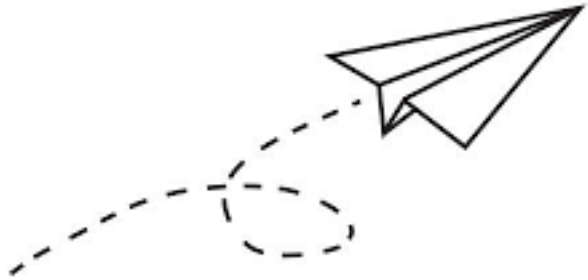
How Far Will it Fly?

Big Picture: The art of paper plane making is a complicated one. What makes one plane fly further than another? What about the different designs make one a better plane than another?



Essential Question: How do you record and analyze data?

Constraints

- Must design three airplanes
- Must use the same material for all three planes
- Must have the same person flying them

Deliverables: Here you will design and construct paper airplanes and fly them to see which of the designs is the most aerodynamic. Through trial and error you will record the flights of these planes and compare them with other planes. You may determine which design is the most successful. Compare and contrast your results.

DAY ONE Teacher demonstration flying three different types of planes *Ask*	**DAY TWO** Have students form teams and set up their plan *Imagine*	**DAY THREE** Have teams do background research and determine which 3 planes they are going to use and make a guess *Plan*	**DAY FOUR** Lesson on what is a variable. Have teams construct their airplanes *Ask*	**DAY FIVE** Have them create plane #1 and test it *Create*
DAY SIX Have them create plane #2 and test it *Create*	**DAY SEVEN** Have them create plane #3 and test it *Create*	**DAY EIGHT** Lesson on line plot. Have teams show the distances flown in feet and inches on a line plot *Create*	**DAY NINE** Teams will report out their findings, using the data to support the conclusion and compare it to their guess *Improve*	**DAY TEN** Teams will compete against one another, putting forth their best plane to determine a class champion

Lesson 1 - Setting up your experiment

You will use the designs to create three paper airplanes. You will then present these to the class and have them guess which they think will fly the furthest. Use the questions in order to spark discussion about the experiment.

Questions for the Class

- Which do you think will fly the furthest?
  (Have them take a sticker and place it on the piece of chart paper labeled plane #1, plane #2, and plane #3)

- Why did you pick the plane you did?

- Would it be more valid just to fly each plane once or multiple times? Why did you choose the one you did?

- What could affect the outcome of the experiment?

- Were you correct in your guess? Why do you think the plane that went the furthest did so?

- How many of me (the teacher) do you think it will take to measure the distance each plane flew?
  (Have students make their guesses, then use yourself to measure the distance each plane flew)

Once you have had your discussion, explain that they will be running a similar experiment in groups where they will fly three planes, trying to test a guess of which they believe will go the furthest.

Which plane do you think will fly the furthest?

Plane #1 Plane #2 Plane #3

Why do you think it will fly further than the others?

Record the distances the planes flew

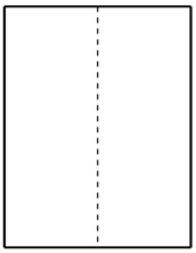
	Plane #1	**Plane #2**	**Plane #3**
Flight #1			
Flight #2			
Flight #3			

Was your guess correct? Yes No

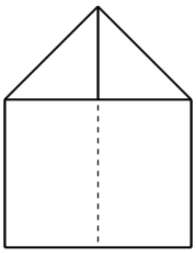
Plane Design #1

start with paper in portrait orientation

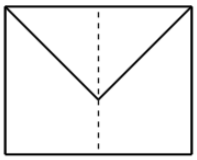
fold in half lengthwise



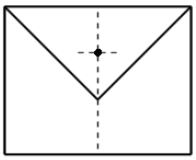
fold the upper edges to the centerline



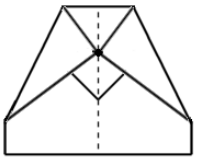
fold the triangle downwards along its lower edge



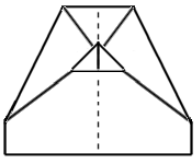
fold the tip of the triangle up to the top to locate the halfway point, then unfold



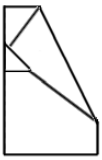
while firmly holding the center in place, fold both upper corners to the halfway point



fold the remaining tab up as far as it will go. it should slightly overlap the previous fold



fold in half along the centerline, with the tab on the outside



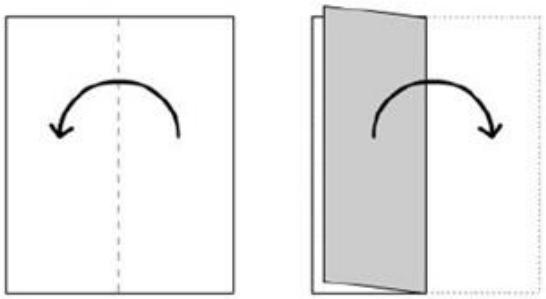
fold one wing such that the outer edge is brought colinear with the plane's centerline

fold the other wing in a symmetrical fashion

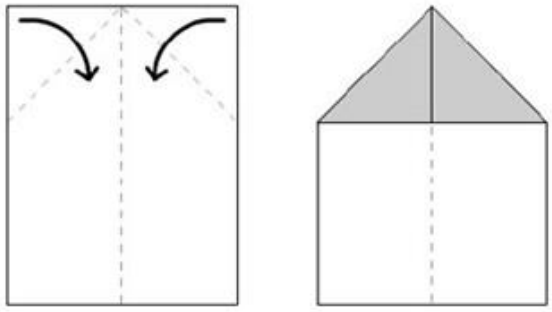
unfold and fly!

Plane Design #2

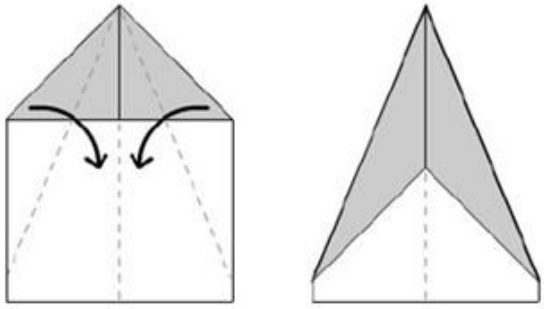
STEP 1: Turn your paper so the printed side is facing down. Fold the paper in half, crease the edge, and unfold.



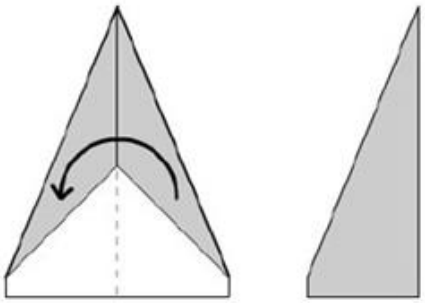
STEP 2: Fold the two upper corners down at a 45-degree angle. Make sure the edges line up with the center crease.



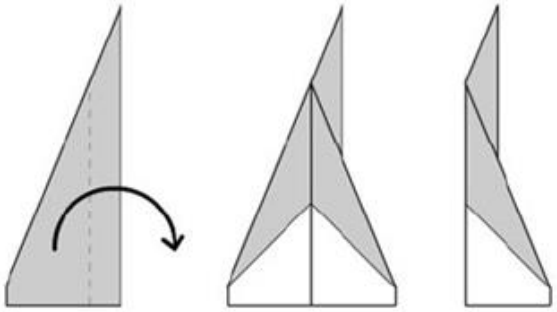
STEP 3: Fold each side again. Make sure the edges line up with the center crease.



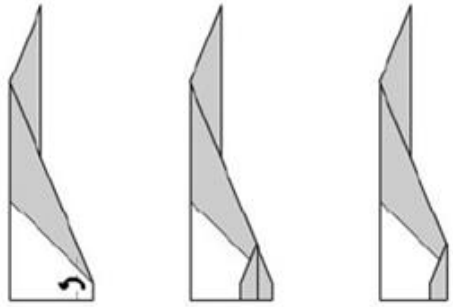
STEP 4: Fold the paper in half along the center crease.



STEP 5: Fold the wing along the line shown. Repeat on the other side.



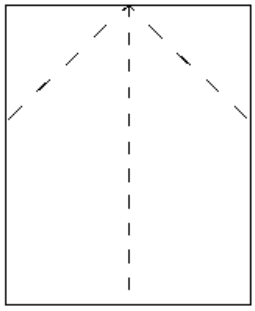
STEP 6: Fold the wing fin along the line shown. Repeat on the other side. Open the wings and fly!



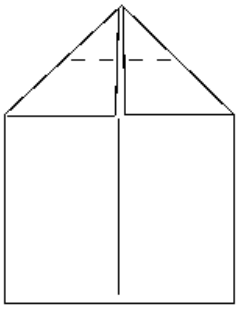
Plane Design #3 (optional):

High Glider

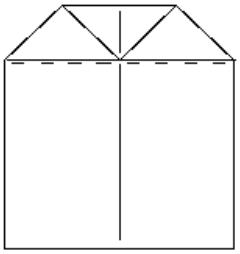
If you throw this one almost straight up, you may get flights of 10 seconds. It is also a good, straight indoor airplane.



Fold an 8.5 x 11 inch sheet of paper in half lenghthwise and open back up. Fold the top corners down to the center.

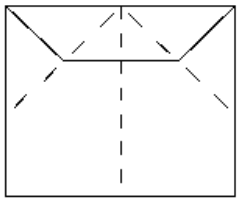


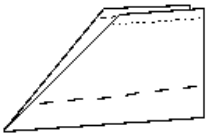
Now fold the point over to the bottom of the previous folds.



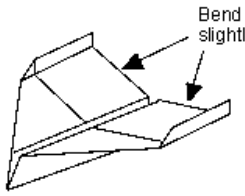
Fold the top down

Fold the top corners down to the center. Fold the plane in half towards you.





Now fold the wings out at an angle as shown. Fold the wingtips up.



Bend the elevators up slightly for best flight.

Split the students into teams of five. Each team member will be responsible for a different part. Group will turn in one set of data and one set of charts/graphs.

Pilot – responsible for flying the planes

Engineer – responsible for making the planes

Surveyor – responsible for measuring the distance of the planes

Statistician – responsible for taking the data and converting it

Analyst – responsible for taking data and putting it into charts

Lesson 2 – What is a variable?

Variables are conditions that can affect the outcome of an experiment. Good scientists try to eliminate as many variables as possible from their experiments so that they are getting the most accurate results.

An example of a variable could be the paper you use to build your planes is of different thickness. In other words, you use standard copy paper for one design but use cardstock for another, this different in sturdiness and weight could have an effect on the outcome where the experiment varies. To eliminate this variable you would want to make the paper airplanes with the same thickness of paper.

What would be some examples of a variable in your project?

Possible answers

- The same person doesn't throw all planes
- The person throwing the planes throws some harder than others
- The person doesn't use the same throwing technique with all the planes
- The person gets tired halfway throw the experiment
- Some planes are thrown indoors while others outdoors
- One plane is made better than another
- One plane has its folds taped down while another does not
- You use different measuring tools to measure the distance
- You are not accurate in your measurement
- You lose half of your data and have to do that part of the experiment again

Plane #1 Design _____

1st Flight

2nd Flight

3rd Flight

Plane #2 Design _____

1st Flight

2nd Flight

3rd Flight

Plane #3 Design _____

1st Flight

2nd Flight

3rd Flight

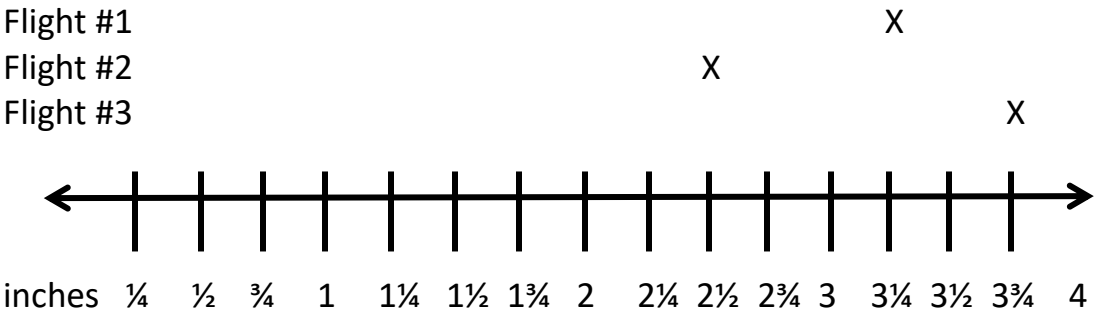
Lesson 3 – How to graph your data?

Step #1 – Gather your data
In this case you have already done this in the experiment you ran with flying the planes.

Step #2 – Organize your data in some kind of order
The factors for you organization should be the type of plane and the number of the flight.

Step #3 – Create a horizontal line

Step #4 – Make a mark above the horizontal line every time the data occurs



Step #5 – Interpret the data
In this example flight #3 flew the furthest and flight #2 the shortest.

Final Reflection

Students can reflect on one or more of these topics. These can be written, in a discussion, or paired and shared.

- Do you think it was important for everyone in the group to have a specific role? What advantages did it provide? What were the disadvantages?
- Did your group work well together? If they did, why do you suppose this was? If not, why do you think that was?
- If you had a choice to work on this project by yourself or with a group, which would you choose and why?
- Why do you suppose it is important to learn how to work in a group? How often do you think you will need to work in groups when you are older?
- What could your group have done to have worked better together and produced a better project?

	Data	Group work
Great	• Data is organized clearly so you can tell what the results were • Data is labeled correctly making it accurate and easy to understand	• Student contributed to their part of the experiment as well as others • Student made themselves a valuable member of the group by offering positive contributions to the group dynamic
Good	• Data is organized for the most part so you can tell what the results were, but a couple of places where it is not • Data is mostly labeled correctly, making it accurate and easy to understand, but a couple of places where it is not	• Student contributed to their part of the experiment but not a lot for others • Student made themselves a valuable member of the group most of the time by offering positive contributions to the group dynamic, but a few times when they were negative or a distraction
Needs improvement	• Data is not well organized making it difficult to tell what the results were • Data is mislabeled in a lot of places, making it inaccurate and difficult to understand	• Student did not even contribute to their part of the experiment • Student did not contribute positively to the group dynamic, often times being negative or a distraction