

Trig Identities, Part 4

Sum, Difference, and Double-Angle Identities

Michell Eike, Sherry Franklin
Published by *K20 Center*

This work is licensed under a Creative Commons CC BY-SA 4.0 License

Grade Level	11th – 12th Grade	**Time Frame**	50-75 minutes
Subject	Mathematics	**Duration**	1-2 class periods
Course	Precalculus		

Essential Question

How do we use trigonometric identities?

Summary

Students will apply what they have learned during this lesson series—Pythagorean, sum, difference, and double-angle identities—to navigate through a pirate-themed escape room. They will look at trigonometric identities graphically and algebraically. Students will use trigonometric identities to evaluate expressions, verify identities, and solve equations. This lesson is the fourth lesson of four in a "Trig Identities" lesson series.

Snapshot

Engage

Students take a graphical approach to verifying trigonometric identities.

Explore

Students evaluate trigonometric expressions using identities.

Explain

Students summarize their learning and create a treasure map reference sheet.

Extend

Students apply what they have learned to solve equations using trigonometric identities.

Evaluate

Students demonstrate their understanding by finding the "lie" among three statements.

Standards

Oklahoma Academic Standards Mathematics (Precalculus)

PC.T.3.1: Algebraically manipulate the structure of a trigonometric expression to identify ways to rewrite it.

PC.T.3.3: Graphically and algebraically verify solutions to trigonometric equations.

Attachments

- Escape Room (Sample Responses)—Trig Identities, Part 4.docx
- Escape Room (Sample Responses)—Trig Identities, Part 4.pdf
- Escape Room (Teacher Guide)—Trig Identities, Part 4.docx
- Escape Room (Teacher Guide)—Trig Identities, Part 4.pdf
- Treasure Map—Trig Identities, Part 4 - Spanish.pdf
- Treasure Map—Trig Identities, Part 4.pdf

Materials

- Escape Room (Teacher Guide) document (attached; for teacher use)
- Escape Room (Sample Responses) document (attached; for teacher use)
- Treasure Map handout (attached; one per student; printed front only)
- Pencil
- Paper
- Desmos account

10 minutes

Engage

Teacher's Note: Desmos Classroom Activity Preparation

To use this Desmos Classroom activity, select the following link: "Trig Identities, Part 4." Create an account or sign in under the "Activity Sessions" heading. After you log in, the green "Assign" dropdown button will be active. Click the arrow next to the word "Assign," then select "Single Session Code." After making some setting selections, select "Create Invitation Code" and give the session code to students. For more information about previewing and assigning a Desmos Classroom activity, go to https://k20center.ou.edu/externalapps/using-activities/.

For more detailed information about Desmos features and how-to tips, go to https://k20center.ou.edu/externalapps/desmos-home-page/.

To set up the activity's pacing for students, select "View Dashboard" (next to the session code). In the upper-left corner of your screen, select the icon above the word "Pacing." Desmos Classroom should then prompt you to select the first and last screens that you want students to see. When prompted to set a range, select screens 1 and 3. Select "Restrict to Screens 1–3" to confirm your selection. This allows students to access only screens 1–3 at this time. For more information about teacher pacing, go to https://k20center.ou.edu/externalapps/pacing-activities/.

Provide students with your session code. Then, have students go to student.amplify.com/join/ and enter the session code.

Teacher's Note: Sign-in Options

If students sign in with their Google or Desmos accounts, then their progress is saved, and they can resume the activity or view their work later. If students continue without signing in, they can complete the activity, but they must do so in one sitting. It is strongly recommended that students sign in; otherwise, they risk losing their work.

Introduce the lesson using **screens 1–2** of the Desmos Classroom activity. **Screen 1** displays the lesson's essential question. **Screen 2** identifies the lesson's learning objectives. Review each of these with students to the extent you feel necessary.

Direct students' attention to **screen 3**. Ask students to type what they think a trigonometric identity would look like graphically. Remind students that it is okay if they are unsure but that you would like to later "read their thinking." Use the dashboard to read responses or ask for a couple of volunteers to share what they think with the whole class.

Direct students to work individually or in pairs. Consider challenging students to try to work independently and having them sit in pairs so they have a partner when/if they get stuck.

On the Dashboard, press the orange plus sign to allow students to progress to **screen 4** and have students get out a piece of notebook paper. Explain that they are to answer the three questions in the left column—the next question displays after answering the first question—and use the right column for scratch work. Let students know that they will see feedback at the bottom of each completed screen and to not progress to the next screen before receiving positive feedback with a check mark of approval: . Also let students know that they are expected to label and show their work on their notebook paper, and they are to turn in their work at the end of the lesson.

Optional Technology

If your students have graphing calculators, they could use those handheld devices as their graphing tool instead of Desmos. It is recommended to use the tool that students are most familiar with.

On the Dashboard, click the orange "Stop" button; now students can complete the Desmos Classroom activity at their own pace.

Teacher's Note: Guiding the Activity

If students try to progress through the activity without answering questions correctly, the Desmos activity will not display the next questions. Instead, they will see a screen with a message indicating that they need to return to the previous screen.

Use the attached **Escape Room (Teacher Guide)** document for quick reference as students navigate the activity. This document contains the final responses and actions needed to unlock each screen of the activity.

At the end of the activity, students are prompted to turn in their notebook paper. The escape room only requires students to submit final results, as it is not best practice to have students type lines mathematical work that uses characters not available on a standard keyboard. Use the attached **Escape Room (Sample Responses)** document to check students' work or to aid in finding a mistake.

If students ask why they are not using their calculators and having to use identities instead, let students know that (1) there were centuries of mathematics being done before calculators were invented, and they needed trigonometric identities, which was the inspiration for the theme of this lesson, and (2) they are practicing their ability to algebraically manipulate an expression, which is a skill they will be using regularly.

After students answer the questions on screen 4 correctly, they can navigate to **screen 5,** which sets the scene that their calculator has malfunctioned and has teleported them back to 1717!

10 minutes

Explore

Students progress to **screen 6** and are given the following story:

Ahoy Lubber. You seem to have landed yourself in a heap of trouble. You are now captain of the Whydah ship and charged with finding the treasure before Captain Blackbeard gets his grubby hands on it. If you are successful, you will be able to return to the present. If you fail, it is Davy Jones' Locker for you because according to history books, the Whydah sinks in 3 days.

On **screen 7**, students are tasked with evaluating trigonometric expressions without the use of their "broken" calculators. Once students answer questions 4-6 correctly, they will unlock the next screen.

On **screen 8**, students are asked to find the value of the cosine of 90° multiple ways. On their notebook paper, they should be writing the multiple options and entering the quantity of ways they discovered into the screen.

10 minutes

Explain

Use the Dashboard to navigate student progress or to circulate the room. Give students on **screen 9** a copy of the attached **Treasure Map** handout and tell them to set aside their Desmos activity. Direct students to use their notes from prior lessons to complete the handout.

Once students have completed their handout, direct them to press the “I have completed my treasure map” button on the screen to unlock the next screen.

Teacher's Note: Guiding the Activity

Encourage students to write the identities that they struggle to remember. For example, students may not feel that they need to write down that cotangent is the ratio of cosine over sine if they have written down that tangent is the ratio of sine over cosine. This handout is intended to help students have a place to quickly reference their trigonometric identities.

10 minutes

Extend

On **screen 10** students are to solve the three equations to get the 3-letter code to unlock the treasure chest and the next screen. Remind students that their calculators are broken and that they will need to use their trigonometric identities. Encourage students to use their Treasure Map handout for quick reference of their identities.

5 minutes

Evaluate

On **screen 11** students are given three statements: two truths and one lie. Students are to select the one statement that is the lie to unlock the next screen.

Teacher's Note: Guiding the Activity

This is why it is important to have students record their work on a piece of notebook paper. They need to demonstrate that they know which two statements are true and prove that they are true. Similarly, they need to be able to prove why the one statement is false. Use students' work to assess their understanding.

After making the correct selection, students move to **screen 12**, which concludes their adventure with a celebration of success.

As students then move to **screen 13**, the story ends, and they are asked to use the Most Valuable Point strategy to determine what information they felt was critical to their understanding of how to use trigonometric identities. Then students are to turn in their notebook paper (scratch work) as proof of "where they have been" this whole time.

Collect student responses and use them to see which misconceptions persist.

Resources

- K20 Center. (n.d.). Desmos Classroom. Tech tools. https://learn.k20center.ou.edu/tech-tool/1081
- K20 Center. (n.d.). MVP: Most valuable point. Strategies. https://learn.k20center.ou.edu/strategy/3034