WAMC Lab Template

Math Concept(s): Inverse Tangent, Pythagorean Theorem

Source / Text:

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Attach the following documents:

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

- Create and fly paper airplanes to fly straight.
- Occurs in the trigonometry and/or Pythagorean theorem (right triangles) section (or both). Could be used in both Algebra 2 (trig) and Geometry (right triangles).

Lab Plan

Lab Title: Paper Airplane Accuracy

Prerequisite skills:

- Understand Pythagorean Theorem.
- Identify legs and hypotenuse of right triangles.
- Ability to calculate a missing component of right triangles.
- Understand and be able to use inverse trig functions (especially $\tan^{-1}$).
- Be able to calculate and understand angles in radians and degrees.

Lab objective:

- (Geometry) Find overall flight distance after finding the two legs of the right triangle (Pythagorean theorem).
- (Algebra 2) Find the "straightness" of flight by determining the angle from directly forward. The lowest angle is the best.

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*

Mathematics K–12 Learning Standards:

- Cluster: Build new functions from existing functions.
  F.BF.B.4 Find inverse functions.
  4a Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse.
  4b Verify by composition that one function is the inverse of another.
  4c Read values of an inverse function from a graph or a table, given that the function has an inverse.
  4d Produce an invertible function from a non-invertible function by restricting the domain.
- Cluster: Define trigonometric ratios and solve problems involving right triangles.
  G.SRT.C.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.
  G.SRT.C.7 Explain and use the relationship between the sine and cosine of complementary angles. G.SRT.C.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Standards for Mathematical Practice:

- Practice 1: Make sense of problems and persevere in solving them.
- Practice 2: Reason abstractly and quantitatively.
- Practice 4: Model with mathematics.
- Practice 5: Use appropriate tools strategically. Practice 6: Attend to precision.

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

- RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
- RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

K-12 Science Standards

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Technology

- 1.3.2 Locate and organize information from a variety of sources and media.

Engineering

- HS-ETS1-2. Design a solution to a complex real-world problem

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☐ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☐ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
☒ Think Creatively
☐ Work Creatively with Others
☐ Implement Innovations
Critical Thinking and Problem Solving
☒ Reason Effectively
☒ Use Systems Thinking
☐ Make Judgments and Decisions
☒ Solve Problems
Communication and Collaboration
☐ Communicate Clearly
☐ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
☒ Access and Evaluate Information
☒ Use and manage Information
Media Literacy
☐ Analyze Media
☐ Create Media Products
Information, Communications and Technology (ICT Literacy)
☒ Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
☐ Adapt to Change
☐ Be Flexible
Initiative and Self-Direction
☐ Manage Goals and Time
☐ Work Independently
☐ Be Self-Directed Learners
Social and Cross-Cultural
☒ Interact Effectively with Others
☐ Work Effectively in Diverse Teams

Productivity and Accountability
☐ Manage Projects
☒ Produce Results
Leadership and Responsibility
☐ Guide and Lead Others
☐ Be Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

- Each person needs to have a piece of paper

Set-Up Required:

- Lay out a straight line with a long tape. (Feet or meters.)
- Need a wide area as most paper airplanes do not fly straight

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Flying and measuring occurs in groups of three.
- Data is gathered in the group.

Cooperative Learning:

- One person flies his/her paper airplane.
- One person marks the plane landing location
- The other person holds the second tape measure perpendicular to the centerline tape.

Expectations:

- Each person will make an airplane.
- Groups of three will fly their airplanes one at a time.
- Each person will take a turn measuring distance along the centerline and measuring the distance from the centerline.

Timeline:

- Instruction (10 minutes)
- Fold paper airplanes (5 minutes)
- Fly and measure (30 minutes)

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- If you are a pilot and you go off course for too long, you might not find your destination.

Career Applications

- Pilots – navigation
- Construction – making things square
- Engineering – trig is the most useful math ever

Optional or Extension Activities

- Pick a destination to fly to from Seattle. Determine how long a flight will take to get there. If your pilot was off by the angle you were off, where would you be at the end of your flight?

Paper Airplane Accuracy Lab

Introduction: How straight can you make a paper airplane fly? Let's find out.

Instructions:

- Each person will get one piece of paper to make a paper airplane.
- Each person will get in groups of three to measure the straightness of their paper airplane flights.
- When instructed, each person will rotate between being the paper airplane launcher, the landing locator, and the square determiner.
- The airplane launcher will launch the airplane and record the two results.
- The landing locator will determine where the airplane landed and will determine the distance from the centerline.
- The square determiner will ensure that the measurement to the landing location is measured perpendicular to the centerline and will tell the distance from launch to the distance along the centerline.
- The group results and then the class results will be recorded at a central location.
- Once the results are compiled, everybody will compute the total distance flown (the hypotenuse) and the angle from the centerline (in degrees and radians).

Paper Airplane Lab – Handout

Group	Distance		Total straightline distance	Angle from centerline
	Along centerline	From centerline		

Paper Airplane Lab – Rubric

	0	1	2	3	4
Follows instructions	Freestyles	Does some things	Completes the process following most instructions	Completes the process following all instructions	Completes the process following directions even to the point of making improvements
Records Data	No data collected	Some data missing or incorrect	Records data correctly but not necessarily orderly	Records data correctly and orderly	Records data for entire class correctly and orderly
Calculates angle (2X)	No calculation	Has a formula. May or may not have correct answer	Uses correct formula, but some calculations are incorrect	Uses formula, most, if not all, calculations are correct	Correct formula used to calculate all the correct angles for all the data
Calculates distance (2X)	No calculation	Has a formula. May or may not have correct answer	Uses correct formula, but some calculations are incorrect	Uses formula, most, if not all, calculations are correct	Correct formula used to calculate all the correct angles for all the data