Unit Title: Flying High, Incoming Eighth Grade Scientific Inquiry Baseline Skills **Date Developed/Last Revised:** May 21, 2013 **Unit Author(s):** Maggie Prevenas	**Grade Level:** 8 **Time Frame:** 10 45-min classes **Primary Content Area:** Science, Math and Engineering

UNIT DESCRIPTION:
Incoming eighth grade students are assessed to determine their level of scientific inquiry skills. In this introductory unit, students build a paper airplane model, and calculate the surface area of the wings. They use this data to provide quantitative evidence of a relationship between area of wing and distance flown. In a subsequent lab, students are exposed to different concepts associated with flight using different activity stations. Summative assessment is done with application of the Engineering Design Process (EDP) to improve student airplane models.

Big Ideas (Student Insights that Will Be Developed Over the Course of the Unit):

- Scientific explanations emphasize logical conclusions based on evidence collected.
- Science and technology are reciprocal.
- Scientific investigations sometimes result in new ideas/questions to study, methods of study, or new technologies to enhance such studies.
- Mathematics is important in scientific inquiry to express and analyze information numerically.
- Engineering Design Process applies science concepts to problems in order to create solutions.

Essential Questions (Questions that Will Prompt Students to Connect to the Big Ideas):

- How can scientific inquiry support the engineering design process?

	BENCHMARKS/STANDARDS/LEARNING GOALS
Science	HCPS lll **SC Standard 1:** The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process **SC Standard 2:** The Scientific Process: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated
Technology	HCPS III **CTE Standard 1:** TECHNOLOGICAL DESIGN : Design, modify, and apply technology to effectively and efficiently solve problems

	CTE 8.2.1: Apply appropriate and safe behaviors for the school, community, and workplace **SC 8.2.1:** Describe significant relationships among society, science, and technology and how one impacts the other
Engineering	HCPS III **CTE Standard 1:** TECHNOLOGICAL DESIGN : Design, modify, and apply technology to effectively and efficiently solve problems
Mathematics	CCSS.Math.Content.7.G.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.
STEM Competencies	**Indicator 3.3:** Generates new and creative ideas and approaches to developing solutions

LESSON SEQUENCE

	Lesson Title/Description	Learning Goals (What Students Will Know and Be Able to Do)	Assessments	Time Frame
1	Paper Plane Inquiry	• Write a question that can be investigated using an experiment • Create an experiment that answers a question and that tests for one variable • Identify the dependent and independent variable in an investigation • Write a hypothesis that uses the independent and dependent variable in a statement • Create a data table to record data as evidence in an investigation • Measure and label data accurately • Analyze data to verify if there is evidence to support or refute a hypothesis • Select appropriate units to measure objects or distance • Identify ways to improve testing methods to avoid and control error	Paper Airplanes & Scientific Methods Baseline Lab Assessment and Rubric	90 min
2	Control Freak	• Identify the dependent and independent variable in an investigation	Formative-Activity Guide Ticket Out the Door	45 min
3	Go Fly a Plane Rotation Lab	• Understand the numbering language used for airplanes • Create two identical aircraft for the EDP activity • Calculate surface area using two different processes • Explain how airplanes fly • Describe similarities and differences between natural flight and human created flight	Formative-Activity Guide Ticket Out the Door	90 min
4	Calculating Surface Area of Wings	• How are geometric designs used to calculate the surface area of airplane wings?	Formative-Learning Guide Ticket Out the Door	90 min
5	Foil Sim: You Can't Eat This Applet	• Practice using applets as a way to learn science and math concepts • Explain how different variables influence flight	Formative-Learning Guide Ticket Out the Door	45 min
6	Back to the Drawing Board- EDP	• Use the Engineering Design Process to improve a paper airplane • Solve real-life and mathematical problems using numerical and algebraic expressions and equations • Why is it important to create solutions and solve problems using both divergent (EDP) and convergent techniques (SI)	Summative-Presentation and Rubric Student EDP Guide Journal Reflection	90 min

Unit Title: Flying High Lesson Title: Paper Plane Inquiry Date Developed/Last Revised: May 21, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 1 Grade Level: 8 Primary Content Area: Science Time Frame: 90 minutes

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **Standard 1:** The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Write a question that can be investigated using an experiment
- Create an experiment that answers a question and that tests for one variable
- Identify the dependent and independent variable in an investigation
- Write a hypothesis that uses the independent and dependent variable in a statement
- Record data in a data table as evidence in an investigation
- Measure and label data accurately
- Analyze data to verify if there is evidence to support or refute a hypothesis
- Select appropriate units to measure objects or distance
- Identify ways to improve testing methods to avoid and control error

2B. Assessment Tools/Evidence:

Summative:

- Paper Airplanes & Scientific Methods Baseline Lab Assessment and Rubric

3. Learning Experiences (Lesson Plan)

Materials: (per group)

- Three different colors of regular weight paper, 200 sheets of each color
- Tape
- Metric ruler or trundle wheel
- Scale/balance
- Graph paper
- Six different airplane models with instructions
- Scissors
- Lab guide

Handouts/Other Resources:

- Student Inquiry Skills Rubric: Taken directly from http://www.education.ne.gov/science/Documents/InquiryRubric.pdf
- Paper Airplanes & Scientific Methods Baseline Lab Assessment
- NASA paper plane directions: http://futureflight.arc.nasa.gov/designs/index.html

Procedure:

- Tell students this lab is meant to assess the level of science skills they have as they enter 8th grade. This is called a baseline assessment.
- Have students choose 1 of the different models of airplane, and have them practice cutting and folding their model they chose.
- Hand out Paper Airplanes & Scientific Methods Baseline Lab Assessment. Tell the students you are assessing what level of science skills they have by having them do this lab independently.
- Allow students to follow basic instructions, and complete the lab.
- Students will write/draw in their journal 'What skills do I have and what do I need to improve?' Also 'What am I looking forward to learning this year?'

Homework Activity (Optional):

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7) **Completed by teacher after instruction has taken place**
4. Teaching and Collecting of Evidence of Student Learning: Teacher Notes:
5. Analysis of Student Products/Performances - Formative: Teacher Notes:
6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes:

Name ____

Paper Airplanes & Scientific Methods Baseline Assessment

1. Identify and state the question or problem.

2. Research.

- Look at the different airplanes, what they are called, and read the descriptions.
- Decide which airplane design to test (choose from the models).
- Ask yourself, why do you think this airplane model is better than the others?
- Choose one variable that you believe will help the airplane fly further if adjusted. Choices may include, but are not limited to, changing the center of gravity, making the airplane from a lighter weight paper, or enlarging the surface of the wing.

3. State a hypothesis.

Based on what you know about paper airplanes, write a hypothesis that states which variable you will adjust for the paper airplane design to help it to fly the greatest distance, and why you think this. Use complete sentences.

4. Experimental design.

1. Select and fold two paper airplanes of the same model. These two planes should be identical to each other.
2. Fold two more paper airplanes of the same model, but with a modification to help it fly farther. These two planes should be identical to each other.
3. Pick a spot to launch the planes each time.
4. Throw the airplanes 3 times each and average the distance they flew.
5. Identify the independent and dependent variable in your investigation.

5. Record the data.

Table 1: Distance flown by paper airplanes

Type of Airplane	Trial 1	Trial 2	Trial 3	Average Distance
Airplane 1: Control 1				
Airplane 2: Control 2				
Airplane 3:Experimental 1				
Airplane 4: Experimental 2				

6. Analyze the data.

Making a graph is a good way to help analyze data. A graph makes a picture of the data and can help you visualize the patterns, trends, and relationships. It is very important to use the right kind of graph when analyzing data. In this investigation, you compared different kinds of paper airplanes. Any time you are comparing data, a Bar Graph is the most appropriate type of graph to use. Make sure you explain how the data provides evidence to support or refute your hypothesis.

Attach Graph

7. Draw a conclusion. (Please write in complete sentences!)

Use your graph to explain how your hypothesis is supported or refuted by the data, and explain how you would change the experimental design to eliminate error. If you were to do another investigation, what new modification would you make to make the plane fly farther?

INQUIRY STUDENT SCORING RUBRIC
MIDDLE SCHOOL
(GRADES 6-8)

Abilities necessary to do scientific inquiry:

	1. Beginning	2. Progressing	3. Proficient	4. Exemplary
A. Identifying Questions and Formulating Hypotheses that May be Examined through Scientific Investigations	Testing the question is not possible; hypothesis is missing or unclear	Formulates testable questions which lead to a scientific investigation; even though the hypotheses is present it does not directly answer the question	Formulates testable questions and hypotheses that lead to scientific investigation	Formulates testable questions and hypotheses that are specific, based on scientific concepts, and lead to scientific investigation
B. Designing and Conducting a Scientific Investigation	Little attempt is made to control and manipulate variables; design of investigation contains major flaws in sequence and logic; extensive teacher intervention is necessary	Flaws are evident in identifying variables; design of investigation contains minor flaws; some teacher intervention is necessary	Identifies what variable is controlled and what variables are manipulated; design of investigation is sequential and logical; experimental design requires minimal teacher intervention	Identifies what variable is controlled and what variables are manipulated; design of investigation is sequential and logical to the hypothesis; experimental design requires minimal teacher guidance
C. Using Appropriate Tools and Techniques to Collect and Record Data	Collects and records invalid data; uses inappropriate equipment and techniques; data collected contains inaccuracies in measurement which alter the results; required extensive teacher intervention or guidance	Collects and records objective data; incorrectly uses equipment and techniques; requires some teacher intervention	Collects and records complete and objective data; uses appropriate equipment and techniques; requires minimal teacher intervention	Collects and records data which is complete, accurate, and objective; uses appropriate equipment and techniques; requires minimal teacher guidance
D. Using Evidence to Develop Explanations and Describe Relationships between Evidence and Explanation	Students are unable to draw inferences (interpretation of an observation)	Students draw faulty inferences based on patterns or previously held ideas	Students draw inferences based on relationships, perceived patterns, or previously held ideas	Data is analyzed objectively; students draw logical inferences based on observed patterns and relationships; inferences lead to questions for future investigations
E. Communicating Procedures, Results, and Explanations of a Scientific Investigation	Scientific information is unclear; presentation lacks focus and organization; medium hinders communication	Scientific information has some clarity; presentation has some focus and organization; medium permits communication	Scientific information is communicated clearly; presentation is focused and organized; medium facilitates communication	Scientific information is communicated clearly and precisely but may also include inventive/expressive dimensions; presentation is effectively focused and organized (e.g., using tables, models, texts, figures); a variety of media enhance communication

Unit Title: Flying High Lesson Title: Control Freak Date Developed/Last Revised: May 21, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 2 Grade Level: 8 Primary Content Area: Science Time Frame: 90 minutes

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **Standard 1:** The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Identify the dependent and independent variable in an investigation

2B. Assessment Tools/Evidence:

Formative:

- Control Freak Student Activity Guide
- Ticket Out the Door- In your own words, explain which presentation helped you understand variables the most. Why do you think that?

Summative:

3. Learning Experiences (Lesson Plan)

Materials:

- Individual student whiteboard or similar surface that can be used as a visual for student presentations
- Dry erase markers
- Colored pencils
- Construction paper

Handouts/Other Resources:

- 5-8 Control Freak situations, printed out and laminated. As an example, 5 situations attached are from the following online resources.
  http://sciencespot.net/Media/scimethodconvar.pdf
  http://sciencespot.net/Media/scimethodconvar2.pdf
- Control Freak Student Activity Guide

Procedure:

- Lab groups (four students) explain the results of one experiment conducted at 'Bikini Bottom.'
- The students are given 30 minutes to identify the answers and develop their lab group presentation to teach the other students in the class.
- They may choose any way to present this information: white boards, posters, acting, or a

game.

- While a group is presenting, the class listens attentively to the results of the experiments, noting the responses in their activity guides, and then questioning each group about their results.
- Students write their answers on the Control Freak Student Activity Guide and hand in activity guide when completed.
- Ticket Out the Door- In your own words, explain which presentation helped you understand variables the most. Why do you think that?

Homework Activity (Optional):

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7) **Completed by teacher after instruction has taken place**
4. Teaching and Collecting of Evidence of Student Learning: Teacher Notes:
5. Analysis of Student Products/Performances - Formative: Teacher Notes:
6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes:

Control Freak Investigations

1 - Patty Power

Mr. Krabbs wants to make Bikini Bottoms a nicer place to live. He has created a new sauce that he thinks will reduce the production of body gas associated with eating crabby patties from the Krusty Krab. He recruits 100 customers with a history of gas problems. He has 50 of them (Group A) eat crabby patties with the new sauce. The other 50 (Group B) eat crabby patties with sauce that looks just like new sauce but is really just mixture of mayonnaise and food coloring. Both groups were told that they were getting the sauce that would reduce gas production. Two hours after eating the crabby patties, 30 customers in group A reported having fewer gas problems and 8 customers in group B reported having fewer gas problems.

2 - Slimotosis

Sponge Bob notices that his pal Gary is suffering from slimotosis, which occurs when the shell develops a nasty slime and gives off a horrible odor. His friend Patrick tells him that rubbing seaweed on the shell is the perfect cure, while Sandy says that drinking Dr. Kelp will be a better cure. Sponge Bob decides to test this cure by rubbing Gary with seaweed for 1 week and having him drink Dr. Kelp. After a week of treatment, the slime is gone and Gary's shell smells better.

3 - SpongeBob Clean Pants

SpongeBob noticed that his favorite pants were not as clean as they used to be. His friend Sandy told him that he should try using Clean-O detergent, a new brand of laundry soap she found at Sail-Mart. SpongeBob made sure to wash one pair of pants in plain water and another pair in water with the Clean-O detergent. After washing both pairs of pants a total of three times, the pants washed in the Clean-O detergent did not appear to be any cleaner than the pants washed in plain water.

4 - Marshmallow Muscles

Larry was told that a certain muscle cream was the newest best thing on the market and claims to double a person's muscle power when used as part of a muscle-building workout. Interested in this product, he buys the special muscle cream and recruits Patrick and SpongeBob to help him with an experiment. Larry develops a special marshmallow weight-lifting program for Patrick and SpongeBob. He meets with them once every day for a period of 2 weeks and keeps track of their results. Before each session Patrick's arms and back are lathered in the muscle cream, while Sponge Bob's arms and back are lathered with the regular lotion.

Time	Patrick	Spongebob
Initial Amount	18	5
After 1 Week	24	9
After 2 Weeks	33	17

5 - Krusty Krabs Breath Mints

Mr. Krabs created a secret ingredient for a breath mint that he thinks will "cure" the bad breath people get from eating crabby patties at the Krusty Krab. He asked 100 customers with a history of bad breath to try his new breath mint. He had fifty customers (Group A) eat a breath mint after they finished eating a crabby patty. The other fifty (Group B) also received a breath mint after they finished the sandwich, however, it was just a regular breath mint and did not have the secret ingredient. Both groups were told that they were getting the breath mint that would cure their bad breath. Two hours after eating the crabby patties, thirty customers in Group A and ten customers in Group B reported having better breath than they normally had after eating crabby patties.

Control Freak Student Activity Guide

An initial observation is something you notice and want to fix or know more about.
An **independent variable** is what you are testing.
The **dependant variable** is what the independent variable is supposed to change.
The **control group** is the group that nothing is done to. They get the fake or placebo instead of whatever you are testing.

1 - Patty Power

a. Which people are in the control group?

b. What is the independent variable?

c. What is the dependent variable?

d. What should Mr. Krabs' conclusion be?

2 - Slimotosis

a. What was the initial observation?

b. What is the independent variable?

c. What is the dependent variable?

d. What should Sponge Bob's conclusion be?

3 - SpongeBob Clean Pants

a. What was the problem SpongeBob wanted to investigate?

b. What is the independent variable?

c. What is the dependent variable?

d. What should Sponge Bob's conclusion be?

4 – Marshmallow Muscles

a. Which person is in the control group?

b. What is the independent variable?

c. What is the dependent variable?

d. What should Larry's conclusion be?

5 - Krusty Krabs Breath Mints

a. Which people are in the control group?

b. What is the independent variable?

c. What is the dependent variable?

d. What should Mr. Krabs' conclusion be?

<u>Ticket Out The Door</u>

In your own words, explain which presentation helped you understand variables the most. Why do you think that?

Unit Title: Flying High Lesson Title: Go Fly A Plane Rotation Lab Date Developed/Last Revised: May 21, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 3 Grade Level: 8 Primary Content Area: Science Time Frame: 90 minutes

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.8.2.1:** Describe significant relationships among society, science, and technology and how one impacts the other

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Describe the numbering language for airplanes
- Create two identical aircraft for the EDP activity
- Calculate surface area using two different processes
- Explain how airplanes fly
- Describe similarities and differences between natural flight and human created flight

2B. Assessment Tools/Evidence:

Formative:

- Go Fly A Plane Activity Guide
- Ticket out the Door- Of all the activities you did today, explain-
  a. Which was your favorite?
  b. From which one did you learn the most? How do you know that?
  c. Which one was your least favorite? Why do you think so?
  d. What do you still have questions about?

Summative:

3. Learning Experiences (Lesson Plan)

Materials:

- Station 1-Laminated Aviation Alphabet from http://en.wikipedia.org/wiki/NATO_phonetic_alphabet, 2/19/13
- Station 2-Print out 150 sheets of 1 cm graph paper from http://www.mathsphere.co.uk/resources/documents/blue1cmsq.pdf, 02/19/2013
- Station 3-Print out and laminate 4 sets of directions from http://www.grc.nasa.gov/WWW/k-12/Summer_Training/Elementary97/dart.html, 2/19/13
- Station 4-Set up computer to BrainPOP website, 'How Things Fly?' http://www.brainpop.com, 2/19/2013 Access to BrainPOP requires a paid subscription.
- Station 5-Print out question 'How are plane wings similar to/different from bird wings?'
- Station 6–Print out 4 copies of the student reading 'Gadgets' from http://www.brainpop.com, key search term "flight," sub category 'flight activities.'

Handouts/Other Resources:

- Go Fly A Plane Activity Guide
- 'Ticket Out the Door' Response (Half sheet of paper with 'Ticket Out the Door' as heading)
- Lab Stations 1,2,3 adapted from this NASA online resource: http://www.grc.nasa.gov/WWW/k-12/aerosim/LessonHS97/paperairplaneac.html
- Lab Station 4,5,6 adapted from activities from online subscription to: http://www.brainpop.com, key search term "flight"

Procedure:

- Students pick up Go Fly A Plane Activity Guide upon entering classroom.
- Tell students they will be doing a rotation lab today. A rotation lab is where lab groups rotate to different stations after being in the station for 10 minutes. An auditory sign (drum beat) will let them know to change to the next station.
- Give students a brief summary of all 6 stations. As stations are explained, walk from station 1 to 2, to 3, to 4, to 5, to 6, back to one.
- Tell students if they don't get done with a station, they are permitted to return to the station, after all students have completed the lab. They may also come during recess to complete the station.
- Assign a lab station to each lab group. Tell them to walk over to their assigned station, and begin.
- Beat the drum after 10 minutes to advance each group.
- Repeat until all lab groups have advanced through all the stations.
- Students return to their assigned seats and complete the questions on the Go Fly A Plane Activity Guide.
- Allow students to return to lab station they have not completed, if necessary.
- Have students turn in their Go Fly A Plane Activity Guide along with the half slip "Ticket out the Door" formative assessment as they exit the room.

Homework Activity (Optional):

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Make sure to check student exit tickets for evidence of student learning.
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Station 1, 2, and 3 were adapted from the NASA Paper Plane Activity.www.grc.nasa.gov/WWW/K-12/aerosim/LessonHS97/paperairplaneac.html

Go Fly A Plane
Activity Guide

Rotation Station Lab for Multiple Intelligences

Station 1- Name that Plane!
Use the aviation alphabet to create a name for your airplane. The only two rules are you may not use more than 7 numbers or letters and the name must begin with N, which stands for the United States.
The name of my airplane is:
N ____

Write your airplane's name using Telephony:

November ____
Aviation alphabet from: Wikipedia,
http://en.wikipedia.org/wiki/NATO_phonetic_alphabet, 2/19/2013

Station 2
You can find out the surface area of your wings through counting. Use the model provided or your own paper airplane wing on the piece of graph paper. Count the number of cm squares that are part of the wing. Write the number here.

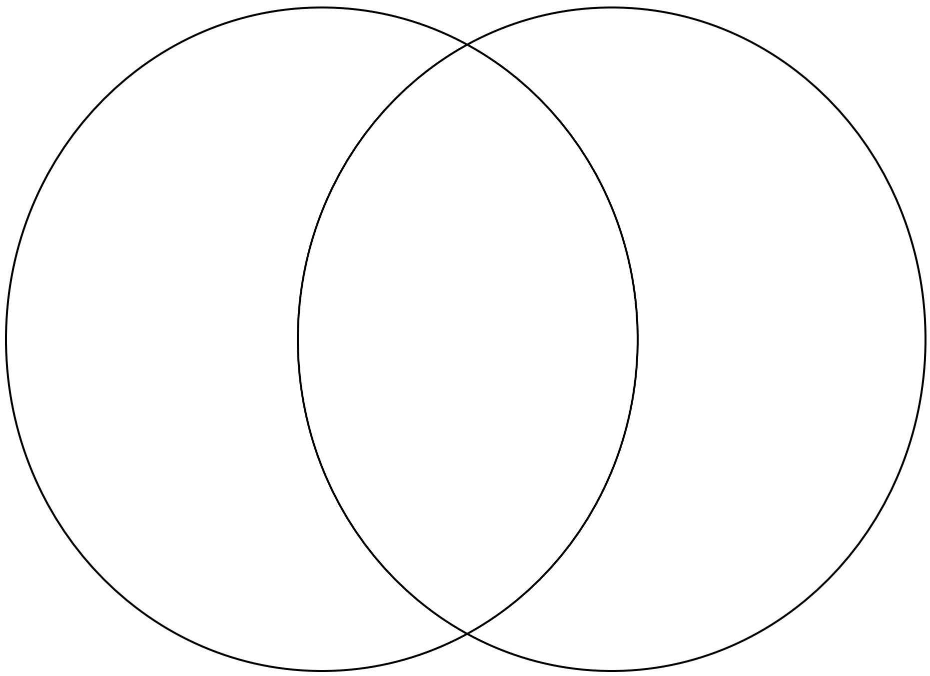
____
Use this number to calculate the total surface area of your wings.
(Graph paper from: Math Sphere,
http://www.mathsphere.co.uk/resources/documents/blue1cmsq.pdf, 2/19/2013)
EXPLAIN, how did you calculate the surface area using graph paper?

Station 3- The Perfect Plane
Here are directions to make a dart. The dart is considered to be an excellent model for this paper airplane investigation. Make another dart exactly like the first one. Now you have two darts. Yay! Name your planes using the name you created at Station 1. Write the name on each plane.

Station 4 (http://www.brainpop.com- search keyword FLIGHT)
BrainPOP: How Things Fly?
Watch the BrainPOP streaming video. After watching it, take the post test. You may talk with each other to ask questions or figure out answers. Write your answers below.

1 ___	6 ___
2 ___	7 ___
3 ___	8 ___
4 ___	9 ___
5 ___	10 ___

Station 5
How is a Bird Wing Like a Plane Wing? (How does technology mirror nature?)
Compare and Contrast Using A Venn Diagram. Write 3 ways they are the same, and 5 ways they are different.



Station 6 (Article from Flight Activities-Brainpop.com)
Read the article ‘Gadgets.’ Answer these questions using information from the reading.

1. What’s an entomopter?

2. Why is it being considered for future Mars Missions?

3. How is Mars atmosphere different than Earth?

Name: ____________________________ Date: _________

Ticket Out the Door

Of all the activities you did today, explain-

1. Which was your favorite?
2. From which one did you learn the most? How do you know that?
3. Which one was your least favorite? Why do you think so?
4. What do you still have questions about?

Name: ____________________________ Date: _________

Ticket Out the Door

Of all the activities you did today, explain-

1. Which was your favorite?
2. From which one did you learn the most? How do you know that?
3. Which one was your least favorite? Why do you think so?
4. What do you still have questions about?

Unit Title: Flying High Lesson Title: Calculating Surface Area of Wings Date Developed/Last Revised: May 21, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 4 Grade Level: 8 Primary Content Area: Science Time Frame: 90 minutes

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- CCSS.Math.Content.7.B.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Use geometric shapes to determine the surface area of airplane wings
- Measure model airplane wings and use area formulas to determine surface area of wing

2B. Assessment Tools/Evidence:

Formative:

- Student Learning Guide: Calculate Surface Area of Plane Wings
  Students, in small groups, are given a model airplane (wing) and asked to determine (solve) the surface area of that wing. They will hand in their written solution as a formative assessment.
- Ticket Out the Door-List three things I (teacher) can do to improve this learning guide.

Summative:

3. Learning Experiences (Lesson Plan)

Materials:

- Cardstock set of geometric shapes for each table of two students (use the shapes from Surface Area of Wing,

http://www.grc.nasa.gov/WWW/K-12/aerosim/LessonHS97/areaact.html, 2/19/13, as a guide

Handouts/Other Resources:

- How To Find Surface Area of Plane Wing:

http://www.grc.nasa.gov/WWW/K-12/aerosim/LessonHS97/WingArea.html, 2/19/2013

- Surface Area Gallery of Airplane Wings :

http://www.grc.nasa.gov/WWW/K-12/aerosim/LessonHS97/Timsplanes.html, 2/19/2013

- Student Learning Guide: Calculate Surface Area of Plane Wings.
  - It is strongly recommended to print out a graph, or have graph paper available to help students visualize the problems.
- Ticket Out the Door

Procedure:

- Students pick up the Student Learning Guide: Calculate Surface Area of Plane Wings upon entering room.
- Review unit so far:
  - Students tested their inquiry skills to see where they were at start of year.
  - Students learned about variables from Sponge Bob.
  - Students experienced a rotation lab where they could see how science, technology, and society reinforce each other.
- Tell students we are going to learn how to calculate surface area of airplane wings using geometric shapes.
- Have students take geometric shapes and ask them if they can see geometric shapes in the model airplane wing? Which ones?
- Another way students can calculate the surface area of airplane wings is to calculate the geometric shapes found in the wing, and add the different areas together.
- Work as a class to calculate the basic airplane wing surface area found on this website:

http://www.grc.nasa.gov/WWW/K-12/aerosim/LessonHS97/areaact.html

- Discuss how student groups solved the wing surface area problem.
- Assign a model airplane wing from this webpage:

http://www.grc.nasa.gov/WWW/K-12/aerosim/LessonHS97/Timsplanes.html

- Students calculate the surface area of the assigned airplane wing model by explaining the steps they went through to solve it.
- Students use one of their model airplanes from The Paper Plane Inquiry (Lesson 2) and use geometric shapes to calculate the wing surface area of their original paper airplane.
- Ask students if they think there is a relationship between the area of the wing and the distance their airplane flew? Discuss.
- Ticket out the door: List three things I (teacher) can do to improve this learning guide.

Homework Activity (Optional):
Students can do an extension activity at home to determine the point at which increasing the surface area of the wings no longer makes the plane fly farther due to the added weight of the plane.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Student Learning Guide: Calculate Surface Area of Plane Wings

To calculate the surface area of your wings, you need to break the complex wing shape into a shape you recognize. Measure the dimensions. Assign a unit to the dimensions (cm, meter). Use the following formulas to calculate the area of your model wings.

The area of a **rectangle** is equal to the height **h** times the base **b**;

A = h * b

The equation for the area of a **trapezoid** is one half the sum of the top **t** and bottom **b** times the height **h**;

A = h * [t + b] / 2

The area of a **triangle** is equal to one half of the base **b** times the height **h**;

A = .5 * b * h

Some fins are **elliptically** shaped. For an **ellipse** with a semi-axis **a** and semi-axis **b**, the area is given by:

A = pi * a * b

where **pi** is the ratio of the circumference to the diameter of a circle and is equal to 3.1415. A special case of the ellipse is a **circle**, in which the semi-axis is equal to the radius **r**. The area of a circle is:

A = pi * r * r

If the root of an elliptical fin is given by **cr** and the distance from the root to the tip is given by **ct**, the area of the fin is:

A = pi * cr *ct

Practice: For a vehicle like the Space Shuttle, you have to break up the wing into simple shapes you measure, compute, and then add them together.

- Use the laminated shapes to create a wing the same shape as the space shuttle.
- Measure the different components to the nearest cm.
- Calculate each components area.
- Add all the components.

Write the name of your assigned plane.

Name of plane: ________________________________

List the steps you took to explain how you calculated the surface area of this plane.   Everyone in your group needs to be able to explain this process of finding surface area.

Name: ___________________________ Date: ________

Ticket Out the Door

List three things I (teacher) can do to improve this learning guide.

Name: ___________________________ Date: ________

Ticket Out the Door

List three things I (teacher) can do to improve this learning guide.

Unit Title: Flying High **Lesson Title:** Foil Sim: You Can't Eat This Applet **Date Developed/Last Revised:** May 21, 2013 **Unit Author(s):** Maggie Prevenas	**Lesson #:** 5 **Grade Level:** 8 **Primary Content Area:** Science **Time Frame:** 45 minutes

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **CTE 8.1.1:** Design, modify, and apply technology to effectively and efficiently solve problems

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Use applets as a way to learn and practice science and math concepts
- Explain how different variables influence flight

2B. Assessment Tools/Evidence:

Formative:

- Student Learning Guide: Foil Sim: Students write responses to questions while using the Foil Sim (elementary version) computer applet. From this practice, students are exposed to computer models that use variables to influence flight.

Summative:

3. Learning Experiences (Lesson Plan)

Materials:

- Download Foil Sim (elementary version) for classroom computers, Foil Sim website, http://www.grc.nasa.gov/WWW/k-12/FoilSim/index.html, 2/19/2013
- Overhead projector
- Computer stations, 1 for every two students

Handouts/Other Resources:

- Student Learning Guide: Foil Sim
- Ticket Out the Door: What did the simulation help you understand about the variables involved in airplane flight?

Procedure:

- Students pick up Student Learning Guide: Foil Sim, upon entering class.
- Introduce students to the Foil Sim (elementary) Program by doing one example problem.
- Ask students to open the applet and follow directions from learning guide and website, to complete the activity.
- When students have mastered the program (or completed the learning guides), invite them to share and show fellow students 3 interesting things they have learned from the applet.
- Students hand in learning guide. Discuss.

- Ticket Out the Door: Students respond to 'What did the simulation help you understand about the variables involved in airplane flight?'

Homework Activity (Optional):

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7) **Completed by teacher after instruction has taken place**
4. Teaching and Collecting of Evidence of Student Learning: Teacher Notes:
5. Analysis of Student Products/Performances - Formative: Teacher Notes:
6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes:

Student Learning Guide: Foil Sim

http://www.grc.nasa.gov/WWW/k-12/FoilSim/index.html

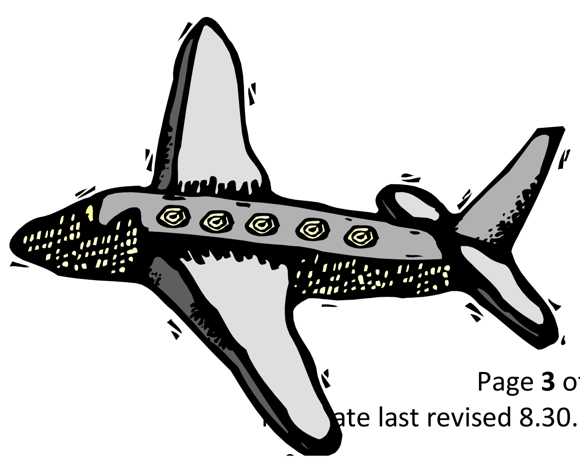
1. What happens to LIFT when you increase the angle? Why do you think this happens?

2. What else happens in the Foil Sim when angle is changed?

3. What happens to LIFT when you double the area? Why do you think this happens?

4. What happens to LIFT when you increase the altitude? Why do you think this happens?

5. What happens to LIFT when you increase the airspeed? Why do you think this happens?



Name: ____________________________ Date: _________

Ticket Out the Door

What did the simulation help you understand about the variables involved in airplane flight?

Name: ____________________________ Date: _________

Ticket Out the Door

What did the simulation help you understand about the variables involved in airplane flight?

Unit Title: Flying High Lesson Title: Back to the Drawing Board-EDP Date Developed/Last Revised: May 21, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 6 Grade Level: 8 Primary Content Area: Science/Engineering Time Frame: 135 minutes

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

HCPS III

- **CTE Standard 1:** TECHNOLOGICAL DESIGN: Design, modify, and apply technology to effectively and efficiently solve problems
- **CTE 8.2.1:** Apply appropriate and safe behaviors for the school, community, and workplace

Math CCSS

- CCSS.Math.Content.7.G.B.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

2A. Criteria- What Students Should Know and Be Able to Do:

- Use knowledge of airplane wing structure and function to design an original airplane model designed to fly as far as possible
- Use the Engineering Design Process to create a prototype that can be entered into The Greatest Airplane Ever Made
- Use math skills and formula to measure the surface area of the model wing as evidence of the quality of their prototype
- Present their prototype and experimental evidence to support their claim for "The Greatest Airplane Ever Made"

2B. Assessment Tools/Evidence:

Formative:

Summative:

- Prototype Airplane Created by Lab Group
- Group presentation of prototype for Greatest Airplane Ever Made
- Rubric "Greatest Airplane Ever Made" This rubric is provided as a guide. Teachers are encouraged to add to it or create a rubric with their students if they so desire.

3. Learning Experiences (Lesson Plan)

Materials: (per group)

- Plain white (letter sized) paper, 4-8 sheets
- Rolls of tape (masking, transparent, duct, electrical)
- Meter sticks
- Stapler, paper clips
- Straws (one for each student)

- Balance
- Aviation Alphabet (from lesson 2)

Handouts/Other Resources: (per group)
- Student EDP Guide: Greatest Airplane Ever Made
- Student Testing Guide: Greatest Airplane Ever Made (for rotation stations set up in class)
- Check off list
- Student activity guides from last week, completed, graded, and filed in student folders

Procedure:
- Teacher introduces the Greatest Airplane Ever Made. Groups are assigned lab stations and given directives to follow the Engineering Design Process.
- Teacher summarizes Engineering Design Process to ensure that all students know the process. Discusses briefly how the Engineering Design Process is different from Scientific Investigation.
- Teacher stops activity after 5 minutes to ask groups for a list of students in the group with their assigned task (roles).
- Teacher monitors group work to ensure all groups get through the brainstorm process within 15 minutes.
- Groups plan and draw a model of their plane and show it to the teacher.
- After the drawing is made, group members create the prototype. After prototype is done, groups must rotate through the 5 lab stations to collect and analyze data. This should be complete within 90 minutes (from start of class).
- Students create and practice their presentations and finish their airplanes. Students present their airplane models and are assessed using the attached rubric. Peers discuss how the model could be improved.
- Reflection on the project, the process, and what was learned is entered in student journals.
- Students volunteer to bring their model to the Greatest Airplane Ever Made Contest held during lunch recess. Suitable prizes/certificates are awarded to the entries.

Homework Activity (Optional):

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Grade 8 Lesson 6 Names_______________________________________

Student EDP Guide: Greatest Airplane Ever Made

Using the Engineering Design Process your group will brainstorm, plan, construct and/or modify a paper airplane model from one sheet of plain paper and other assorted materials. This learning experience requires your group to present the prototype model to the class, using science information to qualify its shape, wing surface, and name (using aviation alphabet). After the presentations, groups will fly their model, to determine which airplane is the classes' 'Greatest Airplane Ever Made.' Throughout this process you will work in your lab group, choosing who will do which tasks. The final race of the greatest airplane will occur during lunchtime recess.

Research
Answer these questions using the information you have learned in the last week.

1. Does wing surface area have any impact on flight distance? How?
2. What are two other variables that impact plane flight speed or distance?
3. How do these variables influence the flight of the airplane?

Engineering Design Process

ASK: What have I learned from my first paper airplane model that I need to remember in the creation of this model? What are different variables that will allow the airplane to fly far?

IMAGINE: Brainstorm a list of variables or changes to the model! Write your suggestions below.

PLAN: Draw a model with different views (sideview, looking down on it, front view). Use the graph paper provided.

CREATE: Use the drawing to make an airplane from the supplies.

EXPERIMENT: Test it. Calculate the average flight distance and the surface area of the wings. Weigh it too. All this data should be written on the group lab report. Rotate through the six lab stations to complete the report.

REFLECT IN YOUR JOURNAL

Remember back to the first day of school in this class. Describe what you learned in this class since then, what was interesting and challenging, what do you still have questions about? Explain how science, technology, and society are inter-related.

Grade 8 Lesson 6 Names of Lab Group______________________________

Student Testing Guide: Greatest Airplane Ever Made

Station 1–Test it!

Does your airplane fly? If it doesn't you need to go back to your lab group and modify the model. If it flies, list what could be done to modify the airplane and make it fly further.

Flyer or Dud _____

Modifications____

Station 2-Measure surface area !

Use the skills you learned last week to determine the surface area of the airplane model.

The wings of the model are ________ cm^2

Station 3-Test it!

The Practice Flights. Attach a straw to the body of the airplane. Insert another straw into the airplane straw. Stand behind the masking tape line. Place straw in mouth and blow. Measure the distance of the flights.

Test 1: _______ Test 2: ______ Test 3: _____

Station 4-Analyze the data!

Weigh it. Weight of airplane: __________

Calculate the average distance your plane flew.

Distance analysis (average):_____________

Station 5-Name that plane!

Use the airplane alphabet to name the plane.

Airplane Name ________________________________

Hawaiian Name (optional) _________________________________

The Hawaiian name translated means ____________________________

Station 6-Work on presentation

Use the rubric as a guide to create a presentation to the class on why your model airplane is 'The Greatest Airplane Ever Made.' Make sure all required information is included. You must show evidence that every group member participated in this EDP mission.

Grade 8 Lesson 6 Names: ___________________________________

Check off list

___ Choose one airplane model you all think will work best.

___ Drawings of the prototype are attached. The drawing shows several different views.

___ Names of all group members are clearly attached/written on the model.

___ Attach the graph paper, and/or calculations used to measure the surface area of your wings.

___ The plane has a name created from the aviation alphabet. It is clearly labeled and attached to the model.

___ Hand in your work as a lab group. Staple this check list to the lab guide.

___ A draft of your presentation (written) along with any presentation material is attached to this list.

___ Each group has a list of three specific improvements made to the prototype. The improvements are qualified using evidence/data from first airplane or experiment.

	Exceeds	Proficient	Approaching	Novice
Quality of Oral presentation	Group spoke clearly and smoothly in an engaging way. Group showed poise and confidence, interacted appropriately with the audience, and handled unexpected problems effectively. Presentation well rehearsed.	Group spoke clearly and smoothly, showed poise and audience awareness. Group rehearsed the presentation. The audience could follow and find interest in the presentation.	The audience sometimes lost interest and had difficulty understanding or hearing group members. Group could have rehearsed the presentation more carefully.	The audience had difficulty following the presentation and understanding the group. The group did not practice enough.
Application of Science Knowledge	Explanations by group members indicate a clear and accurate understanding of scientific principles underlying the construction and modifications.	Explanations by group members indicate a relatively accurate understanding of scientific principles underlying the construction and modifications.	Explanations by group members indicate a basic understanding of scientific principles underlying the construction and modifications.	Explanations by group members indicates little/or no understanding of scientific principles underlying the construction and modifications.
Quality of Prototype Model	Structure functions extraordinarily well, holding up under atypical stresses.	Structure functions well, holding up under typical stresses.	Structure functions pretty well, but deteriorates under typical stresses.	Fatal flaws in function with complete failure under typical stresses.
Data Collection and Analysis	Data taken three times, then averaged in a careful, reliable manner using units. Clear and accurate understanding of surface area relationship to flight.	Data taken twice in a careful, reliable manner. Most units labeled. Clear understanding of relationship between surface area and flight.	Data taken once in a careful, reliable manner. Some units labeled. Some understanding of math applications to surface area.	Data not taken carefully OR not taken in a reliable manner. Unclear understanding of formulas or measurement.
Use of Engineering Design Process	Clear evidence of troubleshooting, testing, and refinements based on data or scientific principles.	Clear evidence of troubleshooting, testing and refinements.	Some evidence of troubleshooting, testing and refinements.	Little evidence of troubleshooting, testing or refinement.