

ADA Accessibility

Inverse Trigonometric Functions

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Grade Level	11th – 12th Grade	**Time Frame**	90 minutes
Subject	Mathematics	**Duration**	2-3 class periods
Course	Precalculus		

Essential Question

How can we use inverse trigonometric functions to determine whether a wheelchair ramp meets the ADA's accessibility standards?

Summary

In this lesson, students will explore angles of incline on different wheelchair ramps by researching the ADA's accessibility standards, measuring different surfaces of a ramp, and uncovering missing angles using inverse trigonometric functions. Students will have the opportunity to share their own ideas regarding safety and accessibility. Additionally, students will use mathematical findings to justify a written argument.

Snapshot

Engage

Students participate in a Four Corners activity to open a dialogue on safety and accessibility in their school. They receive a fake "letter" about a new ADA initiative to ensure that all high school campuses in the U.S. are compliant with the ADA's accessibility standards.

Explore

Students pair up to research what constitutes an acceptable angle of incline, measure ramps on their campus, and determine if the angles of incline are within the ADA's accessibility standards.

Explain

In groups, students discuss how they measured their ramps and what they found. Then, they trade their work to check one another's calculations and correct any misconceptions they have.

Extend

Students complete a Think-Pair-Share activity, answering questions such as: "If a ramp meets the ADA's standards of accessibility, does that mean it is truly accessible to everyone?"

Evaluate

Students reflect on their learning and write a letter back to the Department of Education and the Access Board, articulating what they found and whether the ramps are acceptable. Students then submit their work and their calculations to determine if they were performed correctly.

Standards

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

CCSS.Math.Content.HSF-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.

Attachments

- Lesson Slides—ADA Accessibility.pptx
- Wheelchair Project—ADA Accessibility - Spanish.docx
- Wheelchair Project—ADA Accessibility - Spanish.pdf
- Wheelchair Project—ADA Accessibility.docx
- Wheelchair Project—ADA Accessibility.pdf

Materials

- Lesson Slides (attached)
- Wheelchair Project handout (attached; one per student)
- 2010 ADA Standards for Accessible Design (linked; optional)
- Tape measure
- Pencil and paper
- Access to wheelchair ramps in the building or on campus
- Student devices with internet access

Engage

Teacher's Note: Preparation

Before beginning the lesson, print out a copy of the attached **Wheelchair Project** letter for each student. Also prepare four signs that read "Agree," "Disagree," "Strongly Agree," and "Strongly Disagree" in large print. Then, hang up these signs by placing one in each corner of the classroom.

Introduce the lesson using the attached **Lesson Slides**. Display **slide 3** and show students the essential question: "How can we use inverse trigonometric functions to determine whether a wheelchair ramp meets the ADA's accessibility standards?"

Display **slide 4**, which identifies the lesson's learning objectives. Review each of these slides with students to the extent you feel necessary.

Display **slide 5** and use the Four Corners strategy to group students. To begin, place four signs around the room that read "Agree," "Disagree," "Strongly Agree," and "Strongly Disagree." Then, read aloud the following statement: "Our school is safe and accessible for all." Have students choose their level of agreement and move to the corresponding area of the room, forming a group with those who have chosen the same.

In their groups, have students formulate justifications for their beliefs before they share out to the whole class. Allow for deep, sustained conversation.

Next, have each student find a partner who is in a different agreement group. Inform students they will be partners for the remainder of the lesson.

Teacher's Note: Group Size

If there happens to be an odd number of students, it's okay for some students to work in a group of three.

Have students sit with their partners. Pass out the attached **Wheelchair Project** handout, which is a fake "letter" from the U.S. Department of Education and the Access Board.

After students read the letter, display **slide 6**. Using the KWHL Graphic Organizer strategy, have each student create their own KWHL chart on the back of the handout by writing the following questions in four columns:

1. *Know*: What do I know about the task?
2. *Wonder*: What do I not know (and want to know) about the task?
3. *How*: How will I find the information I need to complete the task?
4. *Learn*: What have I learned about the task?

Explore

Display **slide 7**. Inform students they will research the ADA's accessibility standards. Encourage students to search the internet to access the ADA's webpage and learn more.

Optional Resources

To expedite the research portion, you may provide students with this link to the 2010 ADA Standards for Accessible Design. The document is quite long and may not be good for printing. However, if you would like to provide students with paper copies of ADA standards, feel free to print out only Pages 127–128 and explain that these pages are part of a more comprehensive guide.

Alternatively, two resources from the Express Ramps website are linked in the Resources section at the end of this lesson as easy-to-print guides for ramp regulations.

Once students find out the ratios for ADA-compliant wheelchair ramps, have them convert the ratios to angles using inverse trig functions.

Teacher's Note: Understanding Slope

If you are using this lesson as a way to help students better understand slope, or if you want to have a side conversation about how the ratios are essentially "rise over run," now would be the time to have this conversation.

After finding the standards and the angles, have students find two wheelchair ramps on campus to measure.

Teacher's Note: Finding and Measuring Ramps

There may not be many ramps in your building or on your campus. If this is the case, you may encourage students to measure the same ramp while using different methods.

Students may find it difficult to measure ramps with some sides that are not exposed. In this case, allow extra time for students to brainstorm multiple methods of measuring. Encourage them to start by using the sides they can see, then have them look for a way to measure the height or the base without directly measuring.

Using a tape measure, students may measure any sides they wish, but they need to know and remember which sides so they can apply the correct inverse trig function.

Have students apply the appropriate inverse trigonometric function to the ratios they measured. The result should be an angle that is either less than, equal to, or greater than the angle recommended by the ADA. Ask students to record their findings, explain whether the ramp meets the ADA's standards, and justify their reasoning. If they are unsure, encourage them to remeasure to be certain.

Explain

Display **slide 8**. After students record their findings, assign two pairs to work together as a group of four to discuss which ramps were measured, where they were located, and what was discovered. This allows students to gain a better understanding of multiple wheelchair ramps on campus.

In the same groups of four, have students trade their work with one another and check to ensure all calculations are correct. This helps students correct any misconceptions they have, and they can start thinking about the information they want to include in their letter.

Extend

Display **slide 9**. After clearing up misconceptions, have students complete the following Think-Pair-Share activity.

Think: Ask students to think to themselves, "Did I notice any areas of campus that were not at all accessible? Did I see any places that had only lifts or elevators instead of ramps?"

Pair: Have students work with their partner to discuss these questions.

Share: Have a few volunteers share what they discussed with the whole class.

Display **slide 10**. Ask students to answer the following questions: "If a ramp meets minimum requirements of accessibility by the ADA's standards, does that mean it is truly accessible to everyone? Explain your reasoning. What would a truly accessible ramp look like if you were designing it?"

After they answer the questions, have students work with their partners to write a redesign proposal for what a "truly accessible" campus would look like to them. Next, have them create a list of other things around the school that need to be redesigned to make the campus more accessible.

Evaluate

First, ask students to get out the Wheelchair Project letter they received earlier in the lesson. Then, have students get out a separate piece of paper and divide the page into four quadrants.

Display **slide 11**. Encourage students to organize their thoughts for their letter by using the following quadrant graphic organizer as an outline:

1. *Quadrant 1 (Reflection - What? So What? Now What?)*: Ask students to answer the following questions: What did I do? Why does it matter? What am I taking away from this lesson?
2. *Quadrant 2 (Measurements)*: Have students formalize what they discovered about the wheelchair ramps they measured.
3. *Quadrant 3 (Justifications)*: Ask students to explain whether their ramps are up to code and how they can justify their findings.
4. *Quadrant 4 (Redesign Proposal)*: Have students jot down ideas for how to respond to each of the four tasks outlined in the Wheelchair Project letter.

Have students write a letter back to the U.S. Department of Education and the Access Board, informing them of what they found and whether the ramps are acceptable. The letter should include details from each quadrant of the graphic organizer, and it should address each of the four tasks outlined in the original letter.

Finally, have students submit their work and their calculations to determine if they were performed correctly.

Resources

- Express Ramps, LLC. (n.d.). *ADA Ramp Requirements & Handicap Wheelchair Ramp Guidelines & Ramp Specifications*. ADA Wheelchair Ramps. https://www.adawheelchairramps.com/wheelchair-ramps/ada-requirements.aspx
- Express Ramps, LLC. (n.d.). *ADA Wheelchair Ramp Code, ADA Guidelines & ADA Compliant*. ADA Wheelchair Ramps. https://www.adawheelchairramps.com/wheelchair-ramps/ada-guidelines.aspx
- K20 Center. (n.d.). Four Corners. Strategies. https://learn.k20center.ou.edu/strategy/138
- K20 Center. (n.d.). KWHL Graphic Organizer. Strategies. https://learn.k20center.ou.edu/strategy/127
- K20 Center. (n.d.). Think-Pair-Share. Strategies. https://learn.k20center.ou.edu/strategy/139
- U.S. Department of Justice, Civil Rights Division. (2010). 2010 ADA Standards for Accessible Design. ADA.gov. https://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards.pdf
- U.S. Department of Transportation. (2004). Manual on Uniform Traffic Control Devices handicapped accessible sign [Image]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Handicapped_Accessible_sign.svg