Honors Physical Science

Unit 1 – The Nature of Science

The Sky is the Limit! Building and Testing your own Paper Airplane.

Name: _____ Period: _____

Partner's Name: _____

Note: You and your partner will only turn in ONE copy of this activity packet.

Introduction

Just one sheet of paper can lead to a whole lot of fun. How? Paper planes! All you have to know is how to fold and you can have a simple plane in a matter of minutes! But what design should you use to build the best plane? In this aerodynamics science project, you will research various designs of paper airplanes. Then, you will determine an Independent Variable to test: They type of paper or the mass (inertia) of the paper airplane (you do not do both). There is a lot of cool science in this project, such as how the different *forces* allow a plane to fly, so get ready to start folding!

Objective

To determine how the type of paper used or the mass of the paper airplane affects the distance it flies.

Introduction

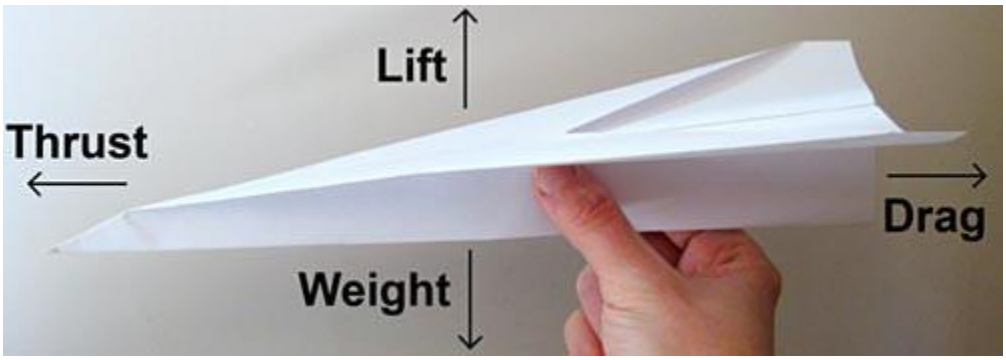
Paper airplanes are fun and easy to make. Just fold a piece of paper into a simple plane and send it soaring into the sky with a flick of your wrist. Watching it float and glide in the air can be very satisfying.

But what allows the paper plane to glide through the air? And why does a paper plane finally land? To find out, we will talk about the science behind flying a paper plane and the different forces that get a paper plane to fly and land. These same forces apply to real airplanes, too. A **force** is something that pushes or pulls on something else. When you throw a paper plane in the air, you are giving the plane a push to move forward. That push is a type of force called **thrust**. While the plane is flying forward, air is moving over and under the wings and is providing a force called **lift** to the plane. If the paper plane has enough thrust and the wings are properly designed, the plane will have a nice long flight.

Note that a paper airplane does not have an engine, so the thrust is simply the inertia (resistance to change of motion) you originally give it. The more mass something has, the more inertia it has.

But there is more than lack of thrust and wing design that gets a paper plane to come back to Earth. As a paper plane moves through the air, the air pushes against the plane, slowing it down. This force is called **drag**. To think about drag, imagine you are in a moving car and you put your hand outside of the window. The force of

the air pushing your hand back as you move forward is drag. Finally, the **weight** of the paper plane affects its flight and brings it to a landing. Weight is the force of Earth's **gravity** acting on the paper plane. Figure 1 below shows how all four of these forces, thrust, lift, drag, and weight, act upon a paper plane:

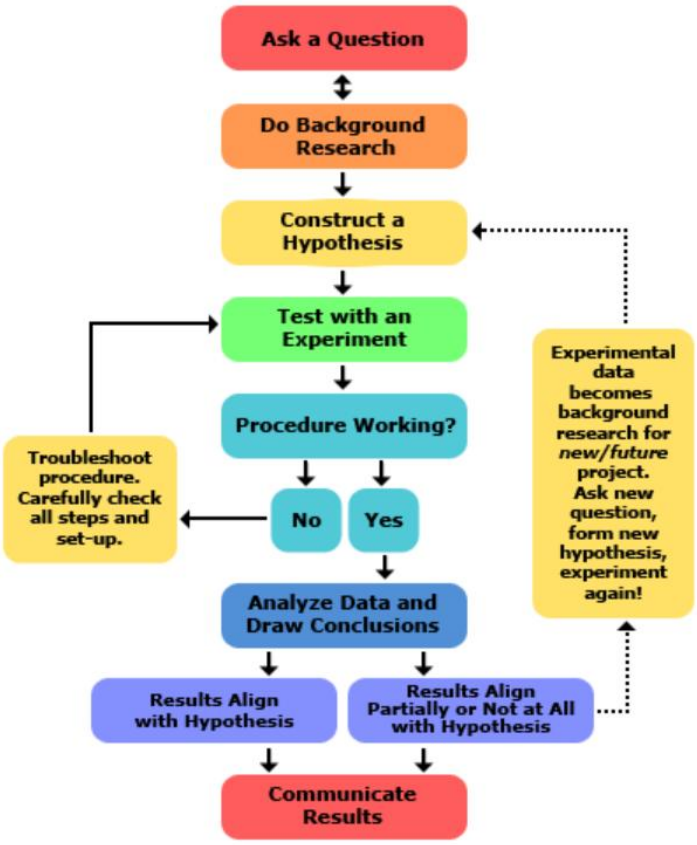


Well, what do you think? Would you like to start experimenting with these forces? In this aerodynamics science project, you will research and make a basic paper airplane. You then have two choices:

1. Make two paper planes of the same design but of two different materials.
2. Make one paper airplane but adjust its mass by adding paperclips to it.

You will then measure the distance your prototypes fly over five trials. Do materials and mass make a difference? You can answer these questions with just a flick of your wrist!

Review: The Scientific Method



Materials Available

You will have access to punched notebook paper, printer paper, construction paper, Scotch tape, and paperclips.

Question 1: What are the differences in the properties among notebook paper, printer paper, and construction paper?

Question 2: Which type of paper are you going to use to make your primary paper airplane? What is it about your choice that helped you make your decision?

Preliminary Research

Using your computers, go online and research various designs for paper airplanes. Remember that your objective is to make the paper airplane travel a distance, not carry a load or do acrobatics. When you have settled on a design, take a screenshot for future reference when you actually create your paper airplane.

Question 3: List at least three sources that you researched before choosing your design.

Question 4: Briefly explain why you chose the design you did.

Coming up with a Hypothesis

You have two options. Circle the one you plan to explore:

1. Make two airplanes, the primary and the secondary, of the same design from two different types of paper to see which design flies the farthest.
2. Test a single airplane with differing mass. The primary paper airplane would be the one without additional mass, and the secondary paper airplane would be the one with a paperclip attached to the bottom center of the same paper airplane.

Question 5: Based on your selection above, write your hypothesis; that is, what do you think will happen (one paper will give a type of result over another, or mass will affect distance in some way).

Build Them!

Based on your hypothesis, construct your paper airplane(s) with the type of paper you chose earlier. If you are testing the relationship between distance and paper type, you will need to make two identical airplanes of the two differing materials – the primary and the secondary.

Data Collection Table

Before actually testing your airplanes, you will need a data table. Use the space on the next page to create a table for your data. You will need at least 5 trials and a column for the average of the five trials. The first row should be for the primary paper airplane, and the second row for the secondary (different material or mass) paper airplane. Be sure to give the table a title and include the units (a floor tile is 1 foot).

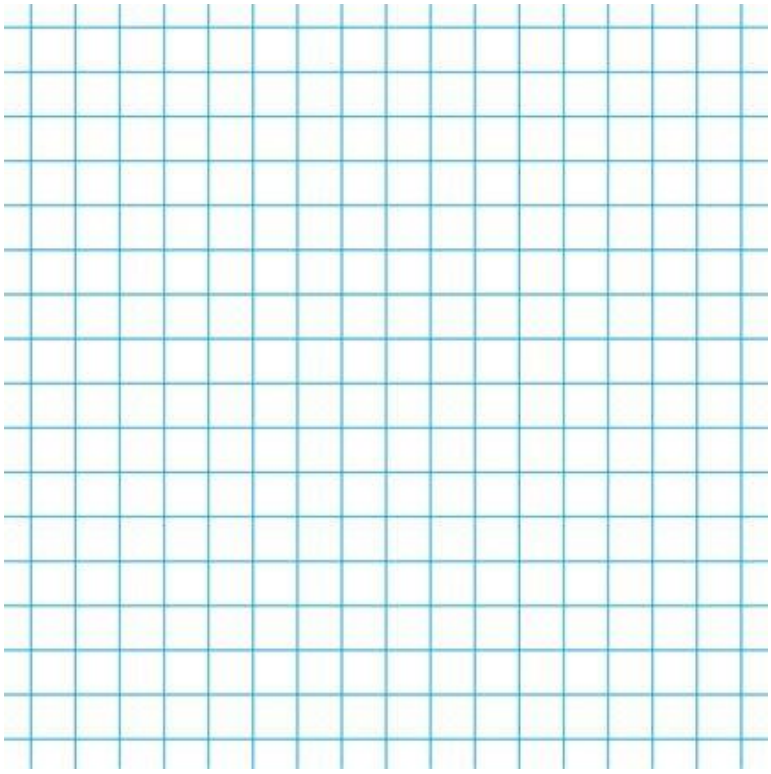
Use the space below the table to do your calculations.

Title: _____

Let's Fly! Data Collection

We will now move to the testing area (the hallway). Have the first person stand at a fixed point and throw the airplane, while the other makes a note where it lands. Record the distances in your table above for both the primary and secondary paper airplanes. Once you have recorded the distance for each of the five trials (ten total), find the average and record it in the last column of both rows.

Question 6: Create a graph of your data below for both trials. Let the x-axis be the trial number and the y-axis the distance in feet (you do not need to convert to SI units). Note that you will have two sets of data points plotted on one graph. Your graph will need a title, have the axes properly labeled, have the proper gradients, and a key to distinguish between the two different paper airplanes.



Question 7: What are the results of your experiment? Do they support your hypothesis? Explain.

Question 8: How would you improve your experiment?

Question 9: If you wanted to continue your experiment, what would be the next steps?

Question 10: List at least three sources of error in your experiment.

Question 11: On the following page, write a five-paragraph lab report. It should include an introduction, the materials used, experimental design and technique, data analysis, and conclusion (including sources of error). You may write your report on separate pieces of paper and attach, if you prefer.

Lab Report

Lab Report (page 2)