Unit 4: Trigonometry Functions, Graphs, and Identities

Content Area: **Mathematics**
Course(s): **Algebra II Honors, Algebra II**
Time Period: **March**
Length: **8 Weeks**
Status: **Published**

Unit Overview

During this unit, students will…

- Use trigonometric functions and their inverses.
- Measure indirectly using side lengths and angles of triangles.
- Use angles of rotation and finding arc lengths of circles.
- Solve problems involving trigonometric functions
- Factor to solve trigonometric functions.
- Use trigonometric functions to model real-world problems.
- Solve trigonometric equations by using algebra and graphs.
- Extend the domain of trigonometric functions using the unit circle.
- Model periodic phenomena with trigonometric functions.
- Prove and apply trigonometric identities.

CHAPTER 10 & CHAPTER 11

Transfer

Students will be able to independently use their learning to...

- Evaluate trigonometric values of both radians and degrees.
- Model real-world situations using trigonometric functions.

For more information, read the following article by Grant Wiggins.

http://www.authenticeducation.org/ae_bigideas/article.lasso?artid=60

Meaning

Understandings

Students will understand that...

- The unit circle can be used to evaluate trigonometric functions.
- The graphs of trigonometric functions are periodic.
- Radian measure is a different unit system for measuring angles.

Essential Questions

Students will keep considering...

- How are trigonometric functions and their graphs used to model real-world data?
- How is the unit circle used to determine trigonometric values?
- How are trigonometric identities used to verify statements and solve trigonometric equations?
- What does a trig function look like and how can I use it to model real-life applications?

Application of Knowledge and Skill

Students will know...

Students will know...

- The relationship between radians and degrees.
- What the graphs of trigonometric functions look like.
- The benefits of using the unit circle.
- The Pythagorean identity.

Students will be skilled at...

Students will be skilled at...

- Converting between radians and degrees.
- Identifying period, amplitude, maximum and minimums.
- Using the unit circle to evaluate trigonometric values of both radians and degrees.
- Proving the Pythagorean identity using the unit circle

Academic Vocabulary

Angle of rotation

Coterminal Angle

Initial Side

Radian

Reference Angle

Standard Position

Terminal Side

Trigonometric Function

Unit Circle

Amplitude

Cycle

Frequency

Period

Periodic Function

Phase shift

Learning Goal 4.1

SWBAT use trigonometry to solve problems and model situations.

Target 4.1.1

SWBAT:

- Understand and use trigonometric relationships of acute angles in triangles. **(DOK 2)**
- Determine side lengths of right triangles by using trigonometric functions. **(DOK 2)**

MA.F-TF.A.3	Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosines, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.
MA.F-TF.B.5	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

Target 4.1.2

SWBAT:

- Draw angles in standard position. **(DOK 2)**
- Determine the values of the trigonometric functions for an angle in standard position. **(DOK 3)**

MA.F-TF.A.2	Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

Target 4.1.3

SWBAT...

- Convert angle measures between degrees and radians. **(DOK 2)**
- Find the values of trigonometric functions on the unit circle. **(DOK 2)**

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7 × 8 equals the well remembered 7 × 5 + 7 × 3, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2 × 7 and the 9 as 2 + 7. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 - 3(x - y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y - 2)/(x - 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x - 1)(x + 1)$, $(x - 1)(x^2 + x + 1)$, and $(x - 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

MA.F-TF.A.1	Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.
MA.F-TF.A.2	Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.
MA.F-TF.A.4	Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

Target 4.1.4

SWBAT:

- Evaluate inverse trig functions **(DOK 2)**
- Use trigonometric equations and inverse trigonometric functions to solve problems. **(DOK 3)**

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Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

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MA.F-TF.B.6

Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

MA.F-TF.B.7	Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.

Target 4.1.5

SWBAT...

- Determine the area of a triangle given side-angle-side information. **(DOK 3)**
- Use the Law of Sines to find the side lengths and angle measures of a triangle. **(DOK 2)**

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MA.G-SRT.D.10	Prove the Laws of Sines and Cosines and use them to solve problems.
MA.G-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).

Target 4.1.6

SWBAT...

- Use the Law of Cosines to find the side lengths and angle measures of a triangle. **(DOK 2)**
- Use Heron's Formula to find the area of a triangle. **(DOK 3)**

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MA.G-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).

Learning Goal 4.2

SWBAT write and graph functions to model trigonometric functions.

Target 4.2.1

SWBAT recognize and graph periodic and trigonometric functions. **(DOK 3)**

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MA.F-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

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	14, older students can see the 14 as 2 × 7 and the 9 as 2 + 7. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 – 3(x – y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.
MA.F-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
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MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
MA.F-BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.
MA.F-TF.B.5	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

Learning Goal 4.3

SWBAT apply trigonometric identities and solve trigonometric equations.

Target 4.3.1

SWBAT use fundamental trigonometric identities to simplify and rewrite expressions and to verify other identities. **(DOK 3)**

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.6	Attend to precision.
MA.F-TF.C.8	Prove the Pythagorean identity $sin^2(\theta) + cos^2(\theta) = 1$ and use it to find $sin(\theta)$, $cos(\theta)$, or $tan(\theta)$ given $sin(\theta)$, $cos(\theta)$, or $tan(\theta)$ and the quadrant of the angle.

Target 4.3.2

SWBAT:

- Evaluate trigonometric expressions by using sum and difference identities. **(DOK 3)**
- Use a rotation transfromation to perform rotations.**(DOK 2)**

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.6	Attend to precision.
MA.F-TF.C.9	Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Target 4.3.3 (+)

SWBAT evaluate and simplify expressions by using double-angle and half-angle identities. **(DOK 3)**

MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.F-TF.C.9	Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Target 4.3.4 (+)

SWBAT solve equations involving trigonometric functions. **(DOK 3)**

MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.6	Attend to precision.
MA.A-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.

Formative Assessment and Performance Opportunities

- academic games
- Class discussions
- Classwork
- Do nows
- Exit tickets
- Homework
- Problem based learning
- student interviews

- Teacher observation
- whiteboard/communicator opportunities

Summative Assessment

- Link It Exams
- Projects
- Quizzes
- student interviews
- Tests
- Unit Exam

21st Century Life and Careers

CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP11	Use technology to enhance productivity.
CAEP.9.2.12.C.3	Identify transferable career skills and design alternate career plans.

Technology

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.1.12.E	Research and Information Fluency: Students apply digital tools to gather, evaluate, and use information.
TECH.8.1.12.F	Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

Accommodations and Modifications

- 504 Accommodations
- centers/stations
- challenge questions
- Common Core Workbook Reference 10-1 (Right Angle Trigonometry)
- Common Core Workbook Reference 10-2 (Angles of Rotation)

- Common Core Workbook Reference 10-3 (The Unit Circle)
- Common Core Workbook Reference 10-4 (Inverses of Trig Functions))
- Common Core Workbook Reference 10-5 (The Law of Sines)
- Common Core Workbook Reference 10-6 (The Law of Cosines)
- Common Core Workbook Reference 11-1 (Graphs of Sine of Cosine)
- Common Core Workbook Reference 11-2 (Graphs of Other Trigonometric Functions)
- Common Core Workbook Reference 11-3 (Fundamental Trig Identities)
- Common Core Workbook Reference 11-4 (Sum and Difference Identities
- Common Core Workbook Reference 11-5 (Double Angle and Half Angle Identities)
- Common Core Workbook Reference 11-6 (Solving Trigonometric Equations)
- Graphing Calculator Exploration to explore periodic trigonometric functions
- IEP Modifications
- manipulatives
- scaffolding questions
- small group instruction
- Unit 4 Exam Review for Test
- Unit Circle Reference Sheet
- use of technology

Unit Resources

- Desmos
- Explorations in Core Math for Common Core: Algebra 2 (Holt McDougal)
- Geometer sketchpad
- Kuta software
- NCTM website
- online textbook materials
- PARCC/NJSLA Released Questions
- SJMAP Resources
- Text