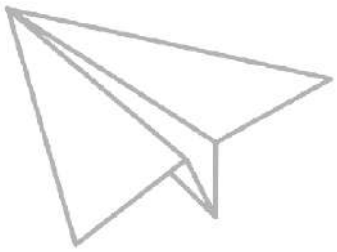

**Paper Airplane STEM Activity**

I. Summary

Watch this video
https://www.youtube.com/watch?v=xiLFiQYsqBI

II. Goal

The goal is to create a paper airplane that has the *greatest airtime*. Airtime is the time spent in the air from the time it is thrown to the time it lands.

III. Materials

The materials that will be allowed to be used for the creation of the airplane will be a 8.5"x11" sheet of paper and a 0.5"x1" piece of transparent tape.

IV. Teams

All students will be placed in teams.

V. Research

Use the Internet to research how to build paper airplanes. Remember, the goal is to create an airplane that has maximum time in the air.

VI. Build

Students must summarize via a narrated video exactly how their airplane was built. The summary will explain where the folds are and where the tape was placed. The reason for this is to allow someone else to create the same paper airplane, if need be. Someone should be able to build your paper airplane in less than 8 minutes of time.

VII. Trials

Data must be gathered that shows the angle of the launch compared to the time spent in the air. Use a table similar to the one to the right to record your trials. This will help your team to determine the best possible launch angle.

| Angle | Time (sec) |
|---|---|
| 0° | |
| 15° | |
| 30° | |
| 45° | |
| 60° | |
| 75° | |
| 90° | |

VIII. Calculation A - Vectors

Assuming you threw the paper airplane using two different velocities, calculate the component forces for those velocities. Your table must have at least one speed/angle combination and work shown. The table below shows only one speed/angle pair.

| Speed and Angle | Horizontal Speed | Vertical Speed |
|---|---|---|
| 450 mph at $30°$ | 389.7 mph | 225 mph |

**Work (example)**

| Horizontal | Vertical |
|---|---|
| $x = 450\cos 30°$ | $y = 450\sin 30°$ |
| $x = 389.7$ mph | $y = 225$ mph |

IX. Calculation B - Probability

You will determine the probability that your airplane reaches different airtimes. Using at least ten trials, count the times it reaches the different time thresholds. Here is an example below with tally marks.

| Lift Time | 1 - 1.99 secs | 2 - 4.99 secs | 5+ secs |
|---|---|---|---|
| Tally marks | \| | \|\|\| | 𝍸 \| |
| Probability | $\frac{1}{10} = 0.1 = 10\%$ | $\frac{3}{10} = 0.3 = 30\%$ | $\frac{6}{10} = 0.6 = 60\%$ |

X. Final Product

The final product will be the narrated video, data table, calculations, airtimes, and the paper airplane.

XI. Competition

The team with the paper airplane that has the greatest airtime will win the competition.

XII. Rubric

Your team will be graded according to the following rubric.

| Video | Hard to Follow | Easy to Follow |
|---|---|---|
| | Poor Directions<br>Hard to Hear<br>Visually Difficult to Follow | Great Directions<br>Easy to Hear<br>Visually Easy to Follow |
| Points: | 0 - 2 | 3 - 5 |

| Data | 0 - 6 trials | 7 trials | 8 - 14 trials | 15+ trials |
|---|---|---|---|---|
| Points: | 0 | 3 | 4 | 5 |

| Calculation A | 0 speed/angles | 1 speed/angles | 2 speed/angles | 3+ speed/angles |
|---|---|---|---|---|
| Points: | 0 | 3 | 4 | 5 |

| Calculation B | 0 - 4 trials | 5 - 9 trials | 10 trials | 11+ trials |
|---|---|---|---|---|
| Points: | 0 | 3 | 4 | 5 |

| Airtime | 1 - 1.99 secs | 2 - 4.99 secs | 5+ secs |
|---|---|---|---|
| Points: | 0 - 2 | 3 - 4 | 5 |

| Grade | 0 - 8 pts | 9 - 13 pts | 14 - 19 pts | 20 - 25 pts |
|---|---|---|---|---|
| Letter: | E | C | B | A |

XIII. Standards

Math CCSS: CCSS.MATH.CONTENT.HSN.VM.A.3, CCSS.MATH.CONTENT.HSS.MD.A.4, CCSS.MATH.CONTENT.HSS.MD.B.7, WHST.6-8.7

CC Math Practices: CCSS.MATH.PRACTICE.MP1, CCSS.MATH.PRACTICE.MP4, CCSS.MATH.PRACTICE.MP5, CCSS.MATH.PRACTICE.MP6

EDP: MS-ETS1-4, MS-ETS1-4, RST.6-8.7,

NGSS: HS-PS2-1, HS-PS2-2, HS-PS2-4

XIV. Prerequisites

Students must have an understanding of how to build data tables, create videos, calculate vector components, and determine probabilities.

XV. Evaluation

The evaluation is: a) the production of the paper airplane project, and b) performance on a MATHguide quizmaster, called *Vectors: Horizontal and Vertical Components* at http://www.mathguide.com/cgi-bin/quizmasters2/VC.cgi.