Algebra 2 Lesson 9.4 – Day 1: Graphing Sine and Cosine Functions
Essential Question: What are the characteristics of the graphs of the sine and cosine functions?

Lesson Objective(s): Students will explore characteristics of sine and cosine functions. Students will stretch and shrink graphs of sine and cosine functions. Students will translate graphs of sine and cosine functions. Students will reflect graphs of sine and cosine functions. **Previous Learning:** In previous chapters, students have graphed the transformations of different parent functions. **New Vocabulary:** amplitude, periodic function, cycle, period, phase shift, midline **Previous Vocabulary:** transformations, *x*-intercept **Materials for Teacher:** none **Materials for Students:** graph paper, whiteboards, graphing calculators **Pacing:** Day 1 – 45 minutes	**CC State Standards** HSF-IF.C.7e HSF-BF.B.3	**CC Mathematical Practice Focus** MP7

INTRODUCTION (5 minutes)

Other Resources
- Dynamic Classroom
- Start Thinking, Warm Up, and Cumulative Review Warm Up
- Homework Check
- Answer Presentation Tool
- Laurie's Notes

Warm Up

Have students answer *Start Thinking* questions. Review the answers as a class.
Review previously assigned homework, if necessary.

***Motivate* from Laurie's Notes in the Teaching Edition**

Have students make a table that shows the time in 15-minute increments from noon until 6 P.M. Corresponding to each time in the table, ask students to indicate how many minutes it is from the nearest hour. Ask students to use a timeline to graph the number of minutes against the time. Their graphs will show an example of a periodic function. In this lesson, students will learn about the characteristics of graphs that are periodic.

EXPLORATION 1 (8 minutes)

Other Resources
- Dynamic Classroom
- Student Journal
- Laurie's Notes

Graphing the Sine Function

In this exploration, students complete a table to graph the sine function. Then they use the graph to identify characteristics of the graph.

- Have students work with a partner to complete parts (a) – (c).
- In this exploration, students will be evaluating the sines of angles that are multiples of $\frac{\pi}{4}$. It should not take long for students to recognize patterns in the table of values.
- Students are asked to draw a smooth curve through the plotted points. To avoid a sharp sawtooth shape, students could evaluate a few additional angle values, such as multiples of $\frac{\pi}{6}$.
- Have students record their answers to the questions in part (c) on whiteboards. Solicit answers and observations.
- Ask the students if the sine function is even, odd, or neither, and have them explain.

EXPLORATION 2 (7 minutes)

Other Resources
- Dynamic Classroom
- Student Journal
- Laurie's Notes

Graphing the Cosine Function

In this exploration, students repeat Exploration 1 for the cosine function.
- Have students work with a partner to complete parts (a) – (c).
- Familiarity with the benchmark angles will be very helpful.
- Ask students if the cosine function is even, odd, or neither, and have them explain.

CHECK FOR UNDERSTANDING (5 minutes)

Other Resources
- Dynamic Classroom
- Student Journal
- Laurie's Notes

Communicate Your Answer

- Give students time to answer Questions 3 and 4.
- As students describe the characteristics of the graphs of sine and cosine, they could discuss what is the same and what is different about the graphs.

Student Focus on Mathematical Practice 7

Discuss the Math Practice statement with students.

EXAMPLE 1 (7 minutes)

Other Resources
- Dynamic Classroom
- Laurie's Notes
- Extra Example
- Lesson Tutorials
- Answer Presentation Tool

Core Concept – Characteristics of *y* = sin *x* and *y* = cos *x*

In this Core Concept, students learn the characteristics of the graphs of the sine and cosine functions.
- Students will know what the graphs of sine and cosine look like from the explorations, so begin with the graphs already drawn.
- Discuss the characteristics of the two functions: domain and range; define *amplitude*, *period*, and *cycle*.
- Have students Turn and Talk to discuss for what domain values each function is positive and negative. Listen for the connection to the four quadrants.
- Draw a horizontal line at $y = \frac{1}{2}$ and at $y = -\frac{1}{2}$ on each graph. Discuss the connection to reference angles and periodic functions.

Core Concept – Amplitude and Period

In this Core Concept, students learn about the amplitude and period of the sine and cosine functions.
- Before stating any of the transformations of the sine and cosine functions, give students time to explore by plotting points using graphing technology (See the *Teaching Strategy* on page T-484 in the Teaching Edition) or reviewing transformations of earlier functions.
- State the Core Concept.

Graphing a Sine Function

In this example, students graph a sine function.
- Pose the example.
- Ask students what effect the 4 will have on the graph of $y = \sin(x)$.
- Ask the students if the *x*-intercepts change.

EXAMPLE 2 (8 minutes)

Other Resources
- Dynamic Classroom
- Laurie's Notes
- Extra Example
- Lesson Tutorials
- Answer Presentation Tool

Graphing a Cosine Function

In this example, students graph a cosine function.
- Have students Turn and Talk to discuss the graph of $g(x) = \frac{1}{2}\cos 2\pi x$. Ask the students how the parent function $f(x) = \cos x$ has been transformed.
- Have students use Think-Pair-Share to answer Monitoring Progress Questions 1 – 4.
- Review the answers together, with students presenting their work to the class.

ASSESS (5 minutes)

Closure (as time permits)

Phone Message: Write a brief phone message that you would leave for a friend who missed today's class. Explain how to graph sine and cosine functions.

Homework Assignment

- 6 – 24 even

Suggestions for Leveling

- Basic: 5 – 17 odd
- Advanced: 14 – 24 even

Other Resources

- Mini-Assessment
- Extra Practice (A and B)
- Dynamic Assessment & Progress Monitoring Tool
- Answer Presentation Tool

Other Resources

- Puzzle Time
- Student Journal
- Lesson Tutorials
- Skills Review Handbook
- Enrichment and Extension
- Differentiating the Lesson