WAMC Lab Template

Math Concept(s): Cosine Function, Force, Work

Source / Text: Big Ideas Math – Algebra 2 A Common Core Curriculum by Larson & Boswell

Developed by: Victoria Kelley E-Mail: Kelley@skschools.org Date: 06/21/2022

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): Lab Plan

Lab Title: Work smarter not harder.

Prerequisite skills: Parallel and Perpendicular Forces, Rearrange Formulas, Basic Trigonometry, Understand the concept of Force.

Lab objective: To figure out the work required to move a heavy table by using Trigonometry to calculate "work" by pulling or pushing a table and considering the angle of the pulling/pushing force. This will be an initial investigation into this topic and will occur before instruction.

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

Mathematics K–12 Learning Standards:

- CCSS.MATH.CONTENT.HSG.SRT.D.11
  (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Standards for Mathematical Practice:

- Make sense of problems and persevere in solving them.
- Reason abstractly and quantitatively.
- Model with mathematics.

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

- CCSS.ELA-LITERACY.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.

K-12 Science Standards

- K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

Technology

- 3.d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

Engineering

- Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)

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

- One table with books/items stacked on it to create weight
- One force meter to measure the force used to pull the table
- One scale to measure the push force

Set-Up Required:

- Stack items on table
- Tie a rope around one side of the table for teams to "pull"
- Attach the hook pull meter to the rope for pulling measurements
- Students pushing will use the scale to push by holding it to the edge of the table

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students must hypothesize with teammates and come up with a strategy to pull or push the table at a certain angle to use the least "work"
- Students will fulfill different roles throughout the lab (materials, secretary/scribe, the force, communication)

Cooperative Learning:

- Students must work with their team to agree on a method to move the table considering the angle (up high/down low) and whether they will pull or push it to use the least work
- Students will fulfill different roles throughout the lab (materials, secretary/scribe, the force, communication)

Expectations:

- Student will calculate the "work" used to move the table 10 feet
- They will strategize together
- They will accurately measure the force and then use that to calculate the work
- Students will use cell phones to measure the angle of the person's arms who is pushing the table or the angle of the rope the person uses to pull the table

Timeline:

- One 2-hour class period

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- What is the easiest way to move a heavy object

Career Applications

- Engineering, Construction, Design, Automotive

Optional or Extension Activities

- How does the angle of force applied to the object affect the force required to move it?
- What direction should you apply force to minimize the work required to move it?
- Describe the physical circumstances requiring the greatest and least amount of force to move an object. Use mathematics to explain why this is true.
- Do you use less work by pushing or pulling a heavy object?

Lab Instructions: Work smarter not harder.

Your team needs to move a heavy table across the room (10 ft.) What is the easiest way to move it? You will tie a rope around the front legs of the table and pull it. What angle should you pull from? Up high? Down low? How can trigonometry help you make the right decision?

In general, we think of work as anything that requires effort, like homework, or going to work, meaning a job, or doing work around the house, meaning chores. But in math and physics, the idea of work is very specific and relies on trigonometry. This definition of work requires a force to act upon an object and for that object to move due to the applied force. The amount of work done depends on the strength of the force F, the distance d that the object moves, and the angle **θ** between the force and the direction of the motion.

Work is measured in a unit called Joules and is defined by $W = F \bullet d \bullet \cos\theta.$

1. How many Joules of work were required for your team to move the table 10 feet?
2. What variables effect the work required?
3. How can you adjust those variables to do even less work to move the table?
4. Discuss your results with other teams in the room. Did they do more or less work than your team to move the table? How did their variables differ from your team?

Rubric	
Work smarter not harder.	**Points**
Students correctly evaluated the cosine function to determine the amount of work their team did to move the table.	0- not correct 1- minor mistakes in calculation 2- correct use of formula and answer
Students understand how each variable effects the work function and can accurately describe how to change their variable to do more and less work.	0- no correct answers 1- partially correct explanations 2- mostly correct explanations 3- correct explanations 4- thoroughly correct explanations 5- throughly correct explanations with examples
Mathematical Practices: Construct viable arguments and critique the reasoning of others. Students should include logical and thorough reasoning.	3- For demonstration of practice. Partial credit can be awarded.
Total Points:	**10 points**

WAMC Lesson Plan

Name(s): Victoria Kelley
Email Address: Kelley@skschools.org
Lesson Title: The Unit Circle Explained
Date: 06/21/2022
Text: Big Ideas – Algebra 2 STEM Correlation: Math Lesson Length: 2 hrs.

Big Idea (Cluster): Students will understand the Unit Circle - Trigonometry

Mathematics K–12 Learning Standards: HSF-TF.A.2

Mathematical Practice(s): 4, 8

Content Objectives:
Students will be able to correctly label all radian and degree measures as well as x & y coordinates of points on the circle corresponding to the 30, 60 & 90 degree reference angles from 0-360 degrees.

Language Objectives (ELL):
CCSS.ELA-LITERACY.RST.9-10.7
Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Vocabulary:
Radian, Unit Circle, Reference Angle, Quadrant, Coordinates, Sinθ, Cosθ, Tanθ

Connections to Prior Learning:
Right Triangle Trigonometry, Geometry

Questions to Develop Mathematical Thinking:
- What patterns do you see between the signs of the coordinates in each quadrant?
- What pattern do you see between the coordinates of each point and the long and short sides of the corresponding right triangles?
- How does the Pythagorean Theorem relate to the coordinates of each point?
- When using the Pythagorean Theorem, what is the length of the hypothenuse of each right triangle in the unit circle?
- Which coordinate represents the Sinθ and which represents the Cosθ in each ordered pair?
- How could you calculate the Tanθ for each angle around the circle?
- How would the each of the values change if given a circle twice as large was given?

Common Misconceptions:
- Sinθ and Cosθ order in the ordered pairs (Cosθ, Sinθ)
- Evaluating Square Roots
- Answering in Degrees when Radians are called for and vice versa
- Not understanding how to evaluate expressions like Sin(π/6), thinking you want them to tell you it's 30 degrees rather than the side length, y-coordinate of the point
- Not understanding when calculating tangent, it's a ratio of the 2 coordinates.
- Not knowing how to reduce or rationalize denominators when calculating the tangent

Assessment (Formative and Summative):

- Students will fill out all angles (degrees and radians) and all coordinates of common angles
- Assessment will continue to be given through the year until students can fill it in with 100% accuracy in 3 mins or less

Materials:

- Blank Unit Circles (1 with 30-60-90 triangles, 1 with 45-45-90 degree triangles)

Instruction Plan:

Introduction:

We will review the *Discovering the Unit Circle* lab findings and how to find the side lengths of the 30-60-90 & 45-45-90 triangles. We will also label the places on the circle that represent the total circumference of 2π and π.

Explore:

Students will calculate all values in quadrants II, III & IV after we do quadrant 1 together

When I observe students:

They will be using the 30-60-90 and 45-45-90 triangle models to find all the coordinates of the points around the Unit Circle and noticing patterns. They will also determine all radian measures noticing 30-60-90 degree angles cut the circle into 12 pieces and the 45-45-90 degree angles cut the circle into 8 pieces.

Questions to Develop Mathematical Thinking as you observe:

What patterns do you recognize? What do you notice about the signs in each quadrant?

Answers:

The same values repeat depending on the short and long sides of the triangles. The signs follow those for points in each quadrant.

Summarize:

Students will realize that the same values repeat around the circle from quadrant I with only the signs changes according to each quadrant. Students will also calculate the Tangent for each angle.

Career Application(s):

- architecture, engineering, geography, astronomy, digital imaging, and a host of other fields

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