

Round and Round We Go

Relationship Between the Unit Circle and the Sine Curve

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Grade Level	11th – 12th Grade	**Time Frame**	140 minutes
Subject	Mathematics	**Duration**	2-4 class periods
Course	Precalculus		

Essential Question

What can trigonometric functions tell us about real world situations?

Summary

Students will explore the rotation of a Ferris wheel and make conjectures about the function represented by the motion. Students will find and plot points in the motion and use technology to find the line of best fit. Students will also manipulate the equation for their function to discover what the variables and constants mean in relation to the Ferris wheel and other sine functions.

Snapshot

Engage

Students watch a variety of video clips and create graphs that match each situation.

Explore

Students record the height of the rider through several rotations of the ride using a K'Nex Ferris Wheel or video clips.

Explain

Students participate in a Gallery Walk to see their peers' work and to clarify misconceptions.

Extend

Students use Desmos to find the approximate equation of their Ferris Wheel's motion. Students manipulate and explain the various parts of the function and their relationship with the Ferris Wheel itself as well as the data collected during the ride (e.g., height, time, amplitude, period). Students explore the different variables of the function $y = A \cdot \sin[B(x - C)] + D$.

Evaluate

Evaluation primarily occurs throughout the lesson through informal formative assessment; however, students conclude the lesson by completing an Exit Ticket.

Standards

Common Core State Standards for Mathematics (Grades 9, 10, 11, 12)

CCSS.Math.Content.HSF-TF.A: Extend the domain of trigonometric functions using the unit circle

Attachments

- Ferris Wheel Mathematics and Desmos—Round and Round We Go - Spanish.docx
- Ferris Wheel Mathematics and Desmos—Round and Round We Go - Spanish.pdf
- Ferris Wheel Mathematics and Desmos—Round and Round We Go.docx
- Ferris Wheel Mathematics and Desmos—Round and Round We Go.pdf
- Lesson Slides—Round and Round We Go.pptx
- Paper Airplanes Graphs—Round and Round We Go.pdf

Materials

- Lesson Slides (attached)
- Paper Airplanes Graphs handout (attached; one per student)
- Ferris Wheel Mathematics and Desmos handout (attached; one per student)
- K'Nex Ferris Wheels (ideally, one per groups of 3-4 students) or Video of the Ferris Wheel
- Timer or stopwatch (students can also use a timer or stopwatch on their smartphone, assuming the teacher is comfortable with this)
- Large poster paper
- Copy paper (for data collection; one per group of 3-4 students)
- Markers
- Rulers (one per group of 3-4 students)
- Yardsticks (one per group of 3-4 students)
- Computer, Chromebook, or iPad with internet access
- Small sticky notes
- Graph paper (1 sheet per group of 3-4 students)
- Optional: Flip camera, iPod, cell phone camera, etc. (if using the K'Nex Ferris Wheel)

20 minutes

Engage

Teacher's Note: Lesson Preparation

Prior to the beginning of the lesson, print out the attached document Paper Airplanes Graph Handout for every student.

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** and discuss the lesson's Essential Question: *What can trigonometric functions tell us about real world situations?* Display **slide 4** and identify the lesson's learning objectives. Review each of these with your class to the extent you feel necessary.

Go to **slide 5**. Pass out the attached **Paper Airplanes Graphs** handout. Have students watch the "Graphing Stories - Elevation of a Plane" video about the elevation of a paper airplane.

Embedded video
https://youtube.com/watch?v=OXZAeXgq4t8

While the students are watching the video, have them graph the elevation of the paper airplane on the Paper Airplane Graphs. Watch the video as many times as needed for the students to get the information they need to make an accurate prediction. After graphing, ask students to defend their graph to their peers using the appropriate mathematical language.

Sample Student Response

Students may respond with, "I know that the function of the paper airplane will start at 20 feet on the y-axis and slowly go down about 5 seconds on the x-axis when it hits the tree. Then there will be a steep slope as the plane falls to the ground. Then it will stay on the x-axis, at zero feet, for the rest of the 15 seconds."

Go to **slide 6** and have students watch the "Ferris Wheel - The Giant Wheel Ride At Yazoo Park Virar" video.

Embedded video
https://youtube.com/watch?v=plKln1Qg3Mk

Using the Think-Pair-Share strategy, have students first hypothesize how they would graph the elevation of a rider on the Ferris wheel. After they individually come up with a solution, have them discuss it with a partner. Lastly, as a pair, have them share their solution with the class.

40 minutes

Explore

Divide students into groups (depending on the number of K'Nex Ferris Wheels you have). Make sure each group has a Ferris Wheel, yardstick, timer, graph paper, and data collection sheet. If you do not have access to Ferris Wheels that students can use in class, feel free to show a clip of a Ferris wheel or ask students to pull up a clip of a Ferris wheel on their smartphone or other device.

Go to **slide 7**. Before collecting data, ask groups to devise a plan for how they will collect their data points. Have students record the height of the rider at least three times per rotation for at least five rotations, making that 15 data points total. If multiple students are having difficulty looking at the Ferris wheel at the same time, record the rotations of the Ferris wheel so everyone can be collecting data at the same time.

Teacher's Note: Guiding Question

Can you find any patterns of time/height that you can use to help? Is there a better location for the timer itself? Can your group see the timer, the wheel, and the yardstick at the same time?

Once students have all their measurements, they will create a graph of their findings. If possible, use the large sticky note graph paper. If not, have students make as large a graph as possible on the paper provided.

30 minutes

Explain

Go to **slide 8**. To clarify misconceptions and to get a better feel for what other groups have accomplished, have the students participate in a Gallery Walk. Have students display their group's graph on the wall and stand by it. Be sure to have groups spread out throughout the room.

All groups will rotate clockwise and look at the graphs of their peers. With sticky notes, have each group leave at least two comments on each of the other graphs:

1. What is one thing your graphs have in common?
2. What is one thing you have a question about?

After the gallery walk, have students return to their poster and read what the other groups have commented. As a class, take some time for groups to ask their questions in order to clarify misconceptions.

Teacher's Note: Gallery Walk

To give the allure of an actual art gallery, consider using a formal accent while playing classical music in the background. Remind students they are in a gallery and to be respectful with their comments.

40 minutes

Extend

Teacher's Note: Using the Desmos Studio Graphing Calculator

Try to become familiar ahead of time with the Desmos Studio graphing calculator to better help students navigate through the following activity. It is not necessary for students to have Desmos accounts to use the Desmos Studio graphing calculator. For more information, go to https://k20center.ou.edu/externalapps/graphing-calculator.

Go to **slide 9**. Have students reunite with their group at their desks and pick up one laptop or Chromebook to complete this section. If there are not enough laptops for each student, students can share.

Pass out the attached **Ferris Wheel Mathematics and Desmos** handout and have students work in their groups to complete the handout. Students should go to this link: https://www.desmos.com/calculator/pcy0aa4ztq.

Once students complete the handout, check in with individual groups to help clarify misconceptions they may have. Ask students to explain their reasoning.

10 minutes

Evaluate

Go to **slide 10**. To evaluate understanding, check the Ferris Wheel Mathematics and Desmos handout for accuracy.

Teacher's Note: It's Okay If It Isn't 100%

Remember, this is meant as an introduction to sine functions, so while it is important to check for accuracy, keep in mind that the students are also developing new understanding and may not always be 100% accurate. Use this as an opportunity to ask students guiding questions to help them better understand the bigger concepts at hand.

Just before students leave class, have students use the Exit Ticket strategy. Ask them to get a sticky note to do the following:

- Have students draw a picture that depicts how they are feeling about the material covered in class.
- Have students write down one question or concern they have about moving forward.

Have students stick their sticky note to the whiteboard as they exit.

Resources

- Buzzmath. (2018, February 23). Graphing Stories - Elevation of Plane by Jose Luis Ibarra [Video]. YouTube. https://www.youtube.com/watch?v=OXZAeXgq4t8
- K20 Center. (n.d.). Bell Ringers and Exit Tickets. Strategies. https://learn.k20center.ou.edu/strategy/125
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- Mumbai. (2011, November 15). Ferris Wheel - The Giant Wheel Ride At Yazoo Park Virar [Video]. YouTube. https://www.youtube.com/watch?v=plKIn1Qg3Mk