Solve Problems Using Right Triangles

Specific Expectations
Solving Problems Involving the Trigonometry of Right Triangles
In this section, students will
MT2.03 solve problems involving the measures of sides and angles in right triangles in real-life applications (e.g., in surveying, in navigation, in determining the height of an inaccessible object around the school), using the primary trigonometric ratios and the Pythagorean theorem
MT2.04 describe, through participation in an activity, the application of trigonometry in an occupation (e.g., research and report on how trigonometry is applied in astronomy; attend a career fair that includes a surveyor, and describe how a surveyor applies trigonometry to calculate distances; job shadow a carpenter for a few hours, and describe how a carpenter uses trigonometry)

Link to Get Ready
The Get Ready segments Solving Proportions and Rounding provide the needed skills for this section. Have students complete these questions before proceeding with Section 2.5.

Warm-Up
1. Solve for each value. Round the answer to two decimal places.

    a) $\sin x = 0.3122$ **b)** $\cos 32° = x$

    c) $\tan x = 44$ **d)** $\sin 52° = x$

2. Solve each ratio. Round the answer to two decimal places

    a) $\sin 21° = \dfrac{X}{44}$ **b)** $\cos 15° = \dfrac{X}{32}$

    c) $\tan 19° = \dfrac{X}{4}$ **d)** $\sin 51° = \dfrac{X}{16}$

3. Solve for each value. Round the answer to two decimal places.

    a) $\sin x = \dfrac{4}{17}$ **b)** $\cos x = \dfrac{11}{83}$

    c) $\tan x = \dfrac{55}{121}$ **d)** $\sin x = \dfrac{4}{7}$

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Warm-Up Answers

1. a) $x = 18.19°$ **b)** $x = 0.85$ **c)** $x = 88.70°$ **d)** $x = 0.79$

2. a) $x = 15.77$ **b)** $x = 30.91$ **c)** $x = 1.38$ **d)** $x = 12.43$

3. a) $x = 13.61°$ **b)** $x = 82.38°$ **c)** $x = 24.44°$ **d)** $x = 34.85°$

- Some students may not tape the clinometer horizontally resulting in a false measurement.
- R$_x$ Have students check the validity of their clinometers by performing a test calculation using a known height.

- Some students may experience skewed clinometer readings if their eye-level height is incorrect.
- R$_x$ Have a measuring tape on hand for students to measure and record their eye-level height.

- Some students may incorrectly identify the angle of depression in the corner between the hypotenuse and the vertical.
- R$_x$ Remind students that the angle of depression is measured from the horizontal; therefore, it should be marked in the corner between the hypotenuse and horizontal (not the vertical).

Ongoing Assessment

- While the students are working on the Investigate circulate to see how well each student works within a group. This may be an opportunity to observe and record the individual student's skills in group work, work habits, organization, and initiative. You may wish to use **BLM A6 Group Work General Scoring Rubric** to assist in assessing your students.
- You may wish to use Practise the Concepts question 4 as a formative assessment. Have students draw the diagram and answer the question on lined paper to hand in. You may wish to use **BLM A1 Knowledge/ Understanding General Scoring Rubric** to assist you in assessing your students.

Accommodations

ESL—Have students create a collage that illustrates the meaning of "angle of elevation" and "angle of depression." This might include a diagram as well as related words and examples.

Memory—Give students practice choosing the appropriate trigonometric ratio. Use a quiz in which students pick the correct ratio for a situation. Have students add a written explanation of when to use which of the three trigonometric ratios to their journal.

Teaching Suggestions
Warm-Up
- Write the Warm-Up questions on the board or on an overhead. Have students complete the questions independently. Then, discuss the solutions as a class. (5–10 min)

Section Opener
- If you have access to a transit, bring it in to show students what surveyors see and to use a workplace tool for measurement of angles and lines of sight.
- Ask students if they have ever seen a surveyor (e.g., on the highway). Let this question lead into a discussion of job prospects and options.
- Have students discuss what they think of when you say elevation and depression. Then, read the introduction aloud. Add "angle of elevation" and "angle of depression" to the word wall.

Investigate
- Have students work with a partner to build a clinometer. You may wish to have a pre-made clinometer as a model for students. You may also wish to display several clinometers at different stages in the assembly process so students can check that they understand the steps.
- Once the clinometers are made, have students find objects to measure. Good targets around the school include the flagpole, basketball nets, and the ceiling in the gym, cafeteria, or auditorium. Or, you may wish to have students go outside for this activity.
- When students have done their measurements you may wish to have them present their findings to the class or collect all results to make a class display.
- Have students read the MathConnect and research how a mariner's quadrant is used.
- Use **BLM G2 Protractor** for students who don't have protractors.
- Use **BLM 2.5.1 Practice: Solve Problems Using Right Triangles** for extra practice or remediation.

> **Investigate Answers (page 84)**
> **2–3.** Answers will vary.

Examples
- Have students look carefully at the diagram in Example 1 to ensure they realize which angle is described. Encourage students to use their clinometers from the Investigate to find an angle of 36°.
- You may wish to have two students come to the front of the class to form a visual reference for the terms used in Example 2. Have one student stand looking up (e.g., to the top of the board) to show the angle of elevation, and have the other look down (e.g., to the bottom of the board) to show the angle of depression. You could use a metre stick to show eye level.

Key Concepts
- Read the Key Concepts to the students and ask if there are any questions.

Discuss the Concepts

- Have students illustrate the difference between the two angles. They might choose to draw, build a model, or create a tableau with other students. Alternatively, invite students to come up with a mnemonic, rhyme, or other memory aid. You may wish to use **BLM A4 Application General Scoring Rubric** to assist you in assessing your students.

> **Discuss the Concepts Suggested Answers (page 86)**
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> **D1.** The angle of elevation looks up (elevates) from the horizontal and the angle of depression looks down (into a depression) from the horizontal.

Practise the Concepts (A)

- Encourage students to refer back to the Examples before asking for assistance.
- Circulate as students are making their diagrams to ensure that students correctly mark the angles of inclination and depression in their diagrams.

Apply the Concepts (B)

- You may wish to use question 7 as a Literacy Connect. The students' explanations will allow you to see if they can effectively communicate their understanding of the problem.
- Have students take turns drawing the diagrams for each question on the board for other students to use as a reference.
- In question 9, students may incorrectly mark the 30° angle from the sun looking down (i.e., between the hypotenuse and vertical) rather than as the angle of elevation. Emphasize that the angle is made "with the ground."
- Question 10 provides students with a chance to relate to an application of trigonometry. Ask if any of them have pets; ask if any students have built pens such as the one in the question.

Extend the Concepts (C)

- Assign the Extend the Concepts questions to students who are not being challenged by questions in Apply the Concepts.
- Extend the Concepts questions can be used as a diagnostic assessment for those students considering a university-level course in grade 11.
- Question 12 allows the student to extend their understanding to a new situation. You may wish to have students follow this up with an Internet search for standards related to the height of and distance between hydro poles.