Edible Oasis (Geometry)

Arc Length and Sector Area of a Circle

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Grade Level	9th – 12th Grade	**Time Frame**	80-90 Minutes
Subject	Mathematics	**Duration**	2-3 Class Periods
Course	Geometry		

Essential Question

How do you calculate the sector area and arc length of any circle?

Summary

Through this lesson, students will use math and equity to discover the equation solving for any circle's arc length and sector area while investigating food deserts and how they impact a community.

Snapshot

Engage 1

Students define food deserts, contemplate their impacts on a community, and use a map and tools to determine if their school is in a food desert.

Explore

Students work in pairs to discover the equation to solve the arc length and sector area for any circle.

Engage 2

Students calculate how much land would be needed to feed every student in the class for a year.

Explain

Students and the teacher review the Explore activity and practice solving for arc length and sector area.

Extend

Students solve various problems for arc length and sector area through a scavenger hunt.

Evaluate

Students decide where a grocery store should be placed to reduce a food desert and write a letter to the city requesting the store.

Standards

ACT College and Career Readiness Standards - Mathematics (6-12)

G701: Use relationships among angles, arcs, and distances in a circle

Oklahoma Academic Standards Mathematics (Geometry)

G.C.1.1: Apply the properties of circles to solve problems involving circumference and area, using approximate values and in terms of pi, using algebraic and logical reasoning.

Attachments

- Arc Length and Sector Area Discovery Activity Teacher Resource—Edible Oasis.docx
- Arc Length and Sector Area Discovery Activity Teacher Resource—Edible Oasis.pdf
- Arc Length and Sector Area Discovery Activity—Edible Oasis.docx
- Arc Length and Sector Area Discovery Activity—Edible Oasis.pdf
- Circle Practice Scavenger Hunt —Edible Oasis.pptx
- Lesson Slides—Edible Oasis.pptx
- Norman Food Desert—Edible Oasis.docx
- Norman Food Desert—Edible Oasis.pdf
- Scavengar Hunt Answer Sheet—Edible Oasis.docx
- Scavengar Hunt Answer Sheet—Edible Oasis.pdf

Materials

- Lesson Slides
- Map of local town (provided by teacher; 1 per student)
- Arc Length and Sector Area Discovery Activity (attached; 1 page; 1 per student)
- Arc Length and Sector Area Discovery Activity Teacher Resource (attached; 1 page)
- Circle Practice Scavenger Hunt PPT (attached; 9 Pages front side only; 1st page answer key)
- Scavenger Hunt Answer Sheet (attached; 1 page; ½ pager per student)
- Optional: Norman Food Desert (attached; 1 page; 1 per person)
- Ruler
- Compass
- Calculator
- Paper (3 pages per student)
- Pencil

25 minutes

Engage 1

Preparing the lesson

Before the lesson, print a map of your town using the instructions below and determine if your school's location is a food desert using the same process found on **slide 10**. This will serve as an example for the students in this phase.

Find a map of your town or a portion of your city that is relevant to your students by searching for "Grocery stores near [type intersection/address]" in Google Maps. This will make it easier to see all of the grocery stores in the area, as they will be marked with an icon. Be aware of the grocery stores marked on this map. Convenience stores, gas stations, and specialty food stores do not count as grocery stores. Take a screenshot of the map and print it out. If your computer uses Windows, use the "Logo Key + PrtScn button as a shortcut for the print screen. If you don't have the PrtScn" button, use "Fn + Windows logo key + Space Bar" to take a screenshot, which can then be printed. On a Mac, use "command+shift+4" and drag the + to draw a box around the part of the screen you wish to capture. That image will be saved to your desktop and can be opened and printed out.

Use the attached **lesson slides** to guide the lesson.

Move through **slides 2-4** to introduce the lesson, essential question, and objectives to the class. Before playing the video on **slide 5**, ask the class if they have ever heard of the term "food desert." Spend a few minutes allowing students in the class to give their definitions of the term or hypothesize what the term means. Once the class has discussed, play the clip on the slide to give a formal definition.

Transition to **slide 6**, and ask every student to get out a piece of paper and a writing utensil.

Remind students that the United States classifies food deserts as areas where people are a mile or more away from affordable and nutritious food. This most often occurs in low-income urban and rural areas where there are not as many grocery stores and farmers markets available. Food deserts are not, however, an indication of poverty. Some individuals may be surprised to know they live more than a mile away from a grocery store because they are easily able to travel to one.

Ask students to think of the struggles people who do not have access to fresh and affordable food would have. Tell the students to independently list as many things they can think of on their paper in the 1 minute 30 seconds provided. Then start the timer.

When the time ends, bring the whole class back together and introduce the Stand Up, Sit Down strategy on **slide 7**. Explain to the class that they will be sharing their list of struggles. Each student will take turns voicing one struggle out loud. If something is said that is on a student's list, they will mark it off. Students will only say something that has not been said out loud. Once all of the items on a student's list have been said, they will sit down. This will continue until every student in the classroom is sitting.

After all students have shared their list, hold a whole class discussion about the challenges people in food deserts might face. Consider using the following guiding questions:

- How many challenges could you think of?
- What items did you have in common with other students?
- What do you consider affordable and nutritious food?
- Where can you buy affordable and nutritious food?
- What item (your own or someone else's) do you think is the most severe implication of living in a food desert?

Move to **slide 8**, and play the clip to show the perspective of the documentary on the challenges those in food deserts face.

Guiding the Lesson

The clip is set to start playing in the correct place in the video. Stop the video at the 5-minute mark, and continue the lesson.

After the video clip, show **slide 9** and introduce the Magnetic Statements strategy. Ask students to predict if their school is in a food desert. They will move to the side of the classroom that indicates their prediction. Ask a couple of students from each group to share why they chose 'yes' or 'no.' Use the following reflection questions when students share their reasoning.

Reflection questions:

- What store are you considering as a grocery store?
- Do they sell fresh fruits, vegetables, and meat?
- Are they frequently out of any of these foods?
- Is the food affordable for people in our town?

After discussing, have students return to their seats, move to **slide 10**, and hand students the map of their town (see teacher note at the beginning of this lesson for instructions), ruler, and compass. Using the steps on the slide, students will determine if their school is in a food desert.

Guiding the Lesson

As students are marking grocery stores on their maps, remind them that the stores must sell fresh fruits and vegetables and cannot regularly run out of these items.

If students do not know how to use a compass consider showing this tutorial to the class: https://www.youtube.com/watch?v=G8r3qacVdKw.

After everyone in the class has determined if they live in a food desert, ask the class if anyone was surprised by the answer. Explain to students that circles and their properties can be used by people like city planners and food banks to determine where grocery stores and food resource centers need to be placed, just as the class used a circle to discover if they live in a food desert.

15 minutes

Explore

Move to **slide 11**, and inform students to put their town map away in a safe location to be used later in the lesson.

Introduce Elbow Partners to the class, and give each student one copy of the **Arc Length and Sector Area Discovery Activity**. Ask the partners to work together to complete this handout.

While pairs are working, float around the room to answer questions as necessary and keep students on track. Use the **Arc Length and Sector Area Discovery Activity Teacher Resource** as needed.

10 minutes

Engage 2

Guiding the Lesson

This phase is intended to re-engage the class if teaching this lesson over two class periods. This activity can be skipped to fit the class. **Slide 13** reflects the scenario for a class of 20. Adjust the math on this slide to fit the number of students in the class before this part of the lesson.

If skipping this activity, skip to **slide 15**.

On **slide 12**, introduce the think-pair-share strategy while each student gets out a piece of paper and a writing utensil. Read the prompt on the slide out loud before asking the class to begin working on the task individually:

It would take 72,843.48 square feet to produce enough vegetables for 1 person for 1 year. How much land would be needed to feed every student in your classroom for one year? Design a circular plot of land to represent the amount of area needed to feed the students in your class. Share this circular plot of land equally, and allocate each student their slice of the circle. Calculate the sector area and arc length of each slice the student needs to feed themselves for 1 year.

While students work, walk around the room to check pacing and ensure that students create products similar to the example on **slide 13.**

Once the students have had an opportunity to try the problem on their own, instruct them to turn and talk to their elbow partner about the problem and either finish the problem or come to a consensus on the answer.

After pairs have worked for a few minutes, move to **slide 13** to review the answer with the whole class.

Transition to **slide 14**, and introduce the S-I-T strategy. Ask students to write anything they found surprising, interesting, and troubling about the facts shared in the problem and the solution they have for the problem posed above. When the students have had enough time to write down their responses, ask a few students to share their responses for each bullet point.

Sample responses:

Surprising - It is surprising that someone can eat that much food!

Interesting - It is interesting that people know the exact square footage needed to feed a person.

Troubling - Where is all of the land to grow this food? Is there enough land for the population?

Adding Significance to the Lesson

75% of Oklahoma's land area is devoted to agriculture. Assuming that all of that land produced food that people can eat, that is roughly 1.5 trillion square feet that can feed 20 million people. If the population of Oklahoma is 4 million, why do people in Oklahoma go hungry?

15 minutes

Explain

Ask all students to have their completed **Arc Length and Sector Area Discovery Activity** out and on their desks, move to **slide 15,** and bring the entire class together to review vocabulary terms and allow students to share what they learned in the Explore phase.

Ask for volunteers from the class to define the terms on the slide and share what equations they created in the Explore activity. Either write directly on the slide, or move to **slide 16** to reveal all the definitions. Encourage students to use the back side of their discovery activity to take notes on as a later reference.

On **slide 17**, introduce the formal equations for arc length and sector area. Allow time for students to ensure they have the correct equations written on their discovery activity.

Conduct a whole class discussion about the three questions on the slide, so students can reflect on the equations.

1. *What is that symbol in the numerator?*

That is the symbol Theta (?); it is a variable in this equation that stands for the central angle of the part of the circle we are measuring. This symbol serves the same purpose as any other variable like *x*.

2. *What do you notice about the equations?*

They both have the ratio of part of the circle to the whole. They both are multiplied by the equation of circumference and area.

3. *How are they similar to the area and circumference equations of a circle?*

The arc length equation is multiplied by the circumference equation. The sector area equation is multiplied by the area equation.

Move through **slides 18-27** to practice arc length and sector area questions together. As a whole class, work through the two examples together by asking students in the classroom to describe how to complete the problem while the teacher progresses through **slides 18-21** to show example 1 and **slides 22-27** to show example 2. Encourage students to practice working out these problems on the back side of their discovery activity to review later in the lesson if needed.

Guiding the Lesson

Inform students that they are expected to answer these questions in terms of pi (?) and decimal form. To answer in terms of ? is the exact solution and requires the students to leave ? in the answer instead of multiplying and rounding.

15 minutes

Extend

Preparing the Lesson

Before the lesson, print the **Circle Practice Scavenger Hunt** PowerPoint, and hang up the papers around the room. Keep page 1 as the answer key.

Move to **slide 28** and pass out the **Scavenger Hunt Answer Sheet** to each student.

Explain to the students that they will be answering each question that is hanging around the room and record their answers on their answer sheets. All solutions are listed on the handout, so if a student does not see their answer, they will need to try the problem again to come up with the correct answer. Once the student has solved the problem and located the answer on their handout, they will write the capital letter from the question page on the line above the solution. The students will know they are finished because they have solved the riddle.

Emphasize to students that the questions can be answered in any order, and they are free to choose which questions to solve first.

Once students understand the instructions, dismiss them to begin working on the scavenger hunt.

While students are working, float around the room to answer questions and keep students on track.

Instruct students to turn in their answer sheets and any scratch paper before returning to their seats when they have completed the Scavenger Hunt.

The solution to the Riddle

Q: What is a baby Parabola's favorite drink?

A: Quadratic Formula

10 minutes

Evaluate

Preparing the Lesson

In the Engage phase, if your class decided that your school is a food desert, unhide **slide 29**. If your class found out their school is not in a food desert, unhide **slide 30** and print the **Norman Food Desert** map.

Once all students have returned to their seats, if your class found that your school is in a food desert, transition to **slide 29** and ask students to get out the map they completed in the Engage phase that shows their school's location compared to nearby stores.

If your class found that your school is not in a food desert, transition to **slide 30** and pass out the **Norman Food Desert** map to each student.

Read the instructions on the slide to the class to explain the activity. Allow students time to work independently to write the letter with the criteria written on the slide.

To end the class, have students turn in their letters, or allow time for students to share their letters with the whole class.

Lesson Extension

Consider contacting the social studies department in your school and working together to teach the students about the role state and local government play in developing towns and the impact residents can have on the decision-making process. If applicable, send student letters to the local government to encourage change.

Resources

- K20 Center. (n.d.). Elbow Partners. Strategies. https://learn.k20center.ou.edu/strategy/116
- K20 Center. (n.d.). Magnetic Statements. Strategies. https://learn.k20center.ou.edu/strategy/166
- K20 Center. (n.d.). S-I-T. Strategies. https://learn.k20center.ou.edu/strategy/926
- K20 Center. (n.d.). Stand up, Sit Down. Strategies. https://learn.k20center.ou.edu/strategy/1771
- K20 Center. (n.d.). Think-Pair-Share. Strategies. https://learn.k20center.ou.edu/strategy/139
- Mario's Math Tutoring. (2016, February 24). How to Use a Compass [Video]. YouTube. https://www.youtube.com/watch?v=G8r3qacVdKw Virginia
- State University. (2015, March 4). Living in a Food Desert Documentary [Video]. YouTube. https://www.youtube.com/watch?v=jicYbi-8ZNU