the hill. What change in condition caused the rock to start falling down the hill? Further suppose that a rolling ball speeds up, slows down or changes directions. Some type of force was applied in each instance to cause a change of the motion of the objects.

> Many examples of inertia can be found in everyday life. Finding examples of inertia would be a good activity for students. One example: Suppose you are standing in the aisle of a bus that is traveling at a constant speed of 40km/h(25 mph). What would happen if the driver suddenly slammed on the brakes? Chances are you'd fall forward as the bus comes to a stop. This would happen because your body has inertia while the bus is traveling forward. Your body is moving in the same direction and at the same speed as the bus. When the driver hits the brakes, the bus comes to a stop, but inertia keeps your body moving forward.

Force, Mass and Acceleration

Newton's Second Law of Motion states that an object begins to move, slows down, speeds up, comes to a stop, or changes direction only when some force acts on the object. Newton's Second Law of Motion states that an object begins to move, speed up, slows down, comes to a stop, or changes direction only when some force acts on the object. For example, a rock on top of a hill might begin rolling down the hill if someone exerted a force on it. Once started down the hill, the rock would continue to gain speed because of the force of gravity acting on it. The rock would continue moving along a straight course down the hill until some new force acted on it. This new force could change its direction, slow it down, speed it up or stop it.

> Consider a ball rolling across a billiard table. The ball might speed up, slow down or change direction. Why? The second law says that such a change occurs when a force acts on the ball. What might provide the necessary force on a billiard ball to change its motion? [3]
> Perhaps the billiard ball is hit by another ball from behind, from the front, or from the side. If contact with the ball is from behind, a pushing force changes the direction of the ball. If contact with the other ball is from the side or the front, a pushing force changes not only the speed of the ball but also the direction in which the ball is moving, Newton discovered a mathematical formula that shows how force causes a change in the speed or direction of an object.

The formula is Force = mass x acceleration. F = m x a. The units used in this formula are newtons (N) for force, kilograms (kg) for mass, and meters per second per second (m/s squared) for acceleration.

The Newton is a unit of force in the metric system. A Newton is defined as the force needed to accelerate a 1-kg object 1 meter per second per second. N = kg x m/s squared. The formula for force tells us many things about the way in which a force acts on an object. For example, suppose an object with a mass of 2 kg accelerates at 5 m/s squared. What force was needed to achieve this acceleration? To answer that question, first write the formula for Newton's second law. F = m x a. Then substitute the values you know for this question. m = 2 kg; a = 5 m/s squared. Finally, use the formula to find the unknown quantity-force.

F = m x a

F = 2 kg x 5 m/s squared

F = 10 kg x m/s squared

F = 10 N [4]

It would require a force of 10 N to make a 2 kg object accelerate at the rate 5 m/s squared.

Friction

Friction is a force that occurs between surfaces that are in contact with each other. Friction resists the motion of one surface over another. When a racecar is at rest on the track, it has no motion. There is no friction between the car's tires and the track. But when the driver steps on the accelerator, the car's tires begin to rotate. Friction begins to develop between the tires and the track beneath them.

The amount of reaction between two bodies depends on many factors but especially on the properties of each surface. Rough surfaces generally result in more friction than do smooth surfaces. Imagine sliding an ice cube across the frozen surface of a lake. Ice is usually very smooth, so there is little friction between the ice cube and the ice on the lake. The ice cube will slide a long way before coming to a rest. What would happen if you slid the ice cube across a rough surface?

Friction also varies with the kind of motion taking place. Objects that roll over a surface produce less friction than objects that slide. Ball bearings are small metal balls inserted between surfaces that rub against each other. There is much less friction with the ball bearings rolling between the surfaces than with the two surfaces rubbing directly against each other.

Friction in Sports

In many winter sports, participants want to reduce friction as much as possible. Downhill skiers often put wax on their skis. The wax reduces the friction between the skis and the snow, causing the skier's speed to increase.

> Although friction slows speed, it can be helpful. Walking is possible because friction prevents your feet from sliding over the ground. In some sports, players want to increase friction. A person who runs the 100 m dash wants the maximum friction between his or her feet and the running track.
> Sir Isaac Newton's Third Law of Motion states that for every action force there is an equal and opposite reaction force. For example, when you shoot a basketball, the ball pushes on you just as hard as you push on it. There are two important things to remember about Newton's third law:
> - forces always occur in pairs made up of an action force and a reaction force
> - the action force and the reaction force always act on different bodies [5]

Mass Matters

Imagine that you are attempting to shoot a basket and your friend is attempting to block your shot. Let's further suppose that she had pushed off the floor with a force exactly equal to the force you used to push off, but she has less mass (the amount of "stuff" in an object) than you. The third law explains that the reaction force of the floor would be equal to your friends action force. The reaction force however, would be acting on a smaller mass; according to Newton's second law, your friend would have a greater acceleration and go higher than you! According to Newton's third law your momentum is equal to your mass multiplied by your velocity. p = m x v.

How to Measure Speed

In addition to direction and distance, motion is also described by how fast an object is moving. There are two measurements needed to describe speed - distance and elapsed time. Speed is defined as the distance traveled in a given amount of time. If you are able to walk 4.8 km (3mi) in an hour, you are moving at a speed of 4.8 km/h (3mph).

Average Speed = Total Distance/Total Time

Average Speed = D(distance)/time

> The term velocity is used to describe speed and direction. Acceleration is used to describe the rate at which velocity changes. On a steep water slide your speed will change quickly; you will accelerate rapidly. On a water slide with a gentler slope your speed will not increase quickly;

therefore your acceleration will be less. Even when your speed is constant, you are accelerating if you change direction. An object accelerates if it speeds up, slows down (decelerates) or changes direction.
Acceleration = (speed 2 - speed 1)time.
Objects in motion in one direction usually slow down because of friction. This decrease in speed is sometimes called deceleration. Since any change in speed or direction is defined as acceleration, deceleration is negative acceleration. Many things can cause an object to decelerate. In a car, brakes are applied to cause the car to decelerate. Gravity can cause deceleration. A ball thrown upward begins to decelerate because of gravity and friction in the air. [6]

Gravity

The force that pulls objects toward Earth and the attractive forces exerted by a body on an object or another object or bodies is called gravity. Gravity causes a ball to fall to the ground after it is thrown into the air. Gravity keeps the Earth in orbit around the sun.

Gravity is a force of attraction between all matter. It is the weakest known force in nature, but it still manages to hold galaxies and the solar system together. The ancient Greek philosophers thought that the motions of the stars and the planets were totally unrelated to events on the Earth. The heavens were the realm of the Gods, where everything existed in perfection. One of these philosophers was called Aristotle. He thought that the stars and planets followed a so-called "natural" motion, and that the force that made them move made contact between them. [7]

Gravity can be measured by using a device called a gravimeter. A metal ball is suspended from a very sensitive coil. Wherever gravity is stronger, it pulls more on the ball, thus stretching the springs. A pointer attached to the spring shows the increase in gravity. Scientists measure gravity because many things depend on it. For example, when launching satellites into space, scientist must know the strength of Earth's gravity so they can determine how fast a satellite must travel to escape the planet's gravity or to remain in orbit around a planet. [8]

The strength of gravity is not the same at all places on Earth. Three things determine the strength of gravity at any given place:

- The distance from the center of Earth

- The spin of the Earth

- The Nearby sources of gravity variations, such as mountains or underground caverns

Consider the distance from the center of Earth. A house at the seashore is at a lower elevation than one in the mountains, which means that it is closer to the center of Earth. The pull of gravity is stronger at the seashore house than it is at the mountain house.

The Earth's spin also produces an effect that can appear to reduce the strength if gravity (though it does not). Known as the centrifugal effect, it is caused by the tendency of a body to move in a straight line unless acted upon by a force trying to change its path. The tendency of a body at the surface of the spinning Earth is to move in a straight line. At the same time, the Earth's gravitational force is pulling the body toward the center of the planet. Part of the Earth's gravitational force is reduced in changing the body's path from a straight line in space into the circle it follows as the earth rotates. This serves to lessen body weight. [8]

Variations in gravity may also be caused by nearby concentrations of mass such as mountain ranges or underground deposits of material. The pull of gravity is greater near large or dense concentrations of mass or deposits of dense materials and is weaker near underground caverns or deposits of light materials, such as oil. Looking for gravity variations with a gravimeter is an important way of searching for deposits of oil or minerals.

Picture This!

Your fuel gauge is below empty. Both engines of the cargo plane you're piloting have sputtered and gone silent. The nose of the plane points down and you begin a terrifying dive toward Earth. In a panic, you make your way out of the cockpit and into the back of the plane where your parachute is stored. A 2,000-kilogram crate is blocking your path. What do you do? No problem! Since the weight of the crate on the plane's floor is actually zero, you would not have to lift it in opposition to gravity or slide it in opposition to its friction with the floor. The force required to overcome inertia of the crate would be small enough to allow you to move it by pushing hard with your foot braced against a wall. How is this so?

Let's look at the crate under normal flight conditions. The weight of the crate pushes down against the floor of the plane. What you might realize is that the floor, which is supported by the airplane's wings and the forces that keep the plane aloft, also pushes up against the crate. It pushes up with a force equal to the weight of the crate, so inside the plane, you're aware of how heavy the crate is.

When your plane goes into free-fall, the crate is still pulled by gravity just as during a normal flight; but the floor is no longer pushing up on the crate, since it and the crate are now falling freely toward the Earth. Gravity is still acting on both the crate and the plane. But inside the airplane, without the upward push from the floor, the crate now seems to be weightless. Both the crate and the pilot will float freely inside the airplane until something like Earth stops them.

Astronauts in orbit experience weightlessness just like objects in the falling aircraft. A space shuttle in orbit is actually in a state of free-fall as it travels around Earth. Hard to imagine? Picture yourself in a small spaceship a few meters above the ground. Now face the setting sun and go in a straight line for about 100 kilometers (62 miles). If you in a perfectly straight line, you should notice that Earth is curving away from you. A shuttle in orbit goes so fast that Earth curves "away" just as much as the shuttle falls. The shuttle falls, but never hits the ground!

Questions to Ponder!

Falling appears to be different for different objects. For instance, which falls faster, a pen or a piece of paper? Why might one fall faster than the other? In real life, when do you experience something like free-fall? For how long? Which falls faster, a one-ton plane or a ten-ton plane? [10]

Try This! Elevator Magic.

You have probably noticed an empty feeling in your stomach when an elevator starts its descent. That feeling is a result of a decrease of pressure against your feet and a corresponding change in the tightness of the muscles in your abdomen. You feel less pressure, because the floor of the elevator is going out from under you momentarily. Find out how you could measure this feeling in more concrete terms, and learn which elevator has the fastest acceleration.

Materials

- bathroom scale (not digital)
- pencil
- Science Notebook

Procedure

1. Divide the class into small groups of two or three. Choose some nearby elevators.
2. Create a data table (see below) for each of the elevators you are going to test.
3. Record each of your weights standing still
4. Take the scale into the first elevator. One student at a time should get the maximum reading on the scale when the elevator starts its ascent and the minimum reading when the elevator starts it descent. Students must have a quick eye and be prepared for approximate results.
5. Have each student record his or her own data for each elevator tried.
6. Follow steps 2 through 5 for each elevator.

Data Table

1. What happens to your weight when you begin your ascent? How long does the change last?

2. Does a person's initial weight have anything to do with the amount of change recorded?
3. What kind of change would occur if the elevator cable were to snap? This by the way could never happen! [11]

Mass and Weight

The term mass is used to describe the amount of "stuff" in an object. The "stuff" is matter. Matter is anything that has mass and takes up space. The mass of an object does not change for any reason. Suppose you had 50 golf balls in a wagon. The mass of the balls is equal to the amount of "stuff" in the balls. Someone told you that the mass of the balls would change if you moved them to a higher location. You are not sure. To test this theory you move the golf balls to the top floor of the tallest building you can find (30 Stories). Once on the 30th floor, you use your balance scale to check the mass of one of the balls-it has not changed!

> The metric unit used to measure mass is the gram. (Note: All measurements in this unit will be metric). The term weight is used to describe the measure of the force of gravity on an object. The same friend who told you that height affects mass also said it affects weight, so you took a scale along to the 30th floor. Prior to leaving the ground floor you weighed your golf balls. After reaching the 30th floor you weighed the balls again. The weight has changed slightly. Can this be true? You know you are weighing all of the balls but the weight is not the same as it was on the ground floor. Does this mean that your friend finally got something right? Yes it does! The gravitational force exerted on the balls is greater when the objects are closer to Earth's surface.
> It is very important to distinguish between mass and weight. Mass is the amount of matter in a body or object. The mass of a body remains the same no matter where the body may be. Weight is a measure of the pull of gravity on a body. Therefore the weight if a body can vary depending upon the pull of gravity on it. The moon has less mass than the Earth, so its gravitational pull is less. [12]

Forces in Pairs

Some objects at rest require little force to move them. Other objects need a great deal of force to move. What do you know about the forces that objects exert on one another?

Imagine that you are an astronaut making a space walk outside your space station. In your excitement about your walk, you lose track of time and use up all the fuel in your jet pack. How do you get back to your station? Your jet pack is empty, but it can still get you back to your station if you throw it away. To understand how, you need to know Newton's Third Law of Motion, which states that if one object exerts a force on another object, then the second object exerts a force of equal strength in the opposite direction on the first object.

Newton realized that forces are not "one sided." Whenever one object exerts a force on a second object, the second object exerts a force back on the first object. The force exerted by the second object is equal in strength and opposite in direction to the first force. Newton called one force the "action" and the other force the "reaction" force.

You may already be familiar with examples of Newton's Third Law of Motion. Perhaps you have watched figure skaters and have seen one skater push on the other. As a result, both skaters move. The skater who pushed is pushed back with an equal force, but in the opposite direction.

The speeds with which the two skaters move depends on their masses. If they have the same mass, they will move at the same rate of speed. If one skater has a greater mass than the other, they will move backward more slowly. Although the action and reaction forces will be equal and opposite, the same force acting on a greater mass results in a smaller acceleration. (This is Newton's Second Law of Motion).

Now can you figure out how to return from your space walk? In order to get a push back to the space station, you need to push on some object. You can remove your empty jet pack and push it away from you. In return, your jet pack will exert an equal force on you, sending you back to the safety of the space station. [13]

Newton's third law is in action all around you. When you walk, you push the ground with your feet. The ground pushes back on your feet with an equal and opposite force. You go forward when you walk because the ground is pushing you! A bird flies forward by exerting a force on the air with its wings. The air pushes back on the wings with an equal force that propels the bird to fly.

One might wonder why action and reaction forces do not cancel each other. To answer this question, you have to consider the objects on which the forces are acting. When opposite and equal force is applied to one object, the forces cancel out. The object does not move. Newton's third law refers to forces on two different objects.

Momentum

When Newton presented his three laws of motion, he used two different words to describe moving objects. He used the word velocity, but he also wrote about something that he called the "quantity of motion." Today we call it momentum. The momentum of an object is the product of its mass and velocity.

Momentum = Mass X Velocity

What is the unit of measurement for momentum? Since mass is measured in kilograms and velocity is measured in meters per second, the unit for momentum is kilogram-meters per second (kg x m/s). Like velocity and acceleration, momentum is described by its direction as well as its quantity. The momentum of an object is in the same direction as its velocity.

The more momentum an object has, the harder it is to stop. You can catch a baseball moving at 20 m/s, for example, but you cannot stop a car moving at the same speed. Why does the car have more momentum than the ball? The car has more momentum because it has more mass.

A high velocity can also produce a large momentum, even when mass is small. A bullet shot from a rifle, for example, has a large momentum. Even thought it has a small mass, it travels at a high speed.

Conservation of Momentum

You know that if someone bumps into you from behind, you gain momentum in the forward direction. Momentum is useful for understanding what happens when an object collides with another object. When two objects collide, in the absence of friction, momentum is not lost. This fact is called the law of conservation of momentum. The Law of Conservation of Momentum states that the total momentum of the objects that interact does not change. The quantity of momentum is the same before an after they react. The total momentum of any group of objects remains the same unless outside forces act on the objects. Friction is an example of an outside force.

Try This! Colliding Cars.

Momentum is always conserved- even by toys!

1. Find two nearly identical toy cars that roll easily
2. Make two loops out of masking tape (sticky side out). Put one loop on the front of one of the cars and the other loop on the back of the other car.
3. Place the care that has tape on the back on the floor. Gently roll the other car into the back of the stationary car. Was momentum conserved? How do you know?

Predict what will happen if you put masking tape on the fronts of both cars and roll them at each other with equal speed. Will momentum be conserved in this case? Test your prediction.

Before you hear the details of this law, you should know that the word conservation means something different in physical science than in everyday usage. In everyday usage, conservation means saving resources. You might conserve water or fuel for example. In physical science, the word conservation refers to conditions before and after an event. A quantity that is conserved is the same after an event as it was before the event.

Lesson Plans

Lesson Plan 1

Purpose: To determine how fast an object is moving using distance traveled and the time required.

Objectives:

- Measure correctly using the metric system
- Identify how the variables of distance and time are used to determine speed

Materials:

metric tape measure
chalk
stopwatch
3 marbles
pencil
science notebook

Procedure:

1. In a gym or hallway of your school, use a metric tape measure to identify a distance 25 m from a wall. With chalk, mark a line at that point on the floor.
2. Kneel 2 m behind the chalk line. While your partner holds a stopwatch, roll a marble at the wall. When the marble crosses the chalk line, your partner should start the stopwatch. When the marble hits the wall, your partner should stop timing.
3. Roll a second and a third marble. Try to roll each of the three marbles at the same speed.
4. Predict how elapsed time will vary as the speed of the marble is changed. Record your prediction. Then repeat steps 2 and 3, this time trying to roll the marbles at a consistently slower speed than the first three trials.
5. Repeat steps 2 and 3, this time trying to roll each of the three marbles at a consistently faster speed.

6. For each of the trials, calculate the speed by dividing the distance the marble had to roll (25 m) by the time it took for the marble to hit the wall. Record the speed for each trial in meters per second (m/s).

Note to Teacher: This information should be recorded in the student's science notebook.

Suggested headings:

Trial Number________Distance of Roll________Elasped Time________Speed (Distance/Time

Assessment:

- Students should be able to predict that elapsed time will vary as marble's speed changed.
- Students should be able to accurately measure time and distance.
- Students should be able to accurately record data.
- Students should be able to use numbers correctly to calculate the marble's speed by dividing distance by time.

Lesson Plan 2.

Purpose: To determine if all objects fall at the same rate.

Objectives:

- Predict, observe and record the rate at which objects of different masses fall.
- Interpret data on a graph to determine information about time and distance for a falling object.

Materials

heavy ball and a light ball
spring scale and mesh bag

science notebook

Procedure:

1. Using a spring scale and mesh bag, weigh each ball and record each value in your science notebook. Place both balls on the edge of a table or cabinet.
2. Predict which ball will hit the ground first if they both roll off the table together. Try it.
3. Students should record your observations in your Science Notebook. Repeat the activity several times.

Assessment:

- Student predictions about which ball would hit the ground first should be reasonable.
- Students should be able to interpret data to infer if objects fall at the same rate.

Lesson Plan 3

Purpose: To help students understand Newton's theory of Action and Reaction.

Objectives:

- Construct and build a rocket
- Identify the steps of Newton's Law of Action-Reaction

Materials:

balloons - long, thin type
string - 3 meters (10 feet) long
straws
tape
markers
scissors

Procedure:

1. Divide students into groups of 3 - 4. Students will work together to construct their rockets
2. Give each group a balloon, some tape, a drinking straw and a length of string at least 3 meters long.
3. Put the string through the straw and then tie the string at each end to something (like door knobs at opposite sides of the room). Make the string taut. This will be the guide track for the rocket.
4. Blow up the balloon. (each group will blow up their balloon to a different size). When the balloon is inflated hold the end closed and get a friend to tape the balloon to the straw so that the end of the balloon is pointed in the same direction as one of the ends of the straw.
5. Back your balloon rocket up so that the balloon end is close to one of the guide track string.
6. Launch your rocket by letting go of the end of the balloon. The air escaping out the end of the balloon gives the rocket a forward motion down the string.
7. Students will record what they observed about their rocket in their Science Notebook.

Assessment:

- Students will be able to relate their observations to those of Newton's Law Third Law of Motion.
- Students should determine that the amount of air in the balloon is relevant to the distance the rocket travels.
- Students should observe that when air was released it gave the rocket a forward thrust.14

Background Information

Rockets, jet engines and space ships are all driven forward by the same principle: every action has an equal and opposite reaction. This means pushing something out of the back of a rocket will give the rocket a forward push of the same force. In the case of rockets and jet engines, the material pushed out the back are the hot expanding gases from the burning of jet or rocket fuel.

Glossary

Acceleration - change in speed during a certain period of time.

Air Resistance - the force with which air opposes the movement of an object through it.

Deceleration - a decrease in speed. Deceleration is a type of acceleration also since it is a change in speed.

Force - a push or a pull on an object that causes a change in motion of the object

Friction - a force that occurs between surfaces that are in contact with each other.

Gravity - force on Earth which pulls all objects toward its center.

Inertia - the tendency of an object to remain at rest or to remain in motion.

Lift - the force that allows for upward motion on a flying object

Law of Conservation of Momentum - the principle that states that momentum can be transferred but cannot be lost.

Mass - the amount of matter in an object or a body.

Matter - anything that has mass and takes up space.

Metric System - a system of measure based on the number 10 and multiples of ten

Momentum - a property of a moving object calculated by multiplying the objects mass by its velocity.

Newton - (named for Sir Isaac Newton) a unit of measurement. It is the force need to accelerate a 1-kg object one meter per second per second.

Newton's First Law of Motion - objects at rest to remain at rest; objects in motion tend to stay in motion, traveling at a constant speed and in the same direction.

Newton's Second Law of Motion - an object begins to move, speeds up, slows down, comes to a stop, or changes direction only when some force acts on it.

Newton's Third law of Motion - for every action force there is an equal and opposite reaction force.

Pressure- the force exerted over a surface divided by the area.

Speed - the distance traveled divided by the length of time it took.

Velocity - the rate of change of displacement of a moving body with time.

Weight - the measure of the force of gravity on an object.

Resources

Teacher Resources

Mc Laughlin, Charles W. *Physical Science* . Glencoe/McGraw-Hill. 1999. Teacher wraparound edition includes fully integrated technology plus activities and mini projects covering all areas of Physical Science. Designed for grades 5 - 8.

Bain, Amy J. *Physical Sciences.* Teacher Ideas Press, Englewood CO. 2001. Offers curriculum resources and activities that are interdisciplinary. Includes bibliographic references and indexes.

Padilla, Michael J, Ioannis Miaoulis,and Martha Cyr. *Prentice Hall Science Explorer.* Prentice Hall, Needham, MA. 2002.

Rillero, Peter and Jeanette Allison *Creative Childhood Experiences in Mathematics and Science:* Projects, activity series and centers of early childhood. This is a practical handbook of activities projects and learning center for promoting active exploration of familiar environments Includes lesson plans and strategies for engaging students in math and science.

Peacock, Graham. Thomson Learning, New York, 1994. *Forces* . A book of physical science activities.

Gardner, Robert. Enslow Publishers, Springfield NJ, 2000 *530.078 Gi762sp* . Presents science projects and experiments related to sports; covering such topics as speed, Newton's Laws, force and motion, gravity, friction and collisions.

Student Resources

Schessinger Media, *All About Force and Gravity* VHS. Wynnewood, PA. 2002. Focuses on the idea that force can be either balanced or unbalanced. This program makes such concepts as friction and magnetism accessible to children through fun, and real life demonstrations.

Laithwaite, Eric R. *The Power Behind Movement.* London, New York: F. Watts, 1986. Examines the various kinds of forces that make movement possible and discusses their application to everyday life. Includes gravity, friction, inertia and more

White, Jack R. *The Hidden World of Forces.* New York: Dodd, Mead. 1987. Discusses some of the forces at work in the universe such as electromagnetism, gravitation surface tension and friction; includes illustrative experiments.

Ruchlis, Hyman, Drawings by Alice Hirsh. *Orbit: a picture story of force and motion* . New York, Harper, 1958. Discusses with illustrative examples the principles of Newton's Laws of Motion and Law of Gravitation.

Lefkowitz, R. J. Illustrated by June Goldborough. *Push! Pull! Stop! Go!* New York, Parents' Magazine Press, 1975. A book about forces and motion. A discussion of gravitational, centrifugal and magnetic forces; what they are and do and how they are applied.

Chase, Sara B. *Moving to Win: The Physics of Sports* , New York, Messner, 1977. Explains basic laws of motion as they apply to sports and the body movement of athletes.

Web Sites

www. einsteins-emporium.com. This site has a section on physics which includes force and motion, inertia, acceleration, gravity, fun stuff and science kits. This site is invaluable for finding resource materials, information and science kits.

www.discovery.com. This site offers a kinds of information relating to science students can build virtual roller coasters, travel in space with Discovery Kids, complete cross word puzzles and so much more. Teachers can find lesson plans, create crossword puzzles, get topics for Science Fair Projects, find products to purchase and so much more. This site is also in Spanish.

www. edugraphics.net. Offers a great selection of posters and pictures - Discover science, technology and more. A must site to visit.

www. askERIC. This site offers lesson plans, teacher guides, resource information many links and information on any subject you can imagine that related to science.

www.nsdl.org - This site has links to science, math, technology, engineering and much more. A must view site!

www.teachersource.com - A PBS site. Contains ideas and directions for how to build almost anything. Contains over 4,000 lesson plans and activities.

www.ericse.org/bookstore. This site contains information on science math and environmental education. Data base can be searched using keyword, title or author.

Endnotes

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1. William Badders, L.J.Bethel, V. Fu, D. Peck C. Summers, *Discovery Works* (Boston, MA: Houghton Mifflin, 2000) 58.

2. Badders, 59.

3. Badders, 65.

4. Badders, 67.

5. Badders, 89 - 91.

6. *The New Book of Knowledge* (Danbury, CT: Grolier, 1999) Volume 7.

7. www.curtin.edu.au/curtin/dept/phys-sci/gravity/history

8. *The New Book of Knowledge,* Volume 7.

9. *The New Book of Knowledge,* Volume 7.

10. www. Tpt.org/newtons/12/gravity.html

11. www.howthingswork.com

12. Badders, 32 - 34

13. Science Explorer, *Motion, Forces and Energy* (Needham, MA: Prentice Hall,2000) 64-65.

14. Note: Ideas for lesson plans came from askERIC, Discovery Works, and Glencoe Physical Science.