Designer Planes Teaching Standards

This lab will allow students to

AP 1 “Big Ideas”:

Big Idea 1: Objects and systems have properties such as mass and charge. Systems may have internal structure.

Big Idea 3: The interactions of an object with other objects can be described by forces.

Big Idea 4: Interactions between systems can result in changes in those systems.

Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.

PHYSICS TEKS: [1A,B; 2A-F; 3A,B]

1. Science Processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

a. Demonstrate safe practices during field and laboratory investigations: and

b. Make wise choices in the use and conservation of resources and the disposal or recycling of materials

2. Scientific Processes. The student uses scientific methods during field and laboratory investigation. The student is expected to:

a. Plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;

b. Make quantitative observations and measurements with precision.

c. Organize, analyze, evaluate, make inferences, and predict trends from data; and

d. Communicate valid conclusions.

e. Graph data to observe and identify relationships between variables and

f. Read the scale on scientific instruments with precision.

3. Scientific Processes. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

a. Analyze, review and critique, scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;

b. Express laws symbolically and employ mathematical procedures including vector addition and right-triangle geometry to solve.

LAB 02-1: Scientific Methods Review **Name:** ______________________________

Physics – McNutt Date: __________ Period: __________

Designer Planes

Please follow the directions for this lab carefully. *An essential component of this lab assignment is following all CHAMPS expectations during Teacher instruction & Student Lab activities*. See the attached rubric for further details regarding how you will be graded.

Background

In this lab you will design a paper airplane and observe its flight. You will work in pairs. Each pair will create one paper airplane and observe: [1.] How far it flies in a straight line (*cm*), and [2.] its "Hang-time" (How long it stays in the air, in seconds (*s*). We will have a competition to see what plane can achieve the longest flight (cm) and longest hang-time (s).

After you have collected data for flight – **distance and hang-time for FIVE trials**, you will use two physics equations to calculate your paper airplane's average velocity and the force you have exerted on the paper airplane with your throw. (It will be helpful to note that one piece of paper has a mass of 4.5*g*).

Materials

8.5" x 11" White Copy Paper	Scissors (optional)
Meter Sticks	Stopwatch
Science Binder	Pencil or Pen

Procedure:

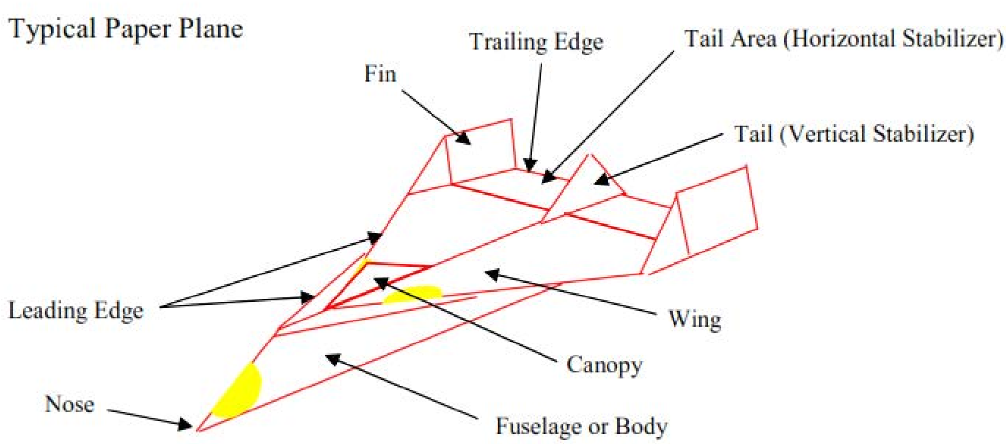
Part 01:

1. Select a partner to work with for this activity. Some classes may have groups of three.
2. Obtain the necessary materials to complete the assignment. You will need one piece of paper, and markers to decorate and label your plane. Each student will be responsible for submitting their own set of results.
3. Construct a paper airplane out of one piece of paper. You may use scissors to modify the design, but no additional materials are to be used.
4. Find the **area** of your **wings** in **cm^2**. **Record this measurement in your notes**. We will be compare wingspan area, flight time and distance in future classes.
5. With the class, proceed to the lab. Ms. McNutt has marked off the launch line for your planes.

6. Once you are in the lab, you will pair with another group. Between the four of you, you will test your planes. **Each group will have a timer and a metre stick. You will need to collect the flight time AND distance for 5 different launches of your plane.** You will need to move quickly to ensure that you have time to finish. Record the distance traveled in centimeters!
7. After you have all of your data for your plane we will return to the classroom to build graphs and work on the physics equations for each plane. *Don't worry if the formulas don't make sense at first in a few days, we will have enough notes to complete the assignment.*

Parts of a Paper Airplane

Before getting started on learning about paper airplanes we need to look at the terminology for the different parts that may make up a paper plane:



Record Initial Observations

Measure the dimensions of your airplane and draw a detailed illustration to scale in the space below. Use the diagram on the previous page to label the parts of your plane.

Scale:

Dimensions of Airplane (*cm*)

Length (nose tip to tail): ___________________________

Wingspan: _______________________________ *(Wingspan is always measured in a straight line, from wingtip to wingtip, independently of wing shape or sweep.)*

Type of wings: ________________________________

Area of your wings (cm^2): ____________________________

Determining the Area of your wings (cm^2)

Constant-Chord Wings: Calculate the wing area of constant-chord wings by measuring the width of either wing and multiplying that by the length of both wings taken together. Constant-chord wings are rectangular wings that do not change width at any point in their length. Measure the length from the end of one wing to the end of the opposite wing, including the fuselage.

Tapered Wings: Calculate the area of tapered wings by first determining their average chord. Average chord is the width of the wing tip divided by the width of the wing at the point where the wing joins the fuselage, or plane body. Multiply this figure by the overall wing span.

Triangular-Shaped Wings: Calculate the area of triangular-shaped wings, known as "delta wings," the same way you would figure the area of a triangle. Multiply the combined length of the wings by the width of the wing as measured against the fuselage. Divide the result in half to obtain the area.

Multi-Taper Wings: Determine the area of wings with multiple tapers by dividing the wings of your model airplane into separate sections. Sections should be divided at whatever point the taper beings to change. Measure each section according to one of the formulas in Steps 1 through 3, depending on the section's shape.

Multi-Wing: Determine the wing area of multi-wing aircraft by calculating the area of each set of wings and adding or multiplying them together.

Record Data

Trial #	**Distance (*cm*)**	**Time (*s*)**	*Flight Path Errors?*
1			
2			
3			
4			
5			

Part II:

1. Modify your original airplane design, making substantial changes to alter the flight path and hang time.
2. List your variables and constants (controlled) in the data table below.
3. Determine any changes to the **area** of your **wings** in **cm^2**. **Record this measurement in your notes** for comparison.
4. When instructed, please proceed to the lab. Ms. McNutt has marked off the launch line for your planes.
5. Once you are in the lab, you will pair with another group. Between the four of you, you will test your planes. **Each group will have a timer and a metre stick. You will need to collect the flight time AND distance for 5 different launches of your plane.** You will need to move quickly to ensure that you have time to finish. Record the distance traveled in centimeters!
6. After you have all of your data for your plane we will return to discuss the relationship of your variables to your results.
7. After you have all of your data for your plane we will return to the classroom to build graphs and work on the physics equations for each plane. *Don't worry if the formulas don't make sense at first in a few days, we will have enough notes to complete the assignment.*

Example Chart for IV, DV & Controls

Student Action	Purposely Changed **Independent Variable**	Response to Change **Dependent Variable**	Remained the Same **Constant**
Refolded Added Clips Added Tape	Wing Shape Center of Gravity Weight of Plane	Flight Time Total Distance Straight Travel Flight Path/Trajectory	Size of Paper Texture of Paper Weight of Paper

Essential Questions to Answer (in Complete Sentences)**:**

1.) What actions did you perform on your plane?

2.) What did you purposely change about your plane? (Independent Variable)

3.) How did you determine your plane's response? (Dependent Variable)

4.) What remained the same about your plane? (Control)

Record Data

Trial #	Distance (*cm*)	Time (*s*)	*Flight Path Errors?*
1			
2			
3			
4			
5			

Part III: Graphing Results

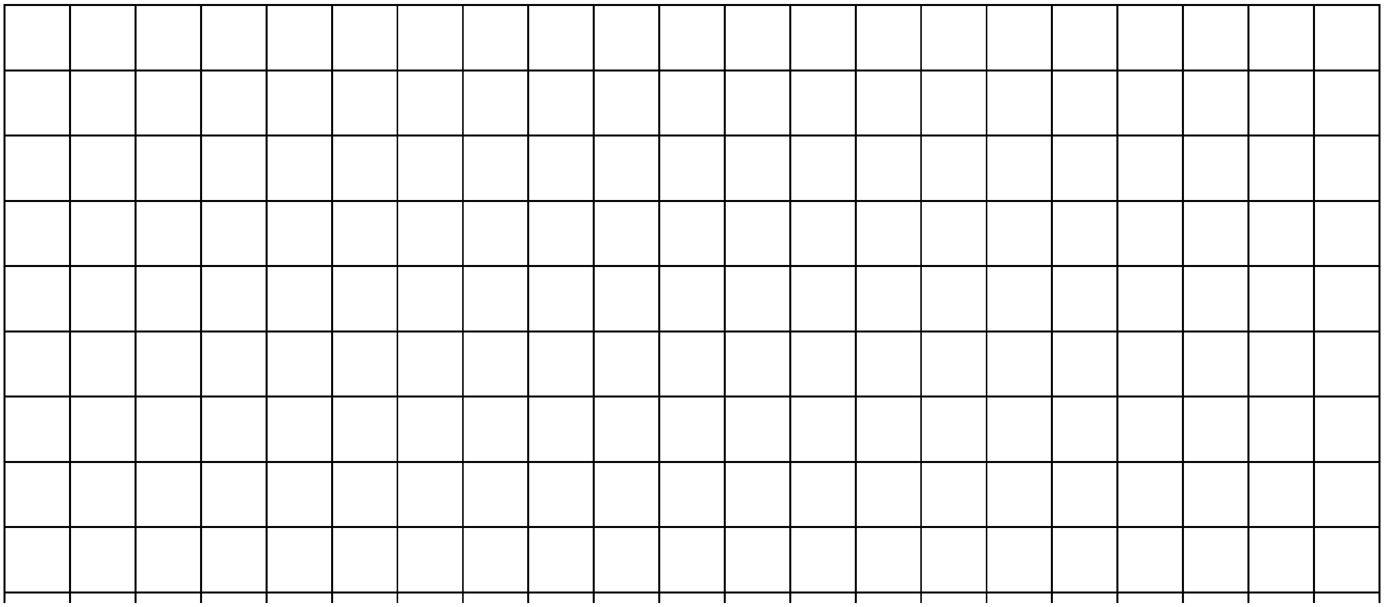
Determine Average Velocity using the following steps:

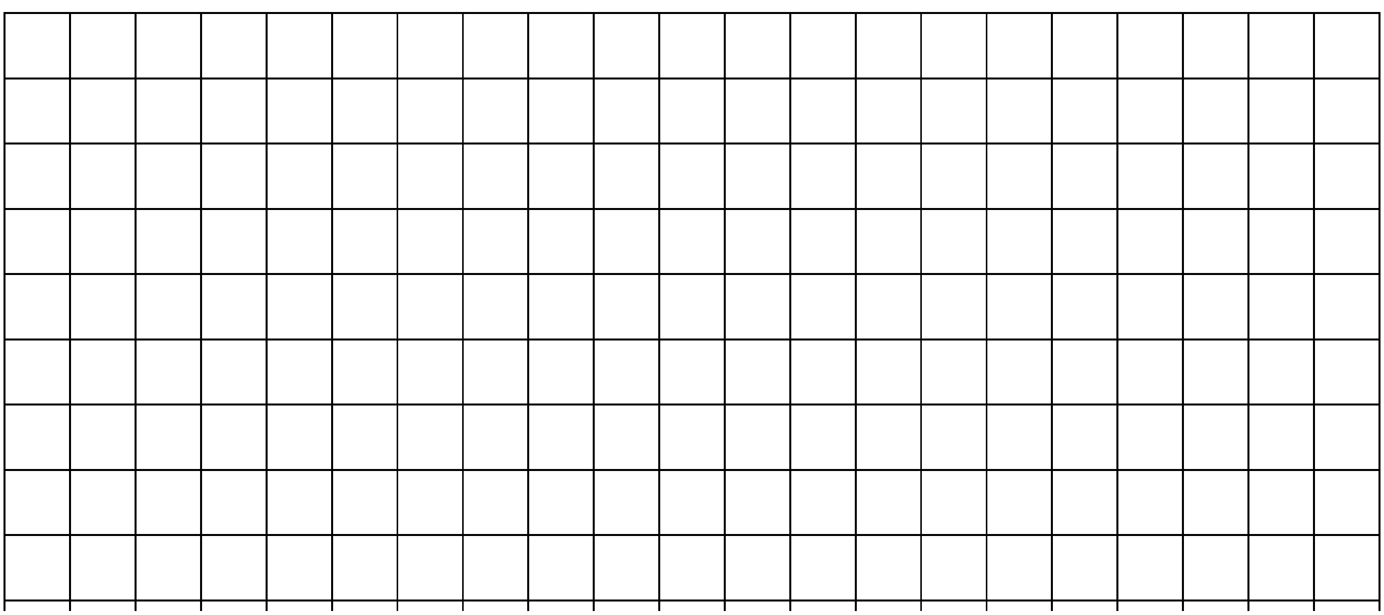
1.) Divide the plane course into even segments every 3 tiles.
2.) Measure and record the distance, in centimeters, at each tile mark.
3.) Group members will stand at each spot. All will start their timers when the plane is released.
4.) Each group member will record the time when the plane passes over their mark
5.) Use the distances recorded (in cm) for each time recorded (in seconds) to the create two graphs below:

Graph #1 - Position vs. Time graph

Graph #2 - Velocity vs. Time graph

Pay attention to what variables are placed upon each axis! Use the provided graph paper and attach them to your lab for submission.





LAB #02-1: Designer Planes **Name:** ___________________________________

Physics – McNutt Date: ____________ Period: ___________

Lab#02-1 – Grading Rubric					
Criteria		**4**	**3**	**2**	**1**
PARTICIPATION	**CHAMPS EXPECTATIONS**	Follows CHAMPS instructions 100% of the time. On-task conversations.	Follows CHAMPS instructions 75% of the time. Talking at inappropriate level or time.	Follows CHAMPS 50% of time. Excessive talking prevents completing tasks in time provided.	"What is CHAMPS?"
	LAB PARTICIPATION	Follows instructions the first time, shares task responsibility effectively with partners.	Follows instructions 75% of the time, but relies on others to complete much of the work.	Excessive talking or off-task behavior (off-task phone use, head down) prevents completing tasks in time provided.	"Wait…What are we doing?" Any form of arguing rather than following directions the first time.
TASK COMPLETION	**Procedures:** **Measurements & Scale Drawing** **Data Tables**	Completes accurate illustration, measurements & data table	Mostly accurate illustration, measurements & data table	Illustration, measurements & data table have significant errors that are not readily corrected.	Does not complete all of the work.
	Overall Lab Performance **&** **Work During Class**	Positive, working to complete each step of lab. Completed ON-TIME & Stayed ON-TASK for the duration of the lab. CLEANS UP after self!	Positive, working to complete each step of lab. Completed ON-TIME & Stayed ON-TASK for the majority of lab	Off-task conversations caused you to miss instructions. Your work was not your best effort.	Horse-play, off-task. "Wait…I had to make my own tables too?"