

**Analyzing Relationship of the Variables Involved in Airplane Routes**

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| **6-12th Grade** |  |
| **Topic:** Analyzing the different variables involved in Airplane Routes and its real-world applications to Pythagorean Theorem, D=R x T, proportionality and other Trigonometric concepts. | **Materials:*** COSMOS Toolkit
* SDR receiver (500 hz -1.7 Ghz)
* Pencil (colored)
* Ruler
* Clip board
* Post-it Chart Paper
* Markers
* Graph Paper
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| **Science & Engineering Practices (SEPs)**Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena. (MS-PS4-2)Using Mathematics and Computational Thinking Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods. Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)  | **Disciplinary Core Ideas (DCIs)**ETS1.A: Defining and Delimiting an Engineering Problem The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)ETS1.B: Developing Possible Solutions A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3**)** | **Crosscutting Concepts (CCs)**Structure and FunctionStructures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2) Structures can be designed to serve particular functions. (MS-PS4-3) Influence of Science, Engineering, and Technology on Society and the Natural World Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3) Science is a Human EndeavorAdvances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3) |

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| **Math Common Core Standards:**Represent and analyze quantitative relationships between dependent and independent variables.**6.EE.9** Use variables to represent two quantities in a real-world problem that change in relationship toone another; write an equation to express one quantity, thought of as the dependent variable, interms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to represent the relationship between distance and time.**7.RP.2** Recognize and represent proportional relationships between quantities.a. Decide whether two quantities are in a proportional relationship, e.g., by testing forequivalent ratios in a table or graphing on a coordinate plane and observing whether thegraph is a straight line through the origin.b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams,and verbal descriptions of proportional relationships.c. Represent proportional relationships by equations. For example, if total cost t isproportional to the number n of items purchased at a constant price p, the relationshipbetween the total cost and the number of items can be expressed as t = pn.**7.EE.3**Solve multi-step real-life and mathematical problems posed with positive and negative rationalnumbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms asappropriate; and assess the reasonableness of answers using mental computation andestimation strategies.**8.G.7** Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.**8.EE.5** Graph proportional relationships, interpreting the unit rate as the slope of the graph. Comparetwo different proportional relationships represented in different ways. For example, compare adistance-time graph to a distance-time equation to determine which of two moving objects hasgreater speed.**8.EE.6** Use similar triangles to explain why the slope m is the same between any two distinct points on anon-vertical line in the coordinate plane; derive the equation y = mx for a line through the originand the equation y = mx + b for a line intercepting the vertical axis at b.**G-SRT.8** Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in appliedproblems.**A-REI.6 59** Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairsof linear equations in two variables.**F-IF.6 71** Calculate and interpret the average rate of change of a function (presented symbolically or as atable) over a specified interval. Estimate the rate of change from a graph. **Build a function that models a relationship between two quantities****F-BF.1 40**Write a function that describes a relationship between two quantities.1. Determine an explicit expression, a recursive process, or steps for calculation from a context.

**S-ID.6 62**Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of thedata. Use given functions or choose a function suggested by the context. Emphasize linear,quadratic, and exponential models.**Apply trigonometry to general triangles****G-SRT.9**(+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary linefrom a vertex perpendicular to the opposite side.**G-SRT.10** (+) Prove the Laws of Sines and Cosines and use them to solve problems.**G-SRT.11** (+) Understand and apply the Law of Sines and the Law of Cosines to find unknownmeasurements in right and non-right triangles (e.g., surveying problems, resultant forces). |
| **Essential Question:** How can you analyze different airplane routes and apply these variables to Pythagorean Theorem and to the concepts involved in distance, time and rate? |
| **Learning Target** | I will be able to run the experiment on Airplane Routes from any of the NYC airports- JFK or La Guardia and be able to:1. describe the relationship of distance, time and rate of a certain airplane flight and analyze these variables in terms of proportionality.
2. use these variables to go deeper into the application of D=R x T, Pythagorean Theorem, Proportionality, Law of Sines and Cosines in the real-world of wireless technology.
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| **Engage** | 1. Teacher and student will perform the experiment on Spectrum Crunch basically observing different airplane routes from the COSMOS Toolkit and complete a See, Think, Wonder ( graphic organizer )
2. Students engage in a see, think, wonder of different airplane routes as shown on the Smartboard or Promethean Board.
	1. See: What do you notice?
	2. Think: What do you think your noticing mean?
	3. Wonder: Create a question that you would like to explore further based on your noticings and conjectures?
3. Discuss with the students their conjectures and wonderings.
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| **Explore** | Grade 6-8 will do **Day 1 & Day 2**High School studentswill extend it to **Day 3** exploration.**Day 1**-Teacher will give the rationale of the experiment to the class and the relevance of this to wireless technology.-Students will play around following some airplane routes by group after the teacher showed an example on the large screen during the mini-lesson.**Day 2**-Students by group will follow an airplane route of their choice and they will analyze the different statistics of the flight such as altitude, distance, rate and time of the given flight and find out the trend.-They will organize their data on the table and plot the graph of the variables involved.-Students in 8th Grade can analyze the correlation of these variables and describe the relationship as strong, medium, low or no correlation.**Day 3-5**-Students will track a specific plane with their team-Find out from a specific location after take-off the angle of elevation and the angle of depression few minutes before the arrival. Using their knowledge on Pythagorean Theorem as well as the Law of Sines and Cosines, students will find out the missing sides or angles as the case may apply. \*Ensure that students are running the COSMOS program correctly\*  |
| **Explain** | 1. In small groups, the students will discuss their observations, their findings, questions, multiple representations of the results and trends based on the data.
2. In a gallery walk, students will present all of their data and make connections across the different groups. They can use this space to discuss results and trends across the groups. \*Peer evaluations\*
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| **Extend**  | * Discuss possible connections of this experiment to science concepts by exploring reasons why an airplane’s flight might be delayed. They can find out the weather conditions of the two locations where the airplane departs and where the airplane will land.
* Students will use these extended experiments as projects to explore in their own space and time.
* Each student/Group of students can choose to track an airplane and analyze the relationship of the variables involved.
* High School students can track two airplanes and see the intersection of their pathway and use systems of equations after they create the linear regression model of each pathway.
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| **Evaluate** | Find out if the students were able to accomplish the main goal/learning target/essential questions posted before the experiment started. Let students present their findings and let them discuss among their classmates and entertain questions regarding the results.  |
| **Differentiation** | Students will be grouped heterogeneously. Each group will be expected to meet the same standards. Graphic organizers and vocabulary sheets will be available to students to use.  |