BOOMERS!

ELEMENTARY FIELDTRIP CURRICULUM

The Boomers! Elementary Curriculum was written by Dr. JP Keener and Ms. Elizabeth Moller under the supervision of Dr. JP Keener and Dr. Laura Saef: Broward County Schools 2008 (jpkeener@browardschools.com, laura.safe@browardschools.com).

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Teacher Guide

Frog Hopper Free-Fall

Activity 1

1. **Imagine every seat of the ride was filled. Each person riding weighed 25 kg. How much weight is on the ride?**
   a. There are 7 seats on the frog hopper. If each one is filled by a 25-kg passenger, the total weight would then be 25 kg x 7 = 175 kg
1. **Think about how the ride's car was lifted. Can you identify the simple machines involved?** Label them on your sketch (look carefully at the top of the ride).
   a. The most obvious simple machines involved are pulleys. Students may also identify a wheel and axel, gears, or screws that may either hold the ride together or that function in the lifting mechanism.
1. **How do the simple machines make the work of lifting many people easier?**
   a. Simple machines make work easier by decreasing the amount of force required to complete work.
1. **Think of some *complex machines* that you may see in the park. Record them in your data.**
   a. Remember: a compound machine is a combination of two or more simple machines. Examples may include ride motors, bumper boats, other machines, etc.

Activity 2

1. **How did your feelings compare on the way up and on the way down?**
   a. The teacher may wish to explain feelings of weight prior to riding the ride. As the rise ascends, students will feel the pushing of the seat against their bottoms. Students may comment that on the way up they felt heavy, or may have experienced "butterflies in their stomachs". On the way down, they should feel lighter, and the excitement of dropping. Their bodies are acclimated to rising, and the change in direction, causing the downward acceleration, will produce a feeling of weightlessness. Students may also comment that they can feel the safety bar better. The safety bar helps to pull them downward initially along with the ride since due to inertia, their bodies "want" to keep going up.

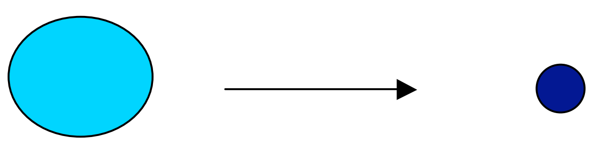
1. **At what point on the ride did you feel weightlessness?**
   a. Students should respond when they initially dropped from the top of the ride.
1. **At what times in the ride did you feel heavier?**
   a. Any time the student raises up, they will feel their weight on the seat as they are lifted.

1. **Why does it feel like the car seat is falling out from underneath you when you initially free-fall?**
    a. Due to inertia, the students' body is still experiencing an upward motion; when the car suddenly changes direction, they feel free-fall, due to the force of gravity.
1. **Why do you push down in your seat when the seat changes direction back upward?**
    a. Due to interia, since the student's body is experiencing downward motion, and the car suddenly changes direction. They experience the feeling of weight again due to the force of the chair pulling them upward counter to their body's wanting to continue in the downward motion.
1. **How did the riders' appearance compare on the way up and down?**
    a. Students will have many descriptions including facial expressions, descriptions of each other's hair standing as they fall, etc.
1. **What force acts on the car causing it to fall?**
    a. Gravity
1. **What provides the force to lift the car and its riders?**
    a. The simple machines working within the larger motor- such as the pulleys that help to life the car.

Bowling Alley Physics

Pre- Lab Marble Activity

1. **After the collision, which marble traveled farthest?**
    a. The collision involving the large marble striking the small marble will produce the largest distance. This is because the larger marble has more inertia, and strikes the smaller marble with the most force. The larger the force applied to an object, the more energy will be transferred therefore producing the most distance. The small marble will not move the larger marble as far due to the fact it has less inertia.



1. **Why do you think this happened?**
    a. Students should relate each of the interactions to inertia, force, and energy. They should understand that if an object has a large mass, it has more inertia, and therefore require more force to get it to move. Because more force is applied, the object will also have more energy, which can cause motion. Again, inertia applies in that once an object is in motion, it will "want" to stay in motion, and require a larger force to stop it. Larger things are harder to stop (require more force) than smaller things.
1. **Does mass have anything to do with how far the marbles traveled?**

a. Yes. The largest the mass striking the smallest will result in the most distance. The largest mass has the most energy, and provides the greatest force for the smallest marble.

1. **Did the hardness of your throw have a possible effect?**
   a. "Hardness of throw" is another way of saying "supply of force". A hard throw has a lot of force; a gentle lob does not supply much force. The greater the force, the more energy stored within the marble. The amount of force will have an effect on marbles.
1. **Complete the sentence**: The smaller marble travels farthest when struck with the most ______*massive*________ marble because the most massive marble has the greatest__*inertia*__________.

Activity 1: Rolling Ball Demo- Effects of friction

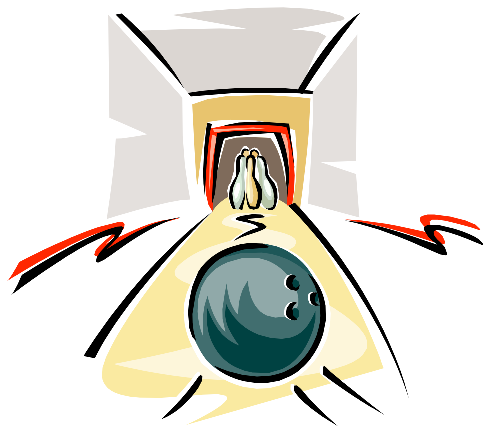
1. **On which surface did the ball seem to roll the farthest?**
   a. Wood, since it provides the least amount of friction.
1. **What difference did you notice between the bowling alley and the carpet?**
   a. The carpet prevents the ball from rolling very far when gently pushed. The carpet is rough, and provides more friction. The wood floor is smooth, and does not have as much frictional force as the carpet.
1. **Which of the two, carpet or wood, provides the least friction?**
   a. The wood, being the smoothest, provides the least amount of friction.
1. **Why are bowling alleys made of wood and not carpeted?**
   a. The wood allows the ball to roll quickly and farther than a carpeted surface. It would take too much force to roll a ball down a laneway made of carpet, because the ball will eventually stop rolling on a carpeted lane and never even make it to the pins.
1. **How do you think it would differ if the bowling alley were made of sand? Grass? How about ice?**
   a. Sand and grass would be difficult to roll the balls, in that they have a lot of friction: they are not smooth surfaces. Ice, being smooth and slippery, would be another alternative to the wood: both are smooth and provide little friction. This is why we slip on ice if we try to walk on it- it provides us with little friction.

Activity 2: Force

1. **On which throw did the ball travel the fastest?**
   a. Students should respond that the ball thrown quickly (the last of the rolls) traveled the fasted. When they try to roll it fast, it means they are supplying more force. A greater amount of force means they will be providing the ball with more energy. More energy overcomes inertia.
1. **On which throw did you apply the most force?**
   a. The last of the trials, where they threw the ball quickly, supplied the most force. Students may indicate a particular trial in which they found the greatest speed after examining their data.

1. **What can you conclude about how hard you throw the ball, and how fast it travels?**
    a. Students will be able to explain that the harder the ball is rolled, the faster it will travel. This is because they are providing the most force when the try to make it go farthest. The force applied to the ball provides the ball with energy.

Activity 3: Angles and Collisions



1. **Which method knocked down the most pins?**
    a. Students' responses will all vary, due to how hard they roll the ball. In general, the straight forceful throw will knock down the most pins.
1. **Which method knocked down the least?**
    a. The throw where they have to bounce the ball off the side-rails will knock down the least amount of pins, due to the fact that the ball looses energy to friction and due to the collisions (energy leaves the ball and it transferred to the rail each time it strikes). In these instances, the ball may not even be able to roll the total distance to reach the pins since it looses so much energy, or it simple does not have enough force to knock down the pins when it reaches them.
1. **What happened to the ball's speed after it bounced each time?**
    a. The ball's speed will decrease.
1. **What happened to the ball's energy after it bounced off of the sides?**
    a. As energy decreases, speed decreases. Some of the ball's energy is transferred to the side-rails each time it strikes them, causing the ball to loose energy, and therefore loose speed.

Laser Tag Challenge

Pre-Lab activity

1. **What color(s) were visible when you shone the flashlight through your hand?**
    a. Students will respond red, orange, or any variations when looking at the color of their skin. Some students may see bones or veins, which will appear dark blue to black.
1. **Did the light shine completely through your palm?**
    a. No. The light is not strong enough to shine completely through the palm. This is why we use X-rays, which are significantly stronger than visible light, to look at internal structures of our bodies.
1. **X-rays are also a form of radiation. How do you think they compare with a flashlight? Explain.**

a. They are much stronger, because they can actually penetrate deep into the body to illuminate bones and other internal structures. This is also why doctors place a heavy cloth over you when you have an X-ray- X-ray radiation is so strong it can be dangerous to certain parts of your body, so you receive some protection from the special cloth.

1. **What happened to your beam of light as your distance increased?**
   a. The light becomes more dispersed, or fuzzy. The initial beam is a focused circle at 1 meter; as distance increases, the light becomes more diffuse and the actual brightness decreases.
1. **How did the light on the wall appear as distance increased: was it a perfect circle?**
   a. No, it is not a perfect circle anymore. The beam is not strong enough to keep the light focused. It should appear as hazy or fuzzy as distance increases.

Activity 1: Graphing Questions

How many hits did Roberto make?_____**55**___

How many hits did Glenda make?_____**85**____

Wave Rider Swings

Activity 1: Swing Motion

1. **Describe the motion of the swings.**
   a. The swings move in a circular path around the center of the ride, but also go up and down. Students may also comment on the fact that when the swings are at rest, they hang vertically, but when the ride is in motion they hang at an angle.
1. **For the two times you observed the ride, were the number of times around the same?**
   a. The ride is a timed ride which allows for similar revolution results each time.
1. **How far does one travel in meters during the ride?**
   a. Use a walking meter to calculate prior to the students making their measurements, so that you have an approximate answer. Students answers should be in meters.
1. **Using this information, calculate your speed on the ride.**
   a. Students will need to know how long (in minutes) the ride lasted. Using the approximate results of the students' distance around measurements,

(you may choose to find the **average** of their distances), the formula to calculate speed is :

$$\text{Speed (in m/min)} = \frac{\text{Distance (m)}}{\text{Time (min)}}$$

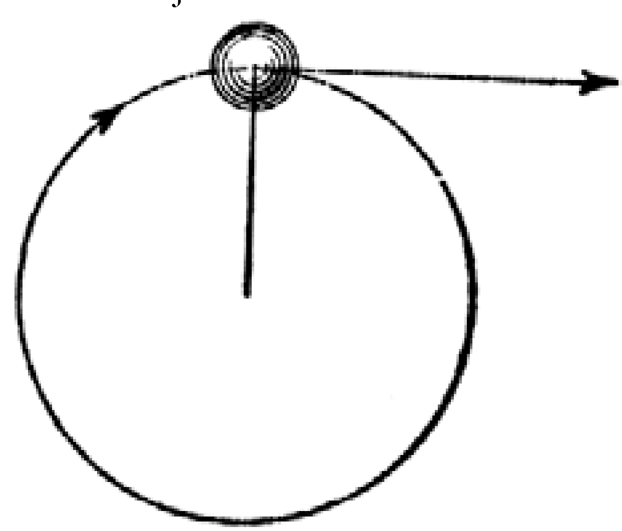
Activity 2: Mass & Swing Angle

1. Select a small student. He/she will ride.
1. Have students predict: which swing with hang out the most- the one with the small student, the one with the teacher (or chaperone) in it, or an empty chair? Write down the predictions.
1. The teacher (or another chaperone) and the small student will ride. Students will record their observations.
1. **Discuss results.**
    a. Students should observe that both the teacher and the small student hangs at exactly the same angle; even the empty chairs hang at the same angle. This is due to the circular motion, the seats being acted on by centripetal force. The chairs are also experiencing gravity. With the combination of the two forces, and the fact that the ride is in constant motion at a constant speed, the mass of the riders has no effect on swing angle.

Activity 3: Amusement Park Physics

1. **On their papers, they need to record their observations and explain why they think they felt the way they do.**

On the Wave Swinger, students are in constant circular motion. Objects in motion have inertia. The students' bodies want to continue in a straight line, but the force of the swing holds them in place. Because they are high off the ground, their bodies experience the downward pull of gravity. The students are also accelerating- they continually change direction which gives a thrilling feeling. The Wave Rider also goes up and down, which alternates the feeling of gravity (heaviness) and weightlessness.



STUDENT WORKPAGES

Frog-Hopper Free-Fall

Objectives:

- To be able to explain the feeling of **inertia**
- To understand the **forces** involved with falling objects
- To be able to explain **gravity** and **weight**
- To be able to identify **simple machines** at work
- To be able to describe **momentum** of falling objects

Standards:
SC.B.1.2.4: The student knows the many ways in which energy can be transformed from one type to another.
SC.B.1.2.5: The student knows that various forms of energy can be measured in ways that make it possible to determine the amount of energy being transformed.
SC.C.1.2.1: The student understands that the motion of an object can be described and measured.
SC.C.2.2.1: The student recognizes that forces of gravity, magnetism, and electricity operate simple machines.
SC.C.2.2.2: The student knows that an object may move in a straight line at a constant speed, speed up, slow down, or change direction dependent on the net force acting on the object.
SC.2.2.3: The student knows that the more massive an object is, the less effect a given force has.
SC.C.2.2.4: The student knows that the motion of an object is determined by the overall effect of all of the forces acting on an object.

Pre-Lab Experience Activity: Weightless Water Demo

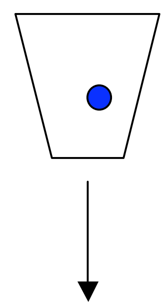
SC.C.2.2.2, SC.C.2.2.4

Introduction:

Have you ever knocked something off of your desk and it fell to the floor? Or how about tripping over something and falling down? And what happens when you toss your backpack on the floor? The one idea that each of these scenarios have in common is that things *fall downward.*

Why do things fall down? It's because of the force of gravity! Gravity holds things to the Earth. Without gravity, everything would float. Gravity is what gives us weight. We all have mass. Mass is a measurement of the amount of "stuff" we contain. The more "stuff" we have, the more *massive* we are. Let's compare you with an elephant. The elephant has more mass. He's bigger and contains more "stuff". Because of gravity, he weighs more. But, compare you to an ant, and you have more mass. You weigh more than an ant and take up more space than it does. More mass also means more <u>inertia</u>. Inertia is the tendency for things to keep on doing what they're already doing.

The only way we can overcome inertia is by applying a <u>force</u>. A force is a push or a pull. Large objects, such as elephants, require a great force to move them. They have a lot of inertia. Less massive objects, such as ants, require less force. They have less inertia. According to inertia, moving objects want to stay moving. Objects at rest want to stay at rest. The only way we can change that is with a force.



Pre-Lab Demo materials:
Plastic cup
Metric ruler
Pen (or other sharp object to poke a hole in the cup.)
Water

Procedure:
Warning: This activity is best demonstrated outside!

1. Obtain a plastic cup.
1. Poke a hole approximately 5 cm from the bottom of the cup, with a 1 cm diameter.
1. Hold your finger over the hole. Fill the cup to the rim with water.
1. Observe what happens to the water when you remove your finger. (It should flow out of the cup.)
1. Record your data.
1. Next, hold your finger over the hole, and fill the cup to the top once more.
1. Hold the cup at arm's length, and drop the cup.
1. Record all observations.

Does the water flow out of the cup on the way down to the ground?

No- it won't! Why? The cup *and* the water are falling at the **same speed**. They are both experiencing the same force. That is the force of **gravity**. The water is in free-fall with the cup. When the cup is at rest, gravity pulls the water out the hole. It makes the water fall downward. The cup is at rest and does not move. The cup has inertia. Gravity acts on the water. Gravity only acts on the cup when we apply a force. We apply force to the cup by picking it up and dropping it. By allowing the cup and the water to fall at the same time, the water acts like it is weightless.

Boomer's Activity 1: The Frog-Hopper and Simple Machines

SC.C.1.2.1, SC.C.2.2.1

Introduction:

A simple machine is a tool used to make work easier. Work is defined as force acting on an object to move it across a distance. Pushing, pulling, and lifting are forms of work. Force is also defined as a push or a pull on an object. To be defined as work though, our object has to move. If we push all day on a wall, and that wall stays where it is, I have done NO work. I may be tired. But, unless the wall moves no work has been done.

Movers do work when they lift furniture. Road workers do work when they dig new roads. Students do work when they raise the school's flag in the morning. Sometimes movers use a ramp to slide heavy furniture into a truck. Road workers use shovels to help them dig. Students hoist the flag using ropes and pulleys. The ramp, the shovel, and the ropes & pulleys are all simple machines. Compound machines have two or more simple machines working together to make work easier. Below are some examples of simple machines.

Draw a line to connect the simple machine to its name:

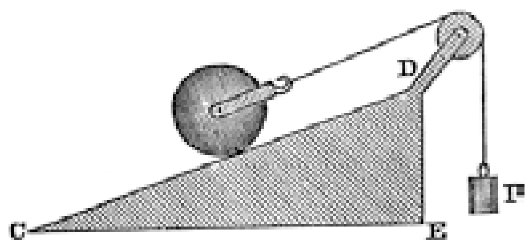
Screw

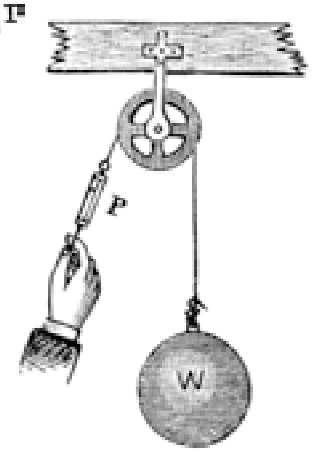
Pulley

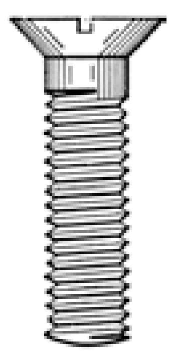
Incline Plane

Lever

Compound Machine







Boomer's Activity 1: The Frog-Hopper and Simple Machines

Procedure:

1. Make a sketch of the ride. Make note of how many people it fits.
1. Standing off to the side. Observe how the ride works.
1. Count how many times the ride goes up and down.
1. Record these observations in a data table.
1. Draw arrows on your sketch to show how the ride moves. Be sure to label your sketch.

Questions:

1. Imagine every seat of the ride was filled. Each person riding weighed 25 kg. How much weight is on the ride?
1. Think about how the ride's car was lifted. Can you identify the simple machines involved? Label them on your sketch (look carefully at the top of the ride).
1. How do the simple machines make the work of lifting many people easier?
1. Think of some *complex machines* that you may see in the park. Record them in your data.

Boomer's Activity 2: Inertia and Weightlessness

SC.C.1.2.1, SC.C.2.2.1, SC.2.2.2, SC.C.2.2.4

Introduction:

The concept of free-fall was first discovered by a man named Galileo. This was a long, long time ago. Legend has it that he dropped balls of different masses from the Leaning Tower of Pisa in Italy. Today, you are not allowed to throw things from buildings. So don't try it. But he found that all things fall at the same speed because of gravity. He also discovered that it didn't matter how heavy something is. All things drop the same, and hit the ground at the same time.

On the Frog-Hopper, you experience weightlessness. This is a tricky feeling because you have mass. How do we feel weightless? On the way up to the top of the ride you are in your seat. The seat travels up because machines supply force. The amount of force to raise the car to the top of the ride depends on the mass of the car plus all riders. You have inertia, but the seat forces you up too. You feel pressed down in your seat. You feel weight. But, when the car drops, so do you! Then you drop due to gravity and you feel weightless.

What happens when you stop? Remember- we said inertia is the tendency for things to keep on doing what they are already doing. If your body is falling, it wants to continue to fall. Just as when you got to the top of the ride, your body wanted to stay at rest at the top. Change in direction, either up or down, makes you feel your inertia.

Procedure:

1. Have a partner make observations. Ride the Frog Hopper.
1. Record how you feel on the way up to the top of the ride. Have your partner record appearance of those riding.
1. Record the feeling on your first drop. Partner will record observations of the riders, such as hair blowing upward.
1. Record any feelings from the second rise and drop. Partner should continue to record observations.
1. Once the ride is over, meet with your partner and discuss your findings. You may want to repeat the experiment.

Questions:

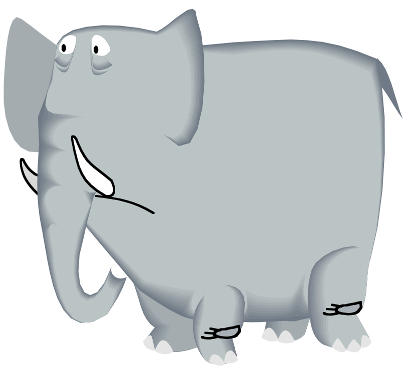
1. How did your feelings compare on the way up and on the way down?

1. At what point on the ride did you feel weightlessness?
1. At what times in the ride did you feel heavier?
1. Why does it feel like the car seat is falling out from underneath you when you initially free-fall?
1. Why do you push down in your seat when the seat changes direction back upward?
1. How did the riders' appearance compare on the way up and down?
1. What force acts on the car causing it to fall?
1. What provides the force to lift the car and its riders?
1. Communicate your results as a class.

Bowling Alley Physics

Objectives:

- To look at how **inertia** effects objects of varying **masses**
- To understand that **friction** is a **force** that can also have an effect on inertia
- To understand that **energy** of moving objects may be transferred between one another
- To see what happens to **motion** of objects during a **collision**
- To see how applied force effects collisions

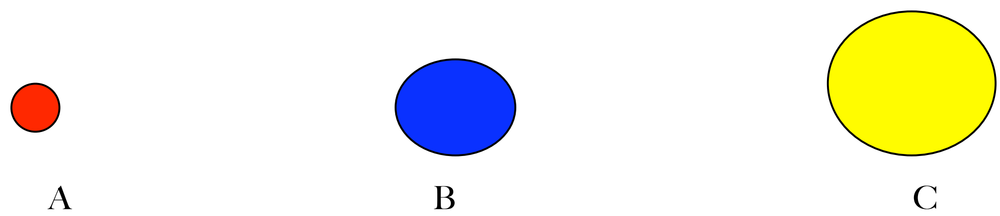


Introduction:

The mass of an object is a measurement of the amount of material in that object. Mass refers to how much "stuff" is there. Elephants are very *massive*, since they contain a lot of "stuff." We can determine mass of an object by weighing it. Have you ever noticed how when you drop something, it falls down? That's because of gravity. Gravity is what gives you weight. If there were no gravity, you would float away. But with or without gravity, you would still have mass.

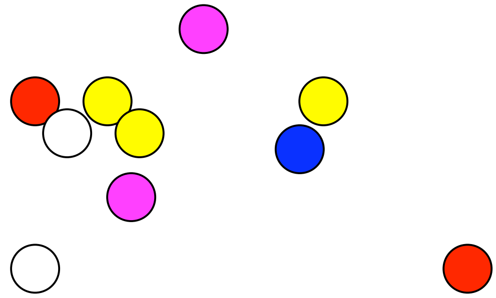
Objects that have a lot of mass also have a lot of inertia. Inertia means that objects want to keep on doing what's they're already doing. For instance, if an elephant is at rest, it is difficult for us to push him to get him moving since he is so massive. He has much inertia. A marble, on the other hand, is not as massive as an elephant. If we chose to move a marble, it would not be as hard as the elephant. A marble has less inertia than an elephant since it has less mass. In either case, objects at rest will stay at rest, and objects in motion will stay in motion unless acted upon by an outside force.

Question: which of these marbles has more inertia? A, B or C?



What is a force? It is a push or a pull on an object. If I tap the marble, I have applied a force to it that will send it rolling across the floor. Energy in my finger will be transferred to the marble and cause it to move. Momentum describes the motion of an object. Any mass that is in motion has momentum. In fact, momentum depends upon mass and speed. Mass is the amount of "stuff" that is moving. Speed is how fast the "stuff" is moving. A running elephant has a lot of momentum. A marble moving at a high speed has less momentum. What happens when a marble collides with another marble that is at rest? Energy in the moving marble is transferred to the marble at rest and will cause it to move, similar to if you struck it with your finger. And the elephant, well, if he ran into the house, he may knock the whole thing down!

Pre-Lab Experience Activity:
Don't Lose Your Marbles!
Marble Mass, Motion & Momentum

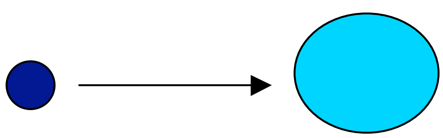


Pre-Lab materials:
4 Marbles with varying sizes and known mass
2, 1-meter pieces of string
A metric ruler

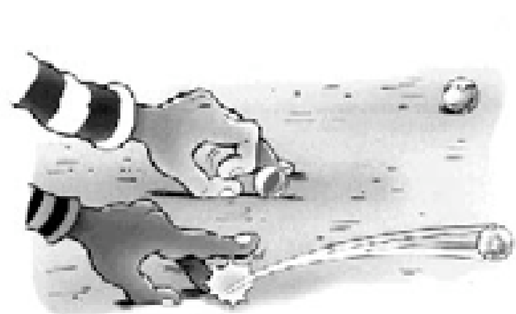
Standards:
SC.B.1.2.4: The student knows the many ways in which energy can be transformed from one type to another.
SC.B.1.2.5: The student knows that various forms of energy can be measured in ways that make it possible to determine the amount of energy that is transformed.
SC.C.1.2.1: The student understands that the motion of an object can be described and measured
SC.C.2.2.2: The student knows that an object may move in a straight line at a constant speed, speed up, slow down, or change direction dependent on net force acting on the object.
SC.C.2.2.3: The student knows that the more massive an object is, the less effect a given force has.
SC.C.2.2.4: The students knows that the motion of an object is determined by the overall effect of all forces acting on an object.

Procedure 1: Mass and Distance

1. Record the masses of each of the four marbles.
1. On Paper, measure a distance of 30 cm using your metric ruler, and draw a 30 cm line
1. Place a small marble on one end of your line, a larger marble at the other.
1. Roll the small marble so that it collides with the larger marble.



1. Measure with your ruler the distance that the larger marble traveled, after the collision.
1. Record your measurement. Do this three times: trail 1, trail 2 and trail 3.
1. Now, Repeat the experiment with the larger marble striking the smaller. You push the larger marble into the smaller one
1. Record your measurement. Repeat this three times.



Questions:

1. After the collision, which marble traveled farthest?
1. Why do you think this happened?
1. Does mass have anything to do with how far the marbles traveled?
1. Did the hardness of your throw have a possible effect?

1. Complete the sentence: The smaller marble travels farthest when struck with the most ______________ marble because the most massive marble has the greatest ___________.

Boomer's Activity 1: Bowling Ball Rolling Demo

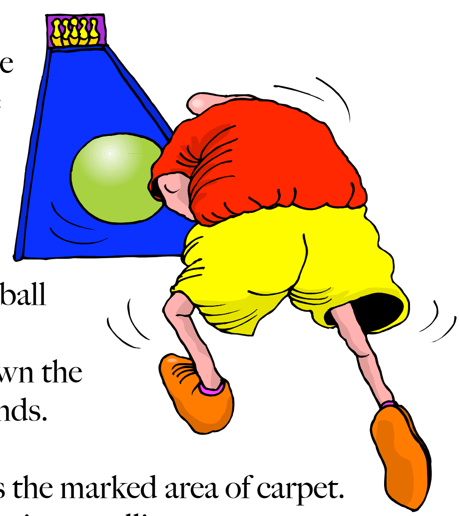
SC.C.1.2.1, SC.C.2.2.2, SC.C.2.2.4

Introduction:

Many forces result from interactions between two objects. Most interactions involve some type of contact. Friction is a force that resists motion of an object. It results from the close interaction between two surfaces that are sliding across each other. Have you ever tried sliding across a wood or tile floor in your socks? How about with your sneakers on? Your sneakers provide your feet with friction, so that you can grip the floor and not slide all over the place. Your socks reduce friction, and make it easy for you to slide. The more friction present, the more force will be required to move that object.

What makes the bowling ball roll best?

Procedure: **This is best done as a teacher demonstration**



1. Using a metric tape measure, measure the length of the bowling lane and the carpeted lane at either end of the alleys. Do not walk on the laneway! This can be measured off to the side.
1. Make a prediction of how far you think your bowling ball will travel in meters in the wooden laneway versus the carpeted floor. State whether you think the ball will roll easier on the carpet or on the wood.
1. Place a ball on the wooden floor and push it **gently** down the wooden laneway from a seated position using both hands.
1. Record the distance traveled.
1. Place a ball on the carpeted floor. Push it gently across the marked area of carpet. Have a student at the other end to stop the ball if it continues rolling.
1. Record the distance traveled.
1. Repeat this procedure 3 times for each.

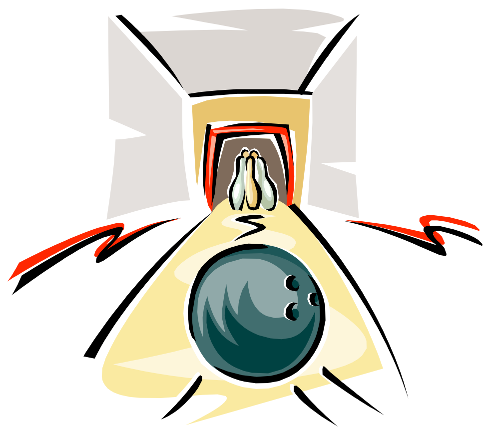
	Distance trail #1	Distance trail #2	Distance trail #3
Carpet			
Wood			

1. Lastly, try to make the ball travel as far on the carpet, and observe the amount of force needed by the one pushing the ball.

Questions:
1. On which surface did the ball seem to roll the farthest?
1. What difference did you notice between the bowling alley and the carpet?
1. Which of the two, carpet or wood, provides the least friction?
1. Why are bowling alleys made of wood and not carpeted?
1. How do you think it would differ if the bowling alley were made of sand? Grass? How about ice?

Boomer's Activity 2: Force and Speed

SC.B.1.2.4, SC.C.2.2.3, SC.C.2.2.4



Introduction:

Does it matter how hard we roll the ball? The answer is…YES! If we do not apply enough force on the ball, it won't have the energy to knock down the bowling pins. The ball might not even make it to the end of the lane! Remember: energy from our arms is transferred to the ball. This makes the ball move. The ball now has momentum moving down the lane. This energy is then transferred to the pins during collision. The energy from the ball causes the pins to fall down. But, both the pins and the ball have inertia. They will not move unless we apply force to them.

A. How do I calculate the ball's speed?

Procedure:

1. Use the data table shown below.

Data Table:

	Lane Distance	Time ball rolled	Partner 1's Ball speed (m/s)	Partner 2's Ball Speed (m/s)
Trial 1				
Trial 2				
Trial 3				
Average				

1. Determine the length of the laneway with a metric tape measure.
1. Have a partner ready with a stopwatch by the side of the lane.

1. For trial 1, from a seated position using both hands, you must push the ball ***gently***.
1. When the ball is released from your hands, start the timer.
1. When the ball reaches the end of the lane, stop the timer.
1. Record the time it took for the ball to travel down the laneway.
1. For trial 2, increase your force and push the ball it ***slightly harder***.
1. Record the time it took for the ball to travel down the laneway.
1. For trail 3, you may stand up. Using one hand, you may roll the ball ***quickly***.
1. Record the time it took for the ball to travel down the laneway.
1. We calculate speed by dividing the distance in meters by the time in seconds. * **Teachers: calculations of this nature are meant for students that have already learned how to divide numbers.**

   Speed = Distance (m) ÷ Time (s)
1. Switch with your partner and repeat the experiment.
1. Calculate the average speed for both you and your partner.
1. Create a **bar graph** of your results.

Questions:

1. On which throw did the ball travel the fastest?
1. On which throw did you apply the most force?
1. What can you conclude about how hard you throw the ball, and how fast it travels?

Boomer's Activity 3: Angles and Collisions

SC.B.1.2.4, SC.B.1.2.5, SC.C.2.2.2, SC.C.2.2.3, SC.C.2.2.4

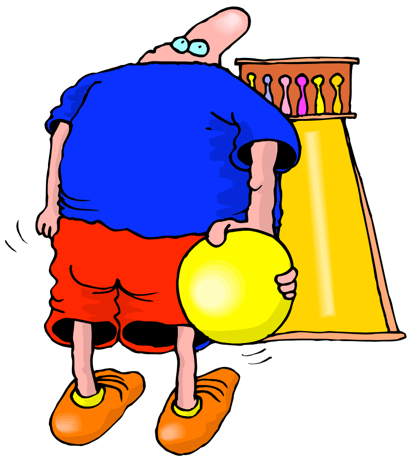
Introduction:

Even if we throw the ball as hard as we can, it doesn't mean that all of the pins will fall down. The energy in the ball must be transferred to the pins to get them to move. The bowling pins have inertia. This means they don't want to fall down on their own. They want to keep standing. To get them to fall, we must apply a force. That force comes from the momentum of our bowling ball. To increase our momentum, we have to increase our force. We also have to increase the balls' torque so its spins long and far. With all these things to think about, are we ready to knock them all down every time?

No, not yet! *Where* we throw the ball is just as important as *how*. Remember- every bowling pin has inertia. They want to remain standing. If no force is applied, none will fall. Our force must be evenly distributed. This means that it has to be spread to every pin. To get a perfect "strike" every time, you have to hit the front pin in just the right way. This is what makes bowling so challenging! Look at the diagram below. Just like dominos, each pin has to hit in the right place to fall. We refer to the direction the ball collides with the pins as it's angle. The arrows show the direction that the energy travels. Would this ball knock every pin down? You bet!!!!! Photo from: http://ffden-2.phys.uaf.edu

Procedure:

1. Roll the ball as straight as you can down the laneway.
1. Record how many pins you knock down.
1. Repeat this 2 more times.
1. Roll the ball slightly to the left of the front pin. Record how many fall.



1. Repeat this 2 more times.
1. Roll the ball slightly to the right of the front pin. Record how many fall.
1. Repeat this 2 more times.
1. Roll the ball down the alley so that it bounces off of the sides. Observe the ball's speed after it bounces.
1. Record how many pins are knocked down.
1. Repeat this 2 more times.
1. Find the average number of pins knocked down using each method.
1. Construct a bar graph of your data.

Data table:

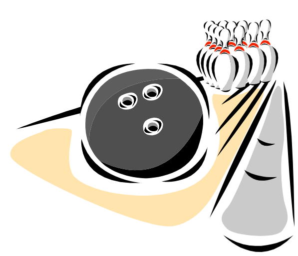
	Straight on	Angle to left	Angle to right	Bounced off sides
Trial 1				
Trial 2				
Trial 3				
Average				

Questions:

1. Which method knocked down the most pins?
1. Which method knocked down the least?
1. What happened to the ball's speed after it bounced each time?
1. What happened to the ball's energy after it bounced off of the sides?

Taking it further:

How could you design an experiment to knock down the most pins?
State a hypothesis. Ask your teacher, and try it!
Don't forget to record your observations & data.



Laser Tag Challenge

Objectives:

- To observe the characteristics of **lasers**
- To recognize **light** as a form of **energy**
- To understand how **light energy** can be **transformed**
- To compare laser light in different media
- To analyze **data** and interpret **results**

Standards:
SC.A.1.2.1: The student determines that the properties of materials can be compared and measured.
SC.A.2.2.1: The student knows that materials may be made of parts too small to be seen without magnification.
SC.B.1.2.2: The student recognizes various forms of energy (heat, light & electricity).
SC.B.1.2.3: The student knows that most things that emit light also emit heat.
SC.B.1.2.4: The student knows the many ways in which energy can be transformed from one type to another.
SC.B.1.2.5: The student knows that various forms of energy can be measured in ways that make it possible to determine the amount of energy that is transformed.
SC.C.1.2.2: The student knows that waves travel at different speeds through different materials.
SC.H.1.2.4: The student knows that to compare and contrast observations and results is an essential skill in science.
SC.H.3.2.2: The student knows that the data are collected and interpreted in order to explain an event or concept.

Pre-Lab Experience Activity: Flash Light Beams

SC.A.1.2.1, SC.A.2.2.1, SC.B.1.2.2, SC.B.1.2.3, SC.C.1.2.2, SC.H.1.2.4

Introduction:

You see things because of **light**. It's hard to see in the dark. That's because there's not enough light to let your see. What color is your blood? Red, right? But, why do my veins look blue? In order to answer this, we need to look at light's properties. Light is a form of **energy**. It is released from particles too small to see. Light is also known as **radiation**. It travels in **waves**. Depending on what type of radiation it is, it can be fast or slow. Some radiation we can see. This is called **visible light**. Visible light is made of all colors of the rainbow. Every color has a different speed. Red, orange and yellow are longer, slower waves. Green, blue, and violet are shorter, more intense waves. These waves have more energy. Waves with more energy can travel faster and farther than others. When we see color we see reflected light. Think about the function of your skin. It protects you. One thing it protects you from is light. High-energy radiation can damage your body. So, the high-energy colors are reflected out when they try to pass through your skin. Look closely at your hands and wrists. Some veins look blue or purple. Sometimes bruises look green. It is because of the way light acts with your layers of skin. In this investigation, we will examine how light behaves.

Materials:
Metric ruler
Falshlight
Pencil & Paper

Procedure 1:

1. Obtain a flashlight.
1. Dim the lights in the room.
1. Hold the flashlight over your palm.
1. Record your observations.

Procedure 2:

1. Measure the diameter of your flashlight.
1. Stand 50 cm from a wall. Shine the flashlight at the wall.
1. Measure the diameter of the reflected light on the wall.
1. Move back to 1 meter. Measure and record your data.
1. Repeat the procedure for 2, 2.5, 3, 3.5, & 4 meters.
1. Construct a bar graph to show how the distance from the wall affects the diameter.

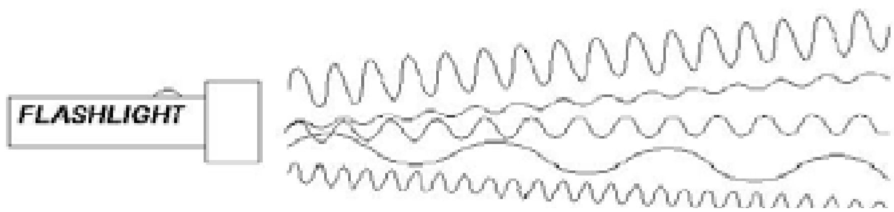
Questions:

1. What color(s) were visible when you shone the flashlight through your hand?
1. Did the light shine completely through your palm?
1. X-rays are also a form of radiation. How do you think they compare with a flashlight? Explain.
1. What happened to your beam of light as your distance increased?
1. How did the light on the wall appear as distance increased: was it a perfect circle?

What is a LASER?

Light is made from particles too small to see. It is energy. This energy travels in waves. There are several types of light. Each type differs in the amount of energy it contains. Think of waves at the beach. Imagine tall waves traveling quickly one after the other. It would be difficult to swim. The waves carry much energy. Now, imagine flat, calm water. The waves are very small. There is not a lot of energy. Long, slow waves have less energy than tall, quick ones.

Light bulb light and sunlight have all kinds of waves. Both give off heat. Both have beams that spread out. Both become less intense with far distances. (Imagine looking at the sun from Pluto!!!!)



A beam of light that has the same frequency and direction is very neat and orderly. Scientists refer to this as coherent. An example of this would be a laser. Waves in a laser beam are uniform. They do not bump into each other. They travel in the same direction at the same speed. The name laser comes from **L**ight **A**mplification by **S**timulated **E**mission of **R**adiation. Radiation refers to energy.

Because of their energy, lasers are very powerful. They can travel long distances. Some lasers are so strong they can burn through metal. Always be careful with lasers and never shine one in someone's eye!!!

Boomer's Activity 3: Lag Tag Analysis

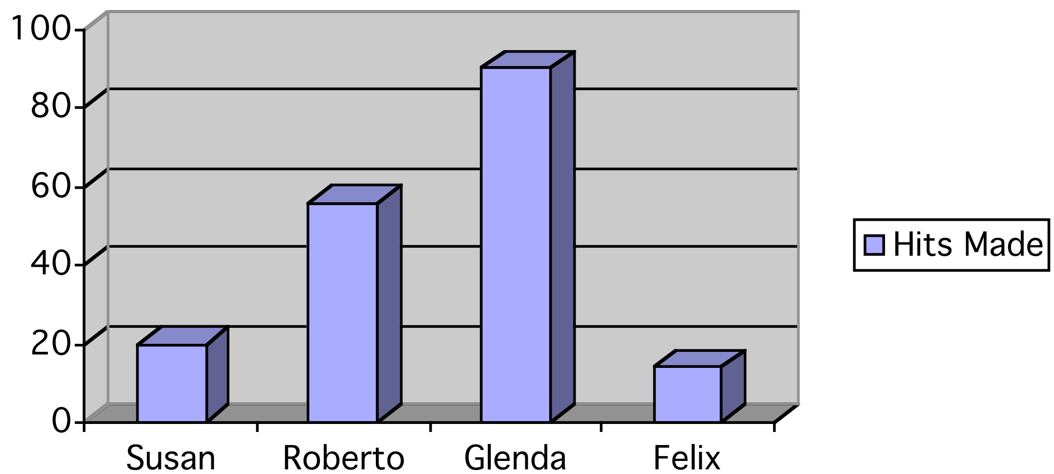
SC.H.1.2.4, SC.H.3.2.2

Procedure:

1. Obtain your laser tag results card.
2. Collect the "number of hits you made" from 3 other classmates. You may use the table below:

Name	Hits you made
(your name here)	

3. Construct a bar graph from the table information. You may use the chart paper on the next page. The bar graph will look similar to this:



Use the Graph:

How many hits did Roberto make?________

How many hits did Glenda make?_________

4. Collect the "number of times you were hit" from 3 other classmates. You may use the table below:

Name	Number of times you were hit

5. Construct a bar graph of the number of hits. You may use the chart paper on the next page.

Hits made:

Number of times you were hit:

Wave Rider Swings

Objectives:

- To describe **motion** and **acceleration**
- To look at how **inertia** effects objects in **motion**
- To calculate total **distance** traveled
- To understand that **gravity** is a force that can have an effect in inertia
- To observe **centripetal force**
- To observe how centripetal force is effected by **mass**
- To better understand why the moon stays orbiting Earth

Standards:
SC.C.1.2.1: The student understands that the motion of an object can be described and measured
SC.C.2.2.2: The student knows that an object may move in a straight line at a constant speed, speed up, slow down, or change direction dependent on net force acting on the object
SC.C.2.2.3: The student knows that the more massive an object is, the less effect a given force has.
SC.C.2.2.4: The student knows that the motion of an object is determined by the overall effect of all of the forces acting on the object.

Boomer's Pre-Lab Activity:

Rotation and Centripetal Force

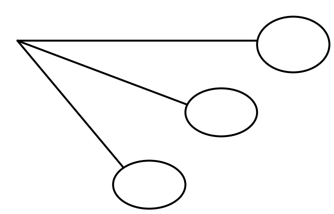
Introduction:

Have you ever wondered why the Earth revolves around the sun? Or why the moon stays around the Earth?

These are all questions that can be answered using physics. In physics, we study forces. A <u>force</u> is a push or a pull on an object. Forces can cause <u>motion</u>. Motion can be observed and measured. To know how fast someone is driving, we can look at the speedometer. Cars can change speed or direction. We call this acceleration. <u>Acceleration</u> can also be observed and measured.

There are many types of forces. Gravity is the downward force on the planet that makes things fall. Gravity is what gives us weight. Movement in a circle produces a special force. It is called centripetal force. It is a force that is directed toward the center of the circle. It is because of the combination of these two forces that we circle the sun. The sun holds us in orbit with it's gravity. Earth keeps the moon in orbit with its gravity. Notice that the larger objects are what control the circling. The sun is bigger than Earth, and the Earth is bigger than the moon.

So why doesn't the moon fly away? Moving objects have inertia. Inertia is the tendency for things to keep on doing what they are already doing. Moving things want to keep moving. Things at rest stay at rest. The only thing that can change this is a force. The moon is moving around the Earth. It continues to move around the Earth due to gravitational pull and centripetal force.



Materials:

1. 1 meter of rope or string
2. a ball or object attach to the end of the string

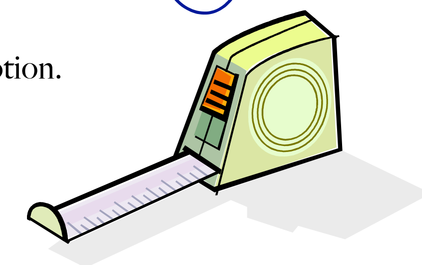
Procedure

1. Teacher swings the ball around their head slowly, and students make observations. What will happen if I swing the ball more quickly?
2. Teacher swings the ball around their head more rapidly, and students make observations. What will happen if I swing the ball more slowly?
3. Teacher swings ball very slowly around their head and students make observations.

Questions:

1. What is the relationship between the speed and the distance the ball is from the teacher?
2. What force pulls the ball down?
3. What force pushes the ball up?

Rotation and Centripetal Force



Materials:

1. Metric tape measure
2. Stopwatch
3. Paper, pencils

Procedure 1: **Motion of Swings**

1. Select a swing to observe. Observe the swing in motion.
2. Record how many times the ride goes around.
3. Have you partner record how long the ride lasts.
4. Measure the distance in meters around the circular path the ride makes.
5. Construct a data table.

Questions :

5. Describe the motion of the swings.
6. How far does one travel in meters during the ride?
7. Using this information, calculate your speed on the ride.

Procedure 2: **Mass & Swing Angle**

6. Select a student. He/she will ride.
7. Have students predict: which swing with hang out the most- the one with the student, or an empty chair? Write down the predictions.
8. Observe the ride and record results.
9. Discuss results.

You should find that all of the swings hang at the same angle, regardless of mass! This is because the centripetal force and gravity on all of the objects are the same.

Questions:

1. What would happen if the ride went faster?
2. What would happen if the ride went slower?
3. How did the ride make you "feel"? What forces did you notice?