**Paper Airplane Flight and Modifications**

By: Mrs. Saylor’s Example

**Question:**

How can a paper airplane be modified to maximize flying distance?

**Hypothesis:**

If pennies are added to the middle of a paper airplane, then it will fly the furthest.

**Materials:**

- 4 Sheets 8 ½” x 11” white printer paper
- 1 Sheet 8 ½” x 11” construction paper
- 2 Pennies
- 2 Large Paperclips
- Stapler with Staples
- Clear Scotch ® Tape
- Meterstick

**Procedure:**

**Part A: Folding the Airplane**

1. First fold the paper in half vertically, or hot dog style.
2. Open up the paper. Fold upper left and right corners into the center crease.
3. Repeat step 2 by folding your new folds in half to line up with the center crease again.
4. Now fold the two sides together down the center crease inwards so that they line up with each other.
5. Fold each side down in half horizontally so a point forms at the nose.
6. Fold out wings and hold where the center crease is at the bottom of the paper airplane.
7. Repeat steps 1-6 three times.
8. Repeat steps 1-6 with the construction paper
9. Number the airplanes: “1, 2, 3, 4, and 5”
**Part B: Modifications**

**Airplane 1:** Do not modify. This is the control.

**Airplane 2:** Put five staples along the top of each side of the wing, as indicated by the in the picture below.

![Diagram](image1)

**Airplane 3:** Attach two paperclips to the rear of the airplane as indicated by the in the picture below.

![Diagram](image2)

**Airplane 4:** Attach two pennies to the middle of the airplane, as indicated by the in the picture below. Use 4 cm of tape to attach each penny to the airplane.

![Diagram](image3)

**Airplane 5:** The modification for this airplane is using construction paper.
Part C: Flight Tests

1. Throw paper airplane #1 ten times using a gentle overhand throw. Be sure to hold the airplane in the middle, between the thumb and forefinger, as indicated by the $\otimes$ in the picture below.

2. Using the meterstick, measure the flight distance, to the nearest tenth of a centimeter. Record data in the table below.

3. Repeat steps 1 and 2 for the other four airplanes.

4. Calculate the average flight distance for each of the airplanes

<table>
<thead>
<tr>
<th>Modifications</th>
<th>Airplane 1</th>
<th>Airplane 2</th>
<th>Airplane 3</th>
<th>Airplane 4</th>
<th>Airplane 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flight 1 (cm)</td>
<td>504</td>
<td>849</td>
<td>757</td>
<td>929</td>
<td>520</td>
</tr>
<tr>
<td>Flight 2 (cm)</td>
<td>898</td>
<td>1,026</td>
<td>683</td>
<td>1,052</td>
<td>643</td>
</tr>
<tr>
<td>Flight 3 (cm)</td>
<td>989</td>
<td>816</td>
<td>1,024</td>
<td>738</td>
<td>703</td>
</tr>
<tr>
<td>Flight 4 (cm)</td>
<td>1,019</td>
<td>877</td>
<td>680</td>
<td>798</td>
<td>455</td>
</tr>
<tr>
<td>Flight 5 (cm)</td>
<td>762</td>
<td>658</td>
<td>500</td>
<td>891</td>
<td>665</td>
</tr>
<tr>
<td>Flight 6 (cm)</td>
<td>890</td>
<td>850</td>
<td>536</td>
<td>569</td>
<td>764</td>
</tr>
<tr>
<td>Flight 7 (cm)</td>
<td>1,200</td>
<td>566</td>
<td>684</td>
<td>547</td>
<td>733</td>
</tr>
<tr>
<td>Flight 8 (cm)</td>
<td>961</td>
<td>622</td>
<td>634</td>
<td>828</td>
<td>632</td>
</tr>
<tr>
<td>Flight 9 (cm)</td>
<td>903</td>
<td>576</td>
<td>591</td>
<td>813</td>
<td>567</td>
</tr>
<tr>
<td>Flight 10 (cm)</td>
<td>849</td>
<td>782</td>
<td>610</td>
<td>721</td>
<td>645</td>
</tr>
<tr>
<td>Average Flight (cm)</td>
<td>897.5</td>
<td>732.3</td>
<td>669.9</td>
<td>778.6</td>
<td>642.7</td>
</tr>
</tbody>
</table>
**Analysis:**

![Airplane Modifications and Flight Distances](image)

**Conclusion:**

The original hypothesis proved to be incorrect. It stated that if pennies are added to the middle of a paper airplane, then it will fly the furthest. Although flight tests 1, 2, and 5 proved the hypothesis to be correct, it was airplane #1 that, on average, had the longest flight distance, with an average flying distance of 897.5cm. Airplane #1 was the control and therefore had no modifications.

The airplane with the second longest flight distance was airplane #4, bearing two pennies. Its average flight was 778.6cm. The third longest flight average was made by airplane #2. This airplane’s modifications were ten staples alone the front of both wings. Its average flight distance was 732.3cm. The fourth longest flight distance average was airplane #3. This
airplane had two paperclips at the rear of the airplane. Airplane #3’s average flight distance was 669.9cm. With every flight test, airplane #3 veered left at an angle of about 25 degrees. This caused this airplane to crash into the hallway walls, quickly increasing the amount of damage, thus reducing the flight distance for this airplane. The airplane with the lowest average flight distance was the airplane made with construction paper: airplane #5. The average flight distance for this airplane was 642.7cm.

There was a problem that may have affected the results of the experiment. After three flight tests, each airplane had acquired some damage from collisions into the ground or hallway wall. Efforts were made to correct the damage, but it may or may not have been completely successful; if the damage had not occurred, perhaps the flight distances would have been greater than recorded. Furthermore, during two of the flight tests, paper airplanes #4 and #5 collided with students loitering in the hall. These flights were not recorded, and were re-flown in order to get the most accurate results.

This experiment raised a question about paper airplanes, possible modifications, and flight speed. Perhaps a future experiment can the maximum speed achieved by modified paper airplanes. This could be accomplished by dropping airplanes from a high-altitude location and measuring the time it takes to reach a certain location. A high-altitude location would be a necessity for this laboratory experiment, as well as a stopwatch to time the flights.

This lab, Paper Airplane Flight and Modifications, applies to real life in a couple of ways. Different airplanes are produced and designed for different reasons, whether to carry people, cargo, or weapons. Some airplanes need to fly longer distances, while others need to carry heavier loads. By designing, hypothesizing, and testing, scientists and engineers are able to gather information about the best designs for the intended purpose. It is from this that the scientists and engineers would learn what materials would be best to build an actual airplane that could fly a longer distance, or carry more cargo or people.

There are many things we enjoyed about this lab. We liked being able to design paper airplanes any way we wanted to, without having to follow a pre-made design. We also liked being able to test them to see which airplane was best designed for distance. What we didn’t like was measuring the distances because it takes a lot of time in order to be accurate within the nearest tenth of a centimeter. We hope to do many more labs like this in the future.