Education Days
2020

March 27, April 3, 6, 17, 24, 30,
May 1, 7, 8, 14, 15, 22 & 29

Atomz Lab

Elementary School
Teacher Workbook
A few vocabulary terms you will hear or see today:

**Acceleration**: how quickly an object speeds up, slows down or changes direction

**Balance**: an even distribution of weight enabling someone or something to remain upright and steady

**Center of Gravity**: the point where gravity pulls an object down

**Force**: any push or pull

**G-force**: also known as a gravitational force

**Gravity**: a force that draws any two objects toward one another

**Kinetic energy**: the energy of an object in motion

**Molecules**: a group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction

**Potential energy**: the energy stored by an object ready to be used

**Scientific method**: a method of procedure that has characterized natural science since the 17th century, consisting in systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses

**Speed**: how fast an object moves. Is equal to the distance that object travels divided by the time it takes

**Surface Tension**: the property of the surface of a liquid that allows it to resist an external force, due to the cohesive nature of its molecules

**Velocity**: the speed and the direction an object traveling

**Weight**: a measure of how hard gravity pulls on an object (mass x gravity)
THE PHYSICS OF ROLLERCOASTERS

Introduction

Act like a frog! When you are down on the ground kneeling like frog, that’s potential energy! When you jump up in the air that’s kinetic energy! Potential energy is when you store energy and kinetic energy is when you use that energy. Ways you might store energy are eating and sleeping and ways you might release energy are playing on the playground and running.

Roller coasters work by converting potential energy into kinetic energy. Potential energy is stored energy and kinetic energy is the energy of motion. A motor from a roller coaster exerts potential energy when lifting the car to the top of the hill. The higher the car is lifted by the motor, the more potential energy is produced. At the top of the hill the car has a huge amount of potential energy, but it has very little kinetic energy. As the car goes down the hill the potential energy is converted into kinetic energy. There is very little potential energy at the bottom of the hill, but there is a great amount of kinetic energy.

Pre-Lab Questions

1. Look at the picture of a rollercoaster below. Which letters do you think will be fast parts of the ride and which letters do you think will be slower parts of the ride?

Fast: B,D
Slow: A,C

2. Kinetic energy is the energy of motion and potential energy is stored energy caused by an object’s position. Based on those definitions, which letters on the picture above do you think have high kinetic energy and which letters would have high potential energy?

High Kinetic energy: B,D
High Potential energy: A,C
Complete this part at the lab station:

1. Predict which will travel the rollercoaster track the fastest, the car with the ________ or the car with ________? (the instructor will tell you what to fill in here)

2. Run the two objects from #1 on the track with no loops and use a phone or stopwatch to record their times. Record your results below. Was your prediction correct?

Object 1: _____ seconds
Object 2: _____ seconds

3. Draw a diagram of the rollercoaster experiment with loops. Label the following points:
   - Maximum potential energy (Highest point on the track) Start of the coaster
   - Maximum kinetic energy (Lowest point on the track) Lowest part of coaster
   - The part of the coaster that demonstrates centripetal force Loop of the coaster

Roller coasters don't have engines, they run through the action of forces. A force is a push or a pull in a certain direction.

The energy for the motion of the roller coaster comes from potential energy being converted into kinetic energy.

1. Can you think of a force that act on us every day and would that force act on a roller coaster?

   Answers will vary. Students should hopefully come up with the force of gravity which would act on the rollercoaster.

Using the stopwatch or a phone, record the time it took for each trail to complete the track:

<table>
<thead>
<tr>
<th>Trial Number</th>
<th>Mass of objects in car (grams)</th>
<th>Time (seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SEESAW BALANCING

Introduction
A seesaw or teeter-totter is a fun piece of equipment on the playground. A heavier person can be balanced by a lighter person if they are on the right place of the seesaw. The seesaw is a lever, which is a simple machine that rotates at a pivot. In physics, simple machines are tools that make it easier to do work. There are many simple machines that are used in amusement park rides and attractions. For example, inclined planes and pulleys are simple machines that are used on “The Fury” and “Afterburn” rides here at Carowinds!

Pre-Lab Questions
1. When using a seesaw to balance two people, who must be closer to the middle to get the seesaw to balance, the larger or the smaller person? Hint: look at the picture below  
Larger Person

2. In the picture below, what could you do to block B to make the seesaw balance? Move it closer to the center of the seesaw

Complete this part at the lab station:

<table>
<thead>
<tr>
<th>Move the “L” cup so it is this many inches away from the middle</th>
<th>Move the RL” cup so it is this many inches away from the middle</th>
<th>Predict the weight you’ll need in the “L” cup to balance the seesaw?</th>
<th>How much weight did you need in the L cup?</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 inches</td>
<td>10 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 inches</td>
<td>10 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 inches</td>
<td>6 inches</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
BALANCING NAILS: A SCIENTIFIC METHOD INQUIRY

Introduction
Let’s talk about gravity! Gravity pulls an object toward the Earth as if all the object’s weight were concentrated at one point on the object. That point is called the center of gravity. An object falls over when its center of gravity is not supported. For balanced, symmetrical objects like a baseball or a meter stick, the center of gravity is exactly at the center of the object. For objects that are not symmetrical, like a baseball bat or the nails were about to experiment with, the center of gravity is closer to the heavier end and can sometimes even be outside the object. In this experiment, the stability of the nails depends on the center of gravity point where they touch the lone standing nail.

Here are the 4 steps of the Scientific Method:
1. Wonder – what do you want to learn from this?
2. Think – What do you think will happen?
3. Act – Test my idea and what happens?
4. Say – Am I right?

Before your field trip: In class, go through these steps of the scientific method and conduct the apple experiment. When you get to this station during your field trip, you will use this method to balance 10 nails on 1!

Apple Experiment

<table>
<thead>
<tr>
<th>Wonder</th>
<th>Apple slices turn brown after sitting out. How can we stop this?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think</td>
<td>If we dip apple slices in a liquid, then they will not turn brown after sitting out.</td>
</tr>
</tbody>
</table>
| Act | 1. Cut an apple into 8 slices  
2. Dip two of the slices in milk  
3. Dip two of the slices in lemon juice  
4. Dip two of the slices in water  
5. Leave two slices undipped  
6. Wait 2 hours, observe the slices, and record the data |
| Group | Slice 1 Observation | Slice 2 Observation |
| Milk | A little brown | A little brown |
| Lemon Juice | Not brown | Not brown |
| Water | Brown | Brown |
| Undipped | Brown | Brown |

Say
We saw that apples dipped in lemon juice did not turn brown after sitting out for 2 hours. The apples that were undipped and the apples that were dipped in water both turned brown. The apples dipped in milk turned just a little brown. We think to stop apples from turning brown when sitting out, you should dip them in lemon juice.

Pre-Lab Questions
1. Were the students in the apple experiment correct with what they thought in the “Think” section?
Yes – the liquid that is the most correct would be lemon juice
2. What did the students in the apple experiment do to test their idea?
The students left some of the apples undipped and then dipped other apples in milk, water, and lemon juice to test their idea.

**Complete this part at the lab station:**
Using the steps on the scientific method, fill out the chart below as you design and carry out an experiment to balance all the nails on the standing nail: All these answers will vary. Here are some ideas:

<table>
<thead>
<tr>
<th>Wonder</th>
<th>How can we balance 10 nails on one nail using the concept of center of gravity?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Think</td>
<td>If we find the center of gravity of the nail, then we can balance all 10 on 1 nail.</td>
</tr>
</tbody>
</table>
| Act                                                                    | 1. Experiment with adding the 10 nails to the one standing nail  
2. Ask questions or seek advice as needed  
3. Eventually balance the nails on the standing nail  
Here students will test their idea and say what happens. |
| Say                                                                    | Here students will describe if they were right and why. |
MAGNETIC PROPULSION

Introduction
Many newer roller coasters, such as the Copperhead Strike at Carowinds, take off quickly instead of making a gradual climb up a hill. This launch style mainly uses magnetic propulsion to achieve quick acceleration at the beginning of the ride. This relies on magnets repelling rather than attracting one another. A magnet has two ends called poles, one of which is called a north pole while the other is called a south pole. The north pole of one magnet attracts the south pole of a second magnet, while the north pole of one magnet repels the other magnet's north pole.

Let’s review some basic facts about magnets and how they work:

1. A magnet has two ends called poles, one of which is called a north pole while the other is called a south pole.
2. The north pole of one magnet attracts the south pole of a second magnet, while the north pole of one magnet repels the other magnet's north pole.
3. A magnet creates an invisible area of magnetism all around it called a magnetic field.
4. Magnetic Propulsion is the principle of accelerating an object by the utilization of a flowing electrical current and magnetic fields.

Pre-Lab Questions
1. If you pointed the north pole of one magnet toward the north pole of another magnet, what would happen?
   The magnets would repel / move away from each other.

2. Why would the Copperhead Strike ride not need to start as high up as the other coasters?
   The Copperhead Strike uses magnetic propulsion rather than potential and kinetic energy for its acceleration, so it does not need to start high up to gain the potential energy that the other rollercoasters need.

Complete this part at the lab station:
Draw the Magnetic propulsion system you just observed using neodymium magnets:
Drawings will vary. For acceleration the poles that face each other should be the same, ex:
WATER SURFACE TENSION

Introduction
On the top of water, water molecules love each other and do not want to break apart. As a result, some objects can float on the surface of water. Some insects (ex: water striders) can run on the surface of water because of this. This is caused by the molecules in water being attracted to each other (cohesion) and is responsible for many of the behaviors of liquids. Here’s how it works:

- The molecules in a liquid pull at each other from all directions. This means they have 0 force.
- The molecules on the surface of a liquid can’t be pulled in all directions, though, because the top or surface molecules don’t have anything but air to pull or push against.
- Because the surface molecules are only being pulled down by the liquid’s other molecules, the surface has more tension—the molecules are tighter and can hold up any object that is lighter or less dense.

Before your field trip: In class, fill a glass of water to the very top. Slowly add a few more drops using an eyedropper. Before it overflows, observe the water forming a dome-like shape above the rim of the glass. This dome-like shape forms due to the water molecules’ cohesive properties, or their tendency to stick to one another. Cohesion refers to the attraction of molecules for other molecules of the same kind, and water molecules have strong cohesive forces thanks to their ability to form hydrogen bonds with one another. Water likes to stick to itself, but under certain circumstances, it prefers to stick to other types of molecules. Adhesion is the attraction of molecules of one kind for molecules of a different kind, and it can be quite strong for water, especially with other molecules bearing positive or negative charges.

Pre-Lab Questions
1. What is the difference between cohesion and adhesion?

   Cohesion is the attraction of water molecules to each other. Adhesion is the attraction of water molecules to a different type of molecule.

2. Besides water strider bugs, what is something you think would be able to float on the surface of water?

   Answers will vary but can include: Feather, Leaf, paperclip, needle, etc.
**Part 1**
Draw a picture of what happens when you place your copper strider bug in the water:

![Picture of a copper strider bug in water]

**Part 2**
You can pour water down a string because water is both cohesive and adhesive. What this means is that water can stick to itself (cohesion) and other things (adhesion).

- Why does the string need to be wet?

  When the string is removed from the water it is wet. This is because the water adheres to the string. This is adhesion. The water being poured out of the glass will cling to the water that is attached to the string (this is cohesion) and will move down the string into the empty glass.
Introduction
The digital **EV3 Ultrasonic Sensor** generates sound waves and reads their echoes to detect and measure distance from objects. It can also send single sound waves to work as **sonar** or listen for a sound wave that triggers the start of a program. The sensor measures distances between one and 250 cm (one to 100 in.) The ultrasonic sensor also has a “listen only” mode that can detect whether another robot is using an ultrasonic sensor nearby. In this mode, the sensor listens for signals but does not send them.

1. **What does SONAR stand for?**
   
   **SOund Navigation And Ranging**

2. **Can you think of practical uses for SONAR technology in today devices?**
   - Anti-Collision Detection.
   - Space program robot on planets.
   - Robot vacuums.
   - People Detection.
   - Contouring or Profiling.
   - Presence Detection.
   - Easy Control of Trash Collection Vehicles.
   - Pallet Detection with Forklifts.
   - Bottle Counting on Drink Filling Machines.

3. Ultrasonic sensing is very similar to what natural skill used by the Bugula Whale or a bat?

   **Eco-location**

**Complete this part at the lab station:**

Move the robot along a path avoiding obstacles in its way. What will the robot do when encountering the object? Will it change direction? Sound an alarm? Move backward?

**Answers will vary.**
For our purpose we will be Comparing Distance Inches

**Tips and Tricks**

- The Ultrasonic Sensor works best to detect objects with hard surfaces that reflect sound well. Soft objects, such as cloth, may absorb the sound waves and not be detected. Objects with rounded or angled surfaces are also harder to detect.

- The sensor cannot detect objects that are very close to the sensor (closer than about 3 cm or 1.5 inches).

- The sensor has a wide “field of view” and may detect a closer object off to the side instead of a farther object straight ahead.

**EXAMPLES USING THE ULTRASONIC SENSOR**

Some examples of how you can use the Ultrasonic Sensor in your program are shown below.

*Example 1: Stop a Certain Distance before a Cup*

This program makes a robot drive forward until the Ultrasonic Sensor detects something closer than 10 inches, then the robot is stopped. The program uses the **WAIT** block in the Ultrasonic Sensor - Compare – Distance Inches mode to wait for the detected distance to become less than 10 inches. If the Ultrasonic Sensor is facing forward, the robot will stop about 10 inches before a cup.

**Tips and Tricks**

Remember to use the “On” mode of the Move Steering block when you want to drive while waiting for a sensor.

Remember to use the “Off” mode of the Move Steering block after sensing or your robot will continue to move forward infinitely.
COLOR SENSOR

Introduction
The EV3 Color Sensor is a digital sensor that can detect the color or intensity of light that enters the small window on the face of the sensor. This sensor can be used in three different modes: Color Mode, Reflected Light Intensity Mode, and Ambient Light Intensity Mode. Color sensors are generally used for two specific applications: true color recognition and color mark detection. Sensors used for true color recognition are required to "see" different colors or to distinguish between shades of a specific color. They can be used in either a sorting or matching mode.

1. Can you think of practical uses for Color Sensor Color Mode technology in present day applications?

   • Color Brick sorter
   • To separate vegetables according to their color
   • Avoids separation of medicines in pharmaceutical industries
   • Following a specific color line to direct a robot where to go

2. Ambient Light mode measures the brightness of the surrounding light. What are some uses can you think of for Color Sensor Ambient Light mode?
   It can be used to automatically start or stop a process or program depending on the light exposure. When the lights are tuned on in a room, the EV3 can sound an alarm.

3. Can you think of practical uses for this Ambient Light technology?

   Room lighting in an office building based on the time of day. When the light in the room reaches a certain light value the lights will come on.

   Outside lights on your house automatically turn on and off based on the sunlight detected.

4. In Reflected light intensity mode, the color sensor emits a red light and measures the amount reflected into itself from the surface you are testing. The intensity of the light is measured as a percentage from 0 to 100, with 0 being very dark, and 100 being very bright. In this mode, would the EV3 need to know the specific color it is sensing?

   No. It is only interested in the intensity of the light reflecting. Black would be a 0 and Yellow could be a 100.
FOR OUR PURPOSE, WE WILL BE USING THE SENSOR IN COLOR MODE

Complete this part at the lab station:
In Color mode, the Color Sensor can detect the color of a nearby object, or the color of a surface near the sensor. You can use the Color mode to detect, for example, the color of a LEGO part held close to the sensor, or the color of different markings on a piece of paper.

This program makes a robot drive forward until the Color Sensor detects something red, then the robot is stopped. The program uses the WAIT block in the Color Sensor – Compare – Color mode to wait until the detected color (Red) is found.

Now let’s add a command for the EV3 to complete when the color is detected, or even change the color it is searching for.

Tips and Tricks
When the Color Sensor is in Color mode, red, green, and blue LED lights on the front of the sensor will turn on.
The sensor can detect seven different colors: black, blue, green, yellow, red, white, and brown. An object that is not one of these colors may be detected as “No Color”, or it may be detected as a similar color. For example, an orange object might be detected as red or yellow, depending on how much red the orange has in it, or as brown or black if the orange is very dark or too far away from the sensor.

Tips and Tricks
The object or surface should be very close to the sensor (but not touching it) to be detected accurately.

Tips and Tricks
Remember to use the “On” mode of the Move Steering block when you want to drive while waiting for a sensor.
Remember to use the “Off” mode of the Move Steering block after sensing or your robot will continue to move forward infinitely.
©2020 Atomz Lab, LLC authorizes individual teachers who use this book permission to make enough copies of material in it to satisfy the needs of their own students and classes. Copying of this book or parts for resale is expressly prohibited. We would appreciate being noted as the source, “Atomz LabTM Charlotte” in all materials used based on this publication.