Education Days 2020

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

Atomz Lab

High 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

**Air Resistance**: the frictional force air exerts against a moving object

**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

**Centripetal force**: a center seeking force; without this force, an object will simply continue moving in straight line motion

**Critical velocity**: the speed needed at the top of a loop for a rollercoaster to make it through the loop

**Electromagnets**: a device consisting of an iron or steel core that is magnetized by electric current in a coil surrounding it

**Equilibrium**: a state in which opposing forces or influences are balanced

**Force**: any push or pull

**Friction**: force caused by a rubbing motion between two objects

**Fulcrum**: the point on which a lever rests or is supported and on which it pivots

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

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

**Inertia**: the resistance of any object to any change in its state of motion

**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

**Momentum**: a measurement describing how much motion an object has: the more motion, the more momentum

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

**Propulsion**: the action of driving or pushing forward

**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

**Symmetrical**: when an object looks the exact same on one side as the other

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

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

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 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 the PE is due to an object’s height then: \( PE = m \times g \times h \)
- \( m \) is the object's mass (kg)
- \( g = 9.8 \text{ m/s}^2 \) (gravitational field strength)
- \( h \) is height (m)

Kinetic energy had a formula of: \( KE = \frac{1}{2} m \times v^2 \)
- \( m \) is the object's mass (kg)
- \( v \) is the object's speed (m/s)

When a rollercoaster travels through a loop, the moving object is forced inward toward what's called the center of rotation. It's this push toward the center -- centripetal force -- that 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. As you ride a roller coaster, its wheels rub along the rails, creating heat as a result of friction. This friction slows the roller coaster gradually, as does the air that you fly through as you ride the ride, eventually bringing it to a stop.

Centripetal force is a net force that acts on an object to keep it moving along a circular path. Newton’s 1st law, the law of inertia, tells us that an object will continue moving along a straight path unless acted on by an external force. The external force here is the centripetal force. Any object moving in a circle (or along a circular path) experiences a centripetal force. That is, there is some physical force pushing or pulling the object towards the center of the circle. The word centripetal, whose definition is “center seeking” is an adjective used to describe the direction of the force.

Objective
Upon completion of this laboratory activity, you will be able to: Understand the relationship between kinetic and potential energy, centripetal force, and inertia
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. What is the PE of a 2,000kg rollercoaster that is 100m off of the ground?

\[ PE = m \times g \times h \]
\[ PE = (2,000 \text{kg})(9.8 \text{ m/s})(100\text{m}) = 1,960,000 \text{ J} \] (J = Joule, the unit for PE and KE)

3. What is the KE of a 1,500 kg rollercoaster car going at a speed of 24 m/s?

\[ KE = \frac{1}{2} m \times v^2 \]
\[ KE = \frac{1}{2} (1,500 \text{kg})(24 \text{ m/s})^2 = 864,000 \text{ J} \]

4. Describe the force of gravity on the rollercoaster as it moves through the loop:

Gravity pulls down on the cars and its riders with a constant force, whether they move uphill, downhill, or through a loop.

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

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? Include the words height, potential energy, and kinetic energy in your answer:

   - Very high starting height gives you more potential energy \( PE = mgh \) which will be converted into kinetic energy which makes the rollercoaster fast
   - More drops = more potential energy converted into kinetic energy
   - Exiting a loop = more potential energy converted into kinetic energy

2. The height of the looped rollercoaster from this lab is _____ m. The mass of the car is _____ kg. (the instructor will tell you what values to put on those two lines)

   a) Calculate the kinetic energy of the rollercoaster if it has the velocity of 17 m/s:

   \[
   KE = \frac{1}{2} m \times v^2 \\
   KE = \frac{1}{2} (\text{mass in kg})(17 \text{ m/s})^2 = \text{______ J}
   \]

   b) Calculate the potential energy of the rollercoaster:

   \[
   PE = m \times g \times h \\
   PE = (\text{mass in kg})(9.8 \text{ m/s})(\text{height in m}) = \text{______ J}
   \]
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 ($F_G$), normal force ($F_N$), force of friction, and centripetal force ($a_c$) 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? **Larger Person**

2. In the picture above, circle the fulcrum. **Shown on picture**

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>10 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 inches</td>
<td>6 inches</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Post-Lab Questions
1. Mathematically the fulcrum weight balance formula is:

\[ M_1 \times a = M_2 \times b \]

A balanced seesaw has two weights on it, the first with mass 4kg and the second with mass 2kg. If the first weight is 4m from the fulcrum, how far is the second weight from the fulcrum?

\[(4\text{kg}) \times (4\text{m}) = (2\text{kg}) \times (X)\]

\[X = 8\text{m}\]

The second weight is 8m from the fulcrum.

2. What conclusion can you draw about the relationship between distance and mass when balancing this type of lever?

- More massive objects have to be closer to the fulcrum in order to balance this type of lever.
- Less massive objects have to be further away from the fulcrum in order to balance this type of lever.
- The weight and the distance from the fulcrum are inversely proportional: if the weight on one side is double that of the weight on the other, it will balance it at half the distance from the fulcrum.

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

4. As time went on, did your guesses about the mass actually needed in the R cup improve? Why?

Yes, my guesses improved as I better understood the relationship between mass and distance in balancing the lever. (or similar)
BALANCING NAILS: A SCIENTIFIC METHOD INQUIRY

Introduction
Let’s talk about gravity! Gravity pulls an object toward the Earth as if all of 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>
| Experiment                               | 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 as the control group  
6. Wait 2 hours, observe the slices, and record the data |
<table>
<thead>
<tr>
<th>Results</th>
<th>Group</th>
<th>Slice 1 Observation</th>
<th>Slice 2 Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk</td>
<td>Milk</td>
<td>A little brown</td>
<td>A little brown</td>
</tr>
<tr>
<td>Lemon Juice</td>
<td>Lemon Juice</td>
<td>Not brown</td>
<td>Not brown</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
<td>Brown</td>
<td>Brown</td>
</tr>
<tr>
<td>Undipped</td>
<td>Undipped</td>
<td>Brown</td>
<td>Brown</td>
</tr>
</tbody>
</table>

Conclusion
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.
**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? Undipped apple

2. In the apple experiment above, what is the experimental group? Dipped apples

3. Where do you think the center of gravity of the nails we will use in their experiment is? Answers will vary, hopefully the say toward the heavier end, at the head of the nail, etc.

**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: All of these answers will vary. Here are some ideas:

<table>
<thead>
<tr>
<th>Purpose</th>
<th>How can we balance 10 nails on one nail using the concept of center of gravity?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>We’re going to skip this part today!</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>If we find the center of gravity of the nail, then we can balance all 10 on 1 nail.</td>
</tr>
<tr>
<td>Experiment</td>
<td>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</td>
</tr>
<tr>
<td>Results</td>
<td>1. Start by balancing one nail sideways across the head of the upright nail 2. Once this is done, the other nails can be hung on this horizontal nail in alternating directions 3. Ensure the center of gravity stays over the head of the upright nail</td>
</tr>
<tr>
<td>Conclusion</td>
<td>In conclusion, we found the stability of the nails depends on the center of gravity being right at or directly below (that is, outside of) the point where they touch the lone standing nail.</td>
</tr>
</tbody>
</table>
Post-Lab Questions
1. Describe how you were able to balance all of the nails:

Lay one nail on a flat surface and place the other nails across this nail, head to head, and then place another nail on top of this assembly, between the heads of the weaved nails. Then, pick up the entire bundle by the bottom nail. The heads of the weaved nails should lock on the top nail. Balance this bundle on the nail sticking out of the block of wood.

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

The nails appear to be hanging off of the initial nail and the 10 are not directly balanced on the initial nail.
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.

Roller Coasters have many functions that involve electromagnets. There are two types of electromagnetic propulsion used on roller coasters: linear induction motors (LIM) and linear synchronous motors (LSM). Linear Induction Motors use multiple sets of high-powered electromagnets secured to the track. It creates a quick acceleration, whereas before roller coasters relied on an uphill chain start. Alternating current (AC) is applied to the magnets to create a magnetic field. Linear Synchronous Motors use the theories of attraction and repulsion. Strong, permanent, rare-earth magnets (like neodymium magnets) are attached to the car. When the car approaches one of the track-magnets, the track-magnet is set to attract the magnets on the train, pulling the train forward. After the train passes over the track-magnet, the track-magnet is reversed to repel the train magnet, pushing the cars down the track. Magnetic brakes have also been applied to rollercoasters so that as magnets attract each other the roller coaster gradually slows down.

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. When the ride starts the electromagnets on the car move closer to the electromagnets on the track. Then the engineer will flip a switch, creating an electric current through the car and the track. Initially, the magnets will attract due to opposite charges, but when the current is reversed the (like) charges propel the cars forward. What would the engineer do to slow down the car?

The engineer would use magnets that attract each other to make the roller coaster gradually slow down.
2. Why would the Copperhead Strike ride not need to start as high up as the other coasters at Carowinds?

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. As a reminder, \( \text{PE} = mgh \), where \( h \) is height.

**Complete this part at the lab station:**
Draw the Magnetic propulsion system you just observed using neodymium magnets, labeling the polarity of the magnets used:

Drawings will vary. For acceleration the poles that face each other should be the same, ex:

![Diagram of magnets with opposite poles facing each other.]

**Post-Lab Questions**
1. Describe what you observed in this lab, using the terms magnetic propulsion and polarity:

   Answers will vary but can include:

   The neodymium magnets undergo magnetic propulsion when two magnets repel one another.

   The parts of the magnet that face each other would have the same polarity.

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

   The poles of the magnets facing each other are the same, so we observe acceleration as they are repelling each other.

   When a rollercoaster slows down, opposite poles of a magnet are attracting each other.
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. List two examples of surface tension you have observed in your daily life:

   *Answers will vary, here are some examples:*
   - Bubbles
   - Floating a needle or paper clip, etc. on water
   - Drop of water on a leaf
   - Beading of water on a waxed car
   - Leaves floating on water

2. The equation for surface tension is $\gamma = \frac{F}{d}$ where $\gamma$ (gamma) is surface tension (units are N/m), $F$ is the force applied on the liquid (measured in Newtons-N), and $d$ is the length where the force acts (measured in meters-m). A piece of metal 0.35 m long has a force of 0.1 N, what is its surface tension? $\gamma = \frac{F}{d}$ $\gamma = \frac{0.1 \text{ N}}{0.35 \text{ m}} = 0.286 \text{ N/m}$
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.

- **Cohesion** – the sticking together of particles of the same substance
- **Adhesion** – the action or process of adhering to a surface or object

-Why is it necessary for the string 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.

-What force is holding the water to the string? **Adhesion**

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

Water striders have the unique ability to distribute their weight onto their long legs in a way that the surface tension of the water can hold them up. Water molecules are attracted to each other and most especially on the surface next to the air. This tension creates a bit of a membrane that allows the water striders to walk on it.

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)

The water strider would sink because the liquid hand soap would break the surface tension of the water as it would disrupt their cohesion.

3. In “Part 2” cohesion take place between **water** and **water**, while adhesion takes place between **water** and **string**.
**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?
   
   **SON**und **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*

![Image of Ultrasonic Sensor setup]

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.

4. 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

5. 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.

2b. 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.

6. 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.
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