Education Days
2020

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

Atomz Lab

Middle School 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)
**Introduction**

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, thus forming a greater amount of kinetic energy when the car is dropped. At the top of the hill the car has a huge amount of potential energy, but it has very little kinetic energy. The faster the body moves the more kinetic energy is produced. The greater the mass and speed of an object, the more kinetic energy there will be. As the car accelerates 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.

When a rollercoaster travels through a loop, its centripetal force keeps an object moving along a curved path. For a roller coaster, gravity pulls down on the cars and its riders with a constant force, whether they move uphill, downhill, or through a loop. The rigid steel tracks, together with gravity, provide the centripetal force needed to keep the cars on the arching path as they move through the loop as a result of the rider’s inertia.

**Objective**

Upon completion of this laboratory activity, you will be able to: Understand the relationship between kinetic and potential 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: ___________

   Slow: ___________

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: ___________

   High Potential energy: ___________
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)
   - Maximum kinetic energy (Lowest point on the track)
   - The part of the coaster that demonstrates centripetal force

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>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Post-Lab Questions
1. What are some design choices you might make when trying to build your own rollercoaster if you want it to be fast?

2. Did your rollercoaster go faster or slower when you increased the mass of the objects in the car?
Roller coasters test the limits of gravity by accelerating and changing position to the ground causing many different forces to act on your body. A force is a push or a pull in a certain direction. The force of gravity (FG), normal force (FN), force of friction, and centripetal force (ac) act on a roller coaster. Neglecting friction and air resistance, a roller coaster car will experience the force of gravity, the normal force, and centripetal force while going through a loop and just the normal force and force of gravity during other parts of the ride. The normal force is directed in a direction perpendicular to the track and the gravitational force is always directed downwards. Centripetal force points inward toward the center of the loop.

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

1. On the diagram below, label the forces acting on the green and orange cars with their direction. See the yellow car as an example:
FULCRUM BALANCE

Introduction
A seesaw or teeter-totter is a fun piece of equipment on the playground. You have probably noticed that a heavier person can be balanced by a lighter person if they are on the right place on the seesaw. The seesaw is a lever, which is a simple machine that rotates at a pivot, or fulcrum. 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!

When a force is applied to one end of a lever, like the weight of a person sitting on it, the lever can lift a weight at the other end. The further from the fulcrum the force is applied, the more weight can be lifted on the other side. If the weight on the other side is moved toward the fulcrum, less force is needed to lift it. If a balance is in equilibrium, the lever arm is parallel to the table and neither end is higher than the other.

Objective
Upon completion of this laboratory activity, you will be able to: Understand the relationship between mass and distance in achieving equilibrium

Pre-Lab Questions
1. When using a seesaw to balance two people, who has to be closer to fulcrum to get the seesaw to balance, the larger or the smaller person?

2. In the picture above, circle the fulcrum.

Complete this part at the lab station:

<table>
<thead>
<tr>
<th>How far is the “L” cup from the fulcrum</th>
<th>How far is the “R” cup from the fulcrum</th>
<th>Predict the mass you’ll need in the “L” cup to balance the fulcrum?</th>
<th>What mass did you actually 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>12 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 inches</td>
<td>6 inches</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Post-Lab Questions
1. What conclusion can you draw about the relationship between distance and mass when balancing this type of lever?

2. In order to balance a lighter mass, should the heavier mass be closer to the fulcrum or further away toward the end?

3. As time went on, did your guesses about the mass actually needed in the R cup improve? Why?
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 6 steps of the Scientific Method:
1. Purpose - What do you want to learn?
2. Research - Find out as much as you can.
3. Hypothesis - Try to predict the answer to the problem. Another term for hypothesis is ‘educated guess’. This is usually stated like “If …(we do something) then…(this will occur).
4. Experiment - The fun part! You will design a test or procedure to confirm or disprove your hypothesis. You’ll want to include a control group (the group in an experiment that does not receive treatment by the researcher) and an experimental group (a group that receives a treatment in the experiment).
5. Results - Record what happened during the experiment. This is also known as ‘data’.
6. Conclusion - Review the data and check to see if your hypothesis was correct!

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!

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Apple slices turn brown after sitting out. How can we stop this?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>Look into why apple slices turn brown after sitting out and different ways to try to stop this.</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>If we dip apple slices in a liquid, then they will not turn brown after sitting out.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cut an apple into 8 slices</td>
</tr>
<tr>
<td>2. Dip two of the slices in milk</td>
</tr>
<tr>
<td>3. Dip two of the slices in lemon juice</td>
</tr>
<tr>
<td>4. Dip two of the slices in water</td>
</tr>
<tr>
<td>5. Leave two slices undipped as the control group</td>
</tr>
<tr>
<td>6. Wait 2 hours, observe the slices, and record the data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Slice 1 Observation</th>
<th>Slice 2 Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>A little brown</td>
<td>A little brown</td>
</tr>
<tr>
<td>Lemon Juice</td>
<td>Not brown</td>
<td>Not brown</td>
</tr>
<tr>
<td>Water</td>
<td>Brown</td>
<td>Brown</td>
</tr>
<tr>
<td>Undipped</td>
<td>Brown</td>
<td>Brown</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>In conclusion, we found 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. Therefore, to stop apples from turning brown when sitting out, we recommend dipping them in lemon juice.</td>
</tr>
</tbody>
</table>
**Objective**
Upon completion of this laboratory activity, you will be able to: Understand the parts of the scientific method and understand center of gravity.

**Pre-Lab Questions**
1. In the apple experiment above, what is the control group?
2. In the apple experiment above, what is the experimental group?
3. Where do you think the center of gravity of the nails, we will use in their experiment is?

**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 of the nails on the standing nail:

<table>
<thead>
<tr>
<th>Purpose</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>We’re going to skip this part today!</td>
</tr>
</tbody>
</table>
| Hypothesis | **If**  
**then** |
| Experiment |  |
| Results |  |
Post-Lab Questions
1. Describe how you were able to balance all of the nails:

2. Why is the title, “Hanging Nails Challenge,” more appropriate for this activity than “Balancing Nails Challenge”? 
MAGNETIC PROPULSION

Introduction
Many newer roller coasters, such as the Copperhead Strike at Carowinds, launch 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. As you probably know, 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. If you cut a bar magnet in half, you get two brand new, smaller magnets, each with its own north and south pole.
5. If you run a magnet a few times over an unmagnetized piece of a magnetic material (such as an iron nail), you can convert it into a magnet as well. This is called magnetization.

Objective
Upon completion of this laboratory activity, you will be able to: Observe the strength of neodymium magnets, view neodymium magnets demonstrating the electromagnetic propulsion of repelling magnets used to launch rollercoasters and other equipment, and understand magnet polarity.

Pre-Lab Questions
1. If you pointed the north pole of one magnet toward the north pole of another magnet, what would happen?

2. Why would the Copperhead Strike ride not need to start as high up as the other coasters?
Complete this part at the lab station:
Draw the Magnetic propulsion system you just observed using neodymium magnets:

Post-Lab Questions
1. Describe what you observed in this lab:

2. How does what you observed relate to the poles of a magnet?
WATER SURFACE TENSION

Introduction
Water surface tension is caused by a strong attraction between the water molecules that cause them to link together and remain uniform. 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 property 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 actually 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.

Objective
Upon completion of this laboratory activity, you will be able to: Understand water cohesion, adhesion, and surface tension

Pre-Lab Questions
1. What is the difference between cohesion and adhesion?
2. Besides water strider bugs, what is something you think would be able to float on the surface of water?
Part 1
Draw a picture of what happens when you place your copper strider bug in the water:

Part 2
You are able to 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 is it necessary for the string to be wet?

Post-Lab Questions
1. How are water striders able to walk on water?

2. What do you think would happen if you were to drop some liquid hand soap on the surface of the water while the water strider was floating on it? (Hint: what would the soap do to the water molecules cohesion)
**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?

2. Can you think of practical uses for SONAR technology in today devices?

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

**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?
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.
**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?

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?

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

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?
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.
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