**Overview:**

In class, you’ve learned that the scientific method allows you to solve problems through focused trial and error. You’ve learned that a controlled experiment involves an experimental/independent variable (the one condition that changes) and controls (the conditions that you want to keep constant).

**In this lab, use the scientific method to figure out how to make a paper airplane that flies farther.**

You will make a paper airplane that you are most familiar with. Make a guess about what might make the paper airplane fly better. This could be a different method of folding the plane or some addition to the plane design. You may change whatever you like, but remember to only change **ONE** aspect **(independent variable)**  on your **control** plane to create your **experimental** plane.

**Instructions:**

* *PART 1*
  + Create a [**question**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.cccq3oz0akj1) i.e. will adding weight to the end of the paper plane nose make it fly further?
  + Create a [**hypothesis**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.jkg62d80tf2e): If (independent variable) …then (dependent variable)
  + Identify the [**controls**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.a0909ftaa9cx) i.e. the same person throws the plane
  + Identify the [**materials**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.dtm5pvrk4fdb)
  + Design the [**procedure**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.br3echr8wis3) and verify that it is detailed enough with your teacher BEFORE collecting your equipment
    - Describe in detail how to make a standard control plane (pictures)
    - Where to throw and how to throw and how to measure.
    - Describe where and how to record your observations.
    - Describe in detail how to make the change in the control plane (pictures)
* *PART 2*
  + Collect your **materials/equipment.**
  + Perform Flight #1 of the **experiment** throwing your **control** plane 5 times.
  + Record observations in [**Table 1**, **Observation section**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.32oyosy8ow1x)**,** based on results of flight #1.
  + Take out the anomalous measured values and **calculate** the average of the remaining values.
* *PART 3*
  + Make the **1 experimental variable** (independent variable) change to your paper airplane
  + Perform Flight #2 of the experiment throwing your **experimental** plane 5 times
  + Record observations in [**Table 2**, **Observation section**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.32oyosy8ow1x)**,** based on results of flight #2
  + Take out the anomalous measured values and **calculate** the average of the remaining values.
* *PART 4*
  + **Analyse, Evaluate, and Synthesise**, the data by graphing your data and answering questions 1-6 in the **C**[**onclusion section**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.293dvm7dm3qi) **of this report.**
* *PART 5*
  + Pair up with another group who is finished and complete [**Group Peer Evaluation**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.pr8g3126acs4) **and** [**Group Self Evaluation**](https://docs.google.com/document/d/1kAXbXO7Mlon_fEwSGjdYlK3Roq7hcf7eMDY0g5KgHvQ/edit#bookmark=id.f59mtgrzqnaq) found below your completed lab**.**

**WHEN YOU ARE FINISHED, DELETE THE ABOVE INSTRUCTIONS AND HAND IN YOUR LAB FOLLOWING YOUR TEACHER’S INSTRUCTIONS.**

**TEACHER ASSESSMENT RUBRIC: LAB THE GREAT PAPER AIRPLANE                 /45**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| RESPONSIBILITY  handle equipment safely and responsibly | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (2) | EXCELLENT  (3) |
| QUESTION  propose a question that forms the basis of a scientific investigation | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (1.50) | EXCELLENT  (2) |
| HYPOTHESIS  make a hypothesis using "If (independent variable) then (dependent variable)" | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (1.50) | EXCELLENT  (2) |
| CONTROLS  performed a “controlled experiment” with only one experimental variable Identified 5 or more controlled variables | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (2) | EXCELLENT  (3) |
| MATERIALS  listed materials include amounts and descriptions | DOES NOT MEET  (0) | SATISFACTORY  (0) | MEETS  EXPECTATIONS  (0) | EXCELLENT  (1) |
| PROCEDURES  conduct a scientific investigation following appropriate procedures | DOES NOT MEET  (0) | SATISFACTORY  (2) | MEETS  EXPECTATIONS  (4) | EXCELLENT  (6) |
| OBSERVATIONS  making and recording qualitative/quantitative observations using appropriate units | DOES NOT MEET  (0) | SATISFACTORY  (2) | MEETS  EXPECTATIONS  (4) | EXCELLENT  (6) |
| CONCLUSION  write a conclusion that relates to the hypothesis using support or refute words | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (1.5) | EXCELLENT  (2) |
| EVALUATE  evaluate the evidence obtained during the investigation and the scientific process used to obtain the evidence | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (2) | EXCELLENT  (3) |
| ERROR  identify potential sources of error in an investigation and how to modify the experiment | DOES NOT MEET  (0) | SATISFACTORY  (0) | MEETS  EXPECTATIONS  (0) | EXCELLENT  (1) |
| CONNECTION  connect science learning to personal experience, other learning, and/or world events | DOES NOT MEET  (0) | SATISFACTORY  (0) | MEETS  EXPECTATIONS  (0) | EXCELLENT  (1) |
| LAB REPORT  - create products that are complete with no spelling or grammar errors - display data in tables, graphs, or charts according to class criteria | DOES NOT MEET  (0) | SATISFACTORY  (2) | MEETS  EXPECTATIONS  (4) | EXCELLENT  (6) |
| PEER EVALUATION  all questions thoroughly and thoughtfully answered | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (2) | EXCELLENT  (3) |
| CHANGES TO ORIGINAL LAB  used a different colour to highlight the changes | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (2) | EXCELLENT  (3) |
| SELF EVALUATION  all questions thoroughly and thoughtfully answered | DOES NOT MEET  (0) | SATISFACTORY  (1) | MEETS  EXPECTATIONS  (2) | EXCELLENT  (3) |

**NAME(S):**

**Block:**

**Date (this is always the day of the experiment):**

*Use the following format to type your lab and submit online.*

**Question:**

**Hypothesis:**

**Controls:**

**Materials:**

**Procedure:**

**Data and Observations:**

**Table #1: Distance thrown of first paper airplane (Control Plane)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Trial** | **1** | **2** | **3** | **4** | **5** | **AVERAGE\*** |
| **Distance (m)** |  |  |  |  |  |  |

**Drop the anomalous data (This is data that may not fit the other data recorded.  Only drop the data, if you can provide sound reasoning for an error\*\*) and average the remaining data.**

\*\* Data Anomalies are:

   Reason for Anomaly**:**

**Table #2: Distance thrown of second paper airplane (Experimental Plane)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Trial** | **1** | **2** | **3** | **4** | **5** | **AVERAGE\*** |
| **Distance (m)** |  |  |  |  |  |  |

**Drop the anomalous data (This is data that may not fit the other data recorded.  Only drop the data, if you can provide sound reasoning for an error\*\*) and average the remaining data.**

\*\* Data Anomalies are:

   Reason for Anomaly:

**Conclusion (USE FULL SENTENCE ANSWERS)**

**Analysis:**

**INSERT GRAPH**

**1)** Was your hypothesis **supported** or **refuted**? Explain using the information you obtained in your experiment.

**Evaluation:**

2)  Why do you think your hypothesis was supported or refuted?

1. Explain why it was important that you change only one thing between your initial experiment and your later experiment.

**Synthesis:**

4. Based on your results, how might you further modify your plane to improve your flight distance?

5. How could the knowledge gained from this lab be applied to real-life situations? (Note: this does not have to mean aircraft-related industries)

**Airplane Lab**

**Peer Group Evaluation**

Names:

Partner Group Name:

Your group will be working with a Partner Group to help you evaluate your lab write up. You will be evaluating your own lab, and the other group will be carrying out your procedure to test the reproducibility of your lab.

Your group will submit the following to your teacher for grading:

1) Your original lab report

2) Your self evaluation

3) Any potential revisions

**Use the spaces below to make notes as you work through your evaluation with your partner group**. **If changes to lab are required, use a different colour to highlight the changes in your lab above.**

**Question:**

Is your question clear?

Does it clearly state what you are testing in this experiment?

**Hypothesis:**

Is your question an “If…then…” statement that relates your independent and dependent variables?

**Controls:**

Now that you have carried out the experiment and analyzed your data, does your list of controls include everything that it should?

**Materials:**

Is everything listed?

Did you miss anything? Your partner group will be able to give you feedback here.

**Procedure:**

How easy was it for your partner group to carry out the experiment?

Were they able to do it the exact same way without asking you any questions?

You may need to revise your procedure (use a **different colour**).

**Data and Observations:**

Are your data tables clear?

Did you include units?

A title?

Is the average distance calculated correctly?

**Analysis Questions:**

Are your answers in full sentences?

Do you fully explain your answers and use your data to support your conclusions?

**Self Evaluation:** Use the space below to write an honest self evaluation of your lab.

1) What are the components of the lab that your group has done well? These are areas where you fully met the lab criteria.

2) What are the components that your group needs to work on? In this space, discuss how you improved lab write up. For full marks, you will need to make revisions to your original lab above in a **different colour**.