

Lesson Plan

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Physical Science in Motion

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What variables influence flight?

Grade Level: 8-12

Level of Inquiry: Discovery or Inquiry dependent upon the specific needs of the class or individual students. Some students will be experiencing different phenomena and identifying simple trends, relationships, or similarities/differences. Others will have enough experience to engage in discussion than explore on their own with minimal teacher guidance (Wenning, 2005).

Identify physical location: CSSE Room 120, Hallway, and Cafeteria

Content Areas

1. Physical Science
2. Computer Technology
3. Visual Arts
4. English Language Arts
5. Mathematics

“Big” Concepts

1. Physical Science
 - a. PA Standard 3.2.10.B2 – Explain how the overall energy in a system remains constant.
 - b. PA Standard 3.2.10.B6 – Explain how the behavior of matter and energy follow predictable patterns that are defined by laws.
 - c. PA Standard 3.2.10.B7 – Compare and contrast scientific theories; know that both direct and indirect observations are used by scientists to study the natural world and the universe; identify questions that guide scientific investigations; formulate and revise explanations and models using logic and evidence; and recognize and analyze alternative explanations and models.
2. Computer Technology
 - a. PA Standard 3.4.10.C2 – Analyze a prototype and/or create a working model by making actual observations and necessary adjustments.
 - b. PA Standard 3.4.10.D2 – Diagnose a malfunctioning system and use tools, materials, and knowledge to repair it.
3. Visual Arts
 - a. PA standard 9.1.12.B – Recognize, know, use, and demonstrate a variety of appropriate arts elements and principles to produce, review, and revise original works in the arts such as paint, draw, craft, sculpt, print, design for environment, communication, multimedia.
4. English Language Arts
 - a. PA standard CC.1.2.11-12.G – Integrate and evaluate multiple sources of information presented in different media or formats (e.g. visually, quantitatively), as well as in words in order to address a question or solve a problem.

- b. PA standard CC.1.4.9-10.C – Develop and analyze with relevant, well-chosen, and sufficient facts, extended definitions, concrete details, quotations and other information and examples appropriate to the audience’s knowledge of the topic; include graphics and multi-media when useful to aiding comprehension.
- c. PA standard CC.1.2.9-10.U – Use technology, including the internet, to produce, publish, and update individual or shared writing products, taking advantage of technology’s capacity to link to other information and to display information flexibly and dynamically.
- d. PA Standard CC.1.5.9-10.D – Present information, findings and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning; ensure that the presentation is appropriate to purpose, audience, and task.

5. Mathematics

- a. PA Standard CC.2.4.HS.B.2 – Summarize, represent and interpret data on two categorical and quantitative variables.
- b. PA Standard CC.2.4.HS.B.3 – Analyze linear models to make interpretations based on data.

(Pennsylvania Department of Education, 2021)

Why do these concepts matter?

Students use physics every day. They have an intuitive feel for the rules that govern motion even if they confuse things like speed and acceleration. Understanding how motion works will help students to be better drivers, better engineers, better mechanics...better citizens. One thing I learned many years ago was that subjects taught in isolation do not help students achieve many of the 21st century soft skills needed as adults. Whenever we work on a science topic, we need ELA, math, technology, art and more. The students need to be able to read, write, and speak to pass their claims, evidence, and reasoning on to their peers and others. Physics help students understand math. Conversely, math helps students understand physics. The UN has devised sustainability goals for the future of the planet. Many of those 17 goals need an understanding of physics to allow us to have a future filled with peace and prosperity for all human beings.

Relevancy to my students lives.

My students struggle with many of the scientific ideas presented in traditional classroom studies. They also struggle with appropriate engagement in school. Some students sleep the day away because they find school boring or “too hard.” Others are disruptive for similar reasons. All of them like extreme adrenaline pumping activities whether from fun like flying airplanes, the dream of going to Mars in a rocket, or running from the cops.

This lesson helps them to discover and inquire into the idea of motion in the context of Aeronautics. They look at why something that is so “heavy” can soar through the air taking us to new places throughout the world.

Meaningful topics that address the “Big” concepts.

1. Internet Research for background information that includes gliders, airplanes, and helicopters as well as physics constraints for their designs.
2. Following the engineering design process to build a kites and gliders.
3. Constructing graphs and tables to analyze data collected during test runs of parts as well as the end-product.
4. Compiling research and data into a whiteboard presentation and demonstration.

Real-Life Contexts:

1. Career Connections
 - a. Engineer
 - b. Mechanic
 - c. Welder
 - d. Project Manager
 - e. Astronaut
 - f. Sheet Metal Fabricator
 - g. Avionics

Interdisciplinary Connections

This lesson can be done as an integrated STEM project enlisting the support of the educational team. With careful planning and curriculum mapping in each discipline, teachers could coordinate showing students how inter-department collaboration works and each piece is necessary for the culminating project. In Science, the students learn the concepts of force and energy clarifying any misconceptions about the natural physics laws. In math, the students would work on the units for measurement, conversions, data collection, graphing, and analysis. In ELA, students would work on completing a literature review and the mechanics of writing a clear and concise observations and making a whiteboard presentation. In Computer Technology or Literacy, students would work on utilizing software, making simulations, and possibly integrating coding into the project. In Art, Students could work with different media to make a preliminary drawing for their whiteboard presentation as well as designing kites and gliders. Each class could cover possible career paths for the actual aeronautical engineer as well as any support staff making that are integral in making a design successful.

Engage in Critical Thinking

I believe this lesson will work well individually to expose students to the process of modeling as suggested by Bozeman (2017). I have found working with intensive emotional support students and utilizing trauma informed strategies that it is sometimes necessary to allow students to work individually with the option of joining a group or asking for help from their peers, as necessary. Students will be encouraged to explore different elements of the final structure to optimize placement in their final product. They will use the engineering design process with multiple iterations along with collaborating with peers when something is not working as intended. Students may use the materials available from the classroom on the Lab material table. Students will use vernier sensors and photogates to analyze pieces of their designs to make improvements.

Learning Targets

- a. Students will explore, define, and quantify forces, work and energy in their exploration of paper kites and gliders.
- b. Students will learn about the significance of the Otto Lilienthal's glider and the Wright Flyer in aviation history.
- c. Students will create their own kites to experiment, like the Lilienthal and the Wrights, with design and lift.
- d. Students will use the engineering design process to develop and construct models of gliders.
- e. Students will determine the relationship between the surface area and weight of scaled gliders.
- f. Students will present their findings on a whiteboard and present in a modified gallery walk.

Activities

- a. Lesson launch:
 1. Show the video clip, <https://www.youtube.com/watch?v=qLuIiwmu3OE> followed by brainstorming the questions: Why do humans want to fly? What are the variables needed for flight?
 2. Think, Pair, Share on Flight, Forces, and Motion.
 3. Student research. How did Wilbur and Orville Wright get to this moment in history? Show video clip on Wilbur and Orville Wright <https://www.youtube.com/watch?v=-kjRL-Q-KBc&t=41s> Whiteboard the types of research students found on individual boards. Group students in groups of three. Have them collaborate and form a group list. Make a class list of ideas. (Note: Make sure to include kites on list for day 2.)

- b. Explore Kite Day (Taken and adapted from NASA First Flyers Educator's Guide, 2010) Have students design kites with the following constraints: maximum size no bigger than a sheet of copy paper. Can only use paper, straws, and tape. Tissue paper for tail. Differentiated: give plans for sled kite from First Flyers Educator's Guide. Follow plan in educator's guide to test kite designs with different length tails. (Note: get permission to go outside to test instead of in hallways.) 10 minutes before end of class: Return to class have students write their observation in journal. Hold class discussion and make class whiteboard on observations. Introduce concept of Lift.

- c. Scaling and Paper Airplanes (Taken from NASA Aeronautics for Introductory Physics, 2015)
 1. Remind the students about Lilienthal's glider on Day 1. Discuss the relationship between weight and surface area. Have students plan how they will collect data make their materials list from available materials on the materials table. Have them design a glider and test it's flyability.
 2. Have the students create their data collection table or tables.

3. Have the students prepare their materials in the correct dimensions to make 6 different iterations of their glider and make their gliders. Remind students to measure twice and cut once.
 4. Calculate the surface area of the wings by identifying the simple geometric shapes that make up the wings. Draw a top-view of your paper airplane, identifying the shapes. Describe – in words – how you calculate the total surface area of the tops of the wings each time.
 5. Have students use a scale to measure the mass of each glider and record the data.
 6. Have students plot their data on graphs. Discuss the parts of a graph and determine the dependent and independent variables. Discuss observations about the resulting graph.
 7. Have students test fly their gliders. Compare the distances of the flights. Discuss and write observations in journals.
- d. Students repeat step c with different materials for the glider. Compare the results from yesterday and today. Write observations in journal.
- e. Evaluate: Teachers use the rubric attached to evaluate student evidence from their data tables, gliders and individual whiteboard representation. White board model day. Students individually complete a model explaining your observations over the past two days. (10 minutes) Group students by threes, have them create a joint model from their combined observations. Present observations to class. Come up with a class model explaining what happened with the gliders.

Glider Rubric				
	4	3	2	1
Glider General Requirements	Built 6 gliders to scale on each of the build days from the two different materials, one material each day.	Built at least 4 gliders to scale on the build days from the two different materials, one material each day.	Built at least 2 gliders to scale on the build days from the two different materials, one material each day.	Only built two gliders from one material.
Data Collection	Collected all data, mass, and size. Presented all data in table and graphical	Collected most data, mass, and size. Presented most data in table and graphical	Collected some data, mass, and size. Presented some data in table and graphical	Collected minimal data, Presented data in table or only graphical format.

	format, Analyzed data correctly.	format, most data analyzed correctly.	format, some data analyzed correctly.	Did not analyze data correctly but tried.
Whiteboard Presentation				
Subject Knowledge	Subject knowledge is evident throughout the project. There are no errors. All information is correct and appropriate.	Subject Knowledge is evident. There are no more than two incorrect pieces of evidence or conclusions drawn.	Some subject knowledge is evident. There are no more than 4 confusing, incorrect, or flawed pieces of evidence or conclusions drawn.	Subject knowledge is not evident. Information is confusing
Organization	The sequence of information is logical. Menus and paths to information are logical, clear, and concise.	The sequence of information is logical. Menus and paths to information have no more than 2 inconsistencies or flaws that cause confusion.	The sequence of information is logical. Menus and paths to information have no more than 4 inconsistencies or flaws that cause confusion.	The sequence of information is not logical. Menus and paths to information are not evident.
Creativity Rubric				
	Very Creative	Creative	Ordinary/routine	Imitative
Variety of Ideas and Contexts	Ideas represent a startling variety of important concepts from different contexts or disciplines.	Ideas represent important concepts from different contexts or disciplines.	Ideas represent important concepts from the same or similar contexts or disciplines.	Ideas do not represent important concepts.
Combining Ideas	Ideas are combined in original and surprising ways to solve a problem, address an issue, or make something new.	Ideas are combined in original ways to solve a problem, address an issue, or make something new.	Ideas are combined in ways that are derived from the thinking of others (for example, of the authors in sources consulted).	Ideas are copied or restated from the sources consulted.
Communicating Something New	Created product is interesting, new, or helpful, making an original contribution that includes	Created product is interesting, new, or helpful, making an original contribution for its intended purpose (for example,	Created product serves its intended purpose (for example, solving a problem or addressing an issue).	Created product does not serve its intended purpose (for example, solving a problem or addressing an

	identifying a previously unknown problem, issue, or purpose.	solving a problem or addressing an issue).		issue).
(Brookhart, 2013)				

References:

- Brookhart, S. (2013, February 1). *Assessing creativity*. ASCD.
<https://www.ascd.org/el/articles/assessing-creativity>
- NASA. (2010). *First Flyers* (pp. 12–17).
https://www.nasa.gov/sites/default/files/atoms/files/first_flyers_k_4.pdf
- Pennsylvania Department of Education. (2021). *View standards - SAS*. PDE Standards Aligned System. <https://www.pdesas.org/Standard/View>
- United Nations. (2015, December 30). *THE 17 GOALS*. United Nations Department of Social and Economic Affairs. <https://sdgs.un.org/goals>
- Vieyra, R., Springer, T., Gipson, L., Werries, M., & Schultz, J. (2015). *Aeronautics for introductory physics* (pp. 13–19). NASA.
https://www.nasa.gov/sites/default/files/atoms/files/aero-intro-physics_0.pdf

