45 Minutes

Objective
Students will conduct an experiment to determine if wing length will affect the descent time of a paper helicopter. Students will analyze their data to formulate reasonable explanations and form valid conclusions using the C.E.R. (Claims, Evidence, Reasoning) method.

TEKS
- 8.2B—design and implement comparative and experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology;
- 8.2C—collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers
- 8.2D—construct tables and graphs, using repeated trials and means, to organize data and identify patterns
- 8.2E—analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends
- 8.3C—identify advantages and limitations of models such as size, scale, properties, and materials
- 8.4A—use appropriate tools to collect, record, and analyze information, including lab journals/notebooks, beakers, meter sticks, graduated cylinders, anemometers, psychrometers, hot plates, test tubes, spring scales, balances, microscopes, thermometers, calculators, computers, spectroscopes, timing devices, and other equipment as needed to teach the curriculum

Guiding Questions
1. Differentiate between an Independent Variable and a Dependent Variable.
   Dependent Variable—The variable that responds and is found on the Y-Axis
   Independent Variable—The manipulated variable that is found on the X-Axis

2. Identify the qualitative data you are collecting in this experiment.
   The spinning of the helicopter

3. Identify the quantitative data you are collecting in this experiment.
   The descent time of the helicopter
   Different lengths of the helicopter blades

4. What type of graph will you use to graph your data? Justify your answer.
   A bar graph should be used because we are comparing average descent times.

Materials
- Paper Helicopter
- Stopwatch
- Chair
- Scissors
- 2 Meter Sticks
- Paperclip
Teacher Notes
- The paper helicopters are printed 3 to a page, but each group only needs 1 helicopter. You may want to cut them apart before class begins.
- You may need to review the following terms: Independent Variable, Dependent Variable, Constant, Qualitative, Quantitative

<table>
<thead>
<tr>
<th>D</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent</td>
<td>Manipulated</td>
</tr>
<tr>
<td>R</td>
<td>I</td>
</tr>
<tr>
<td>Responding</td>
<td>Independent</td>
</tr>
<tr>
<td>Y-Axis</td>
<td>X-Axis</td>
</tr>
</tbody>
</table>

Teaching Procedure
- Divide the students into groups of 3-4.
- Have students go through the procedures and complete the lab.
- While students are completing the lab, circulate through groups, monitoring for understanding, and redirecting as needed.
- Have students share their C.E.R. at the end of class as a reflection.
### Number of Seconds for Each Descent

<table>
<thead>
<tr>
<th>Propeller Wing Length (cm)</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average Descent Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As the propeller length gets shorter, the average speed will get faster.

### Average Descent Time of a Paper Helicopter with Different Wing Lengths

This is an example of what the graph should look like.

Length of the Paper Helicopter Wings (cm)
Prompt
How does wing length affect the descent time of a paper helicopter?

Claim
The length of the wing affects the descent time of the paper helicopter because the ___shorter___ the wing length, the shorter the descent time. The ___longer___ the wing length, the longer the descent time.

Evidence
The data shows that when the wing length was reduced each time, the change in descent time, ___increased/decreased_________________. On average the descent time for the longest wing length was ___(answers vary)______________________ seconds while the average descent time for the shorter wing length was ___(answers vary)______________________ seconds.

Reasoning
When the wings were ___shorter___ there was less air resistance to slow it down.

As the wing length ___decreased___ so did the descent time.
Name:_____________________________        Date:__________
Period:__________

Objective
Students will conduct an experiment to determine if wing length will affect the descent time of a paper helicopter. Students will analyze their data to formulate reasonable explanations and form valid conclusions using the C.E.R. (Claims, Evidence, Reasoning) method.

Materials
- Paper Helicopter
- Scissors
- Stopwatch
- 2 Meter Sticks
- Chair
- Paperclip

Procedures
1. Be sure you only cut along the SOLID lines, never cut along the dotted lines. You will be using the same helicopter model for all four wing lengths, so be sure you leave all four length sections of your helicopter model intact.
2. Prepare your helicopter by cutting around the outside edges of your helicopter model. (See figure 1)
3. Cut down Line A, but be sure to stop when you get to the dotted line. (see figure 2)
4. Cut lines B and C, but be sure to stop when you get to the dotted line. (see figure 3)
5. Fold the bottom section up so that the words are on the inside, and then fold the left and right sections so that the words are on the inside. (See Figure 4)
6. Place a paperclip on the bottom of the helicopter to increase the mass. 
   (See Figure 5)

7. Fold the shaded section of the wings on the dotted line toward you and fold the unshaded section of the wings on the dotted line away from you. 
   (See Figure 6)

8. One member of the group should stand in the chair and hold on to the helicopter by the paperclip.

9. Drop the helicopter from a height of 2 meters. Do not throw the helicopter, just release it. When you drop the helicopter, start the stopwatch. Stop the stopwatch when the helicopter hits the ground.

10. Use your Data Sheet to record the number of seconds it takes for the helicopter to reach the floor (descent time).

11. Complete three trials at wing length 1, and record your data each time.

12. Calculate the average descent time for wing length 1.

13. Cut off the end of each wing at the next line.

14. Repeat steps 8-13 for Lengths 2, 3 and 4.

15. Graph your average data (be sure to label each axis, use a consistent interval and title your graph)

16. Complete the C.E.R.
### Number of Seconds for Each Descent

<table>
<thead>
<tr>
<th>Propeller Wing Length</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
<th>Average Descent Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Prompt
How does wing length affect the descent time of a paper helicopter?

Claim
The length of the wing affects the descent time of the paper helicopter because the ___________ the wing length, the shorter the descent time. The __________________ the wing length, the longer the descent time.

Evidence
The data shows that when the wing length was reduced each time, the change in descent time, ______________________________. On average the descent time for the longest wing length was ______________________________ seconds while the average descent time for the shorter wing length was ______________________________ seconds.

Reasoning
When the wings were ______________________________ there was less air resistance to slow it down.

As the wing length ______________________________ so did the descent time.