Experiment 1: Displacement Vectors

Materials:
1. 3 orange cones
2. 25-foot tape measure
3. Tape to fasten cones to carpet

Setup:
1. Tape three orange cones to the carpet so that they form a large right triangle as shown.
2. Label the cone at the right angle as “cone 1”.
3. Label the cone at the corner of the short adjacent edge as “cone 2”.
4. Label the cone at the corner of the long adjacent edge as “cone 3”.

Procedure:
NOTE: You have 15 minutes to complete this experiment.
1. Visually estimate where the center of each cone is. Measure the distance from the center of cone 1 to the center of cone 2 using the tape measure to the nearest 1/8th inch. Record the distance in the table as distance “A”.
2. Measure the distance from the center of cone 1 to the center of cone 3 using the tape measure to the nearest 1/8th inch. Record the distance in the table as distance “B”.
3. Measure the distance from the center of cone 2 to the center of cone 3 using the tape measure to the nearest 1/8th inch. Record the distance in the table as distance “C”.
4. Convert the distances from inches to distances in meters (1 inch = 0.0254 m) and record the values in the table.
5. Square the distances in meters and record the values in the table.

Data:

<table>
<thead>
<tr>
<th>Cones</th>
<th>Side</th>
<th>Distance (in)</th>
<th>Distance (m)</th>
<th>Distance Squared (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone 1 to Cone 2</td>
<td>A</td>
<td></td>
<td></td>
<td>A² =</td>
</tr>
<tr>
<td>Cone 1 to Cone 3</td>
<td>B</td>
<td></td>
<td></td>
<td>B² =</td>
</tr>
<tr>
<td>Cone 2 to Cone 3</td>
<td>C</td>
<td></td>
<td></td>
<td>C² =</td>
</tr>
</tbody>
</table>

Analysis:
1. Compute the quantity A² + B² = ______________ m²
2. Compare this value with the value of C². Are the two values close? Why or why not?
Experiment 2: Centripetal/Centrifugal Force

Materials:
1. Small pail with handle
2. Meter stick
3. Water
4. Towel

Setup:
1. Fill the pail half full of water.

Procedure:

NOTE: You have 15 minutes to complete this experiment.

1. Hold the pail of water to your side using your dominant hand.
2. Have a lab partner measure the approximate distance in meters from your shoulder joint to the half-way point of the water in the pail. Record the value in the table.
3. Swing the pail of water over your head so it’s going at least one revolution every two seconds (unless you want to get wet and clean up the mess!)
4. After a few rotations to get the rhythm, have a lab partner use the stopwatch on a cell phone to measure the time it takes to make 10 full rotations of the pail over your head as shown in the picture. Record the time to the nearest 1/10th second in the table.
5. Compute the time for a single rotation and record it in the table.
6. Compute the angular speed using the formula below and record it in the table.
7. Compute the linear speed using the formula below and record it in the table.

Data:

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Measurement</th>
<th>Value with Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from shoulder to pail</td>
<td>( r )</td>
<td>m</td>
</tr>
<tr>
<td>Time for 10 rotations</td>
<td>10( t )</td>
<td>s</td>
</tr>
<tr>
<td>Time for 1 rotation</td>
<td>( t )</td>
<td>s</td>
</tr>
<tr>
<td>Angular speed</td>
<td>( 360^\circ/\text{t} )</td>
<td>°/s</td>
</tr>
<tr>
<td>Linear speed</td>
<td>( 2\pi r/\text{t} )</td>
<td>m/s</td>
</tr>
</tbody>
</table>

Analysis:
1. Did you get wet? Why or why not?
Experiment 3: Center of Gravity

Materials:
1. Laminated irregularly shaped cutout with three numbered holes around the edge
2. Hanger with weighted string
3. Marker
4. Ruler or straight edge
5. Paper towel or dry eraser

Setup:
1. None

Procedure:

NOTE: You have 15 minutes to complete this experiment.
1. Hang the shape using the hanger from hole 1.
2. Mark the point on the bottom edge where the weighted string crosses the edge.
3. Draw a straight line from the hole to the marked point on the edge.
4. Repeat steps 1 to 3 for hole 2.
5. Repeat steps 1 to 3 for hole 3.

Data:
1. None.

Analysis:
1. Do the three lines cross each other at nearly the same point? Why or why not?
2. Try to balance the shape on your fingertip by placing your finger directly under the point that is closest to where the three lines cross. Does the shape balance? Why or why not?
3. When done, use a paper towel to erase your lines for the next group.