

Ari Tells Height

Vocabulary

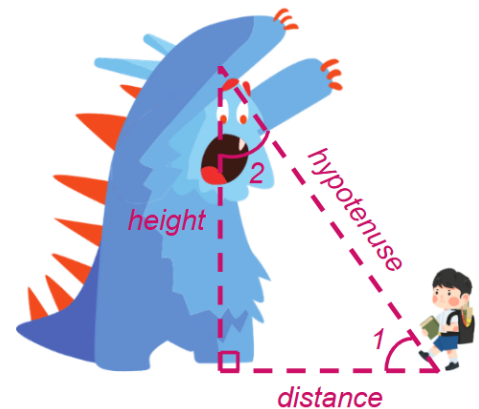
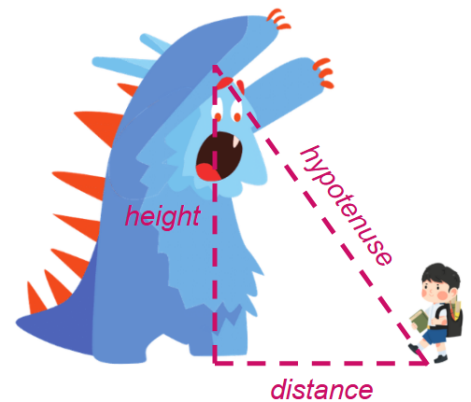
Right Triangle - A triangle with two perpendicular sides that form a 90-degree angle, also called a right angle.

Perpendicular - Two lines that cross to make a 90-degree angle.

Direct Instruction

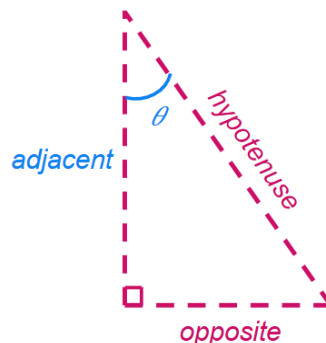
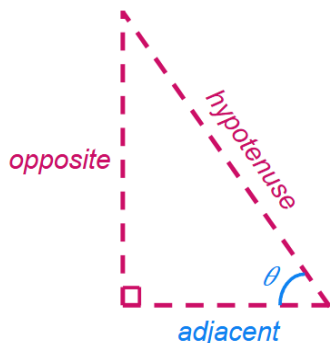
Introduction

1. A monster approaches you and says he'll eat your lunch unless you can guess his height. You can use measuring tools, but you cannot directly measure the monster's height.
2. What strategy would you use to try and guess the monster's height?
3. One thing you might notice is that we can make a triangle out of this image. We end up with 3 lines: the distance from the person to the monster, the monster's height, and the hypotenuse, which connects from the top of the monster's head to the person's feet.
4. These 3 lines also create 3 angles. There is a right angle where the perpendicular lines meet, an angle by the person's foot, and an angle at the monster's head.
5. Luckily for us, there are special functions that can be used to solve for the unknown side and angle lengths, as long as we have a bit of information to work with.
6. These are called trigonometric functions, and the three basic ones are **sine (sin)**, **cosine (cos)**, and **tangent (tan)**.



Ari Tells Height

7. For a triangle with an angle θ , the three functions are calculated as follows:



$$\sin(\theta) = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos(\theta) = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan(\theta) = \frac{\text{opposite}}{\text{adjacent}}$$

NOTE: The **adjacent** and **opposite** sides depend on which angle you are using.

8. To remember these functions, mathematicians have developed a mnemonic.

$$\sin(\theta) = \text{opposite} / \text{hypotenuse} \rightarrow \text{SOH}$$

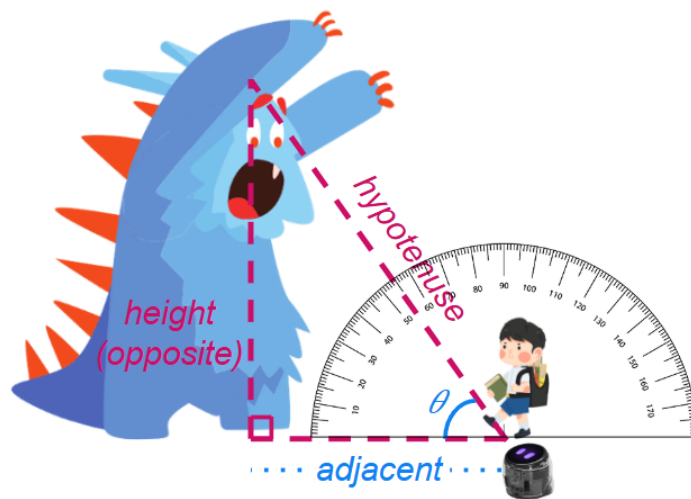
$$\cos(\theta) = \text{adjacent} / \text{hypotenuse} \rightarrow \text{CAH}$$

$$\tan(\theta) = \text{opposite} / \text{adjacent} \rightarrow \text{TOA}$$

All you have to remember is SOHCAHTOA (pronounced so-ka-toe-a). Easy!

9. Back to our monster friend. We can use measuring tools, but we cannot measure the monster's height.

10. We can use a tool like Ari to measure the distance from the monster to us. For this example, say the distance is 4 meters. We can also use a protractor to measure the angle, which is 55° .



11. Now that we have the **adjacent** length and the angle θ , we use the tangent formula to calculate the **opposite** length (the height).

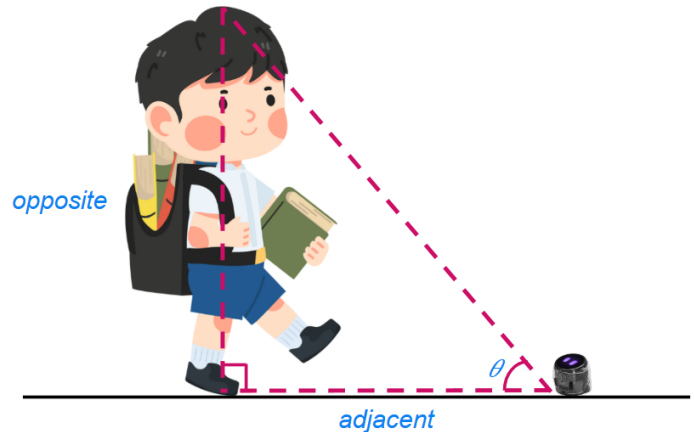
$$\tan(\theta) = \frac{\text{opposite}}{\text{adjacent}} \Rightarrow \text{opposite} = \tan(\theta)(\text{adjacent}) = \tan(55)(5) = 5.71 \text{ meters}$$

Ari Tells Height

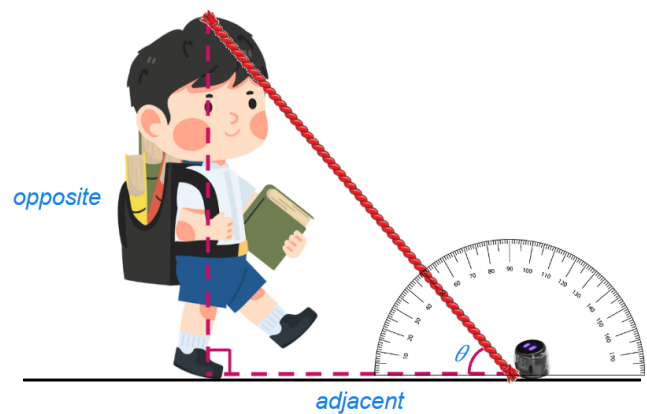
12. The monster is, therefore **5.71 meters**, or **18.7 feet tall**! Scary, but no lunch for this monster!

Activity 1 - Finding the Angle and Adjacent Side

1. For this activity, the goal is to use trig functions to calculate their height given the angle and adjacent side. For part 1, students will measure the adjacent side and angle using Ari and a protractor.
2. Place students into groups and provide each group with one Ari, a protractor, and the 2.2-meter yarn.
3. To set up the experiment, students should place Ari on the floor a short distance from their feet.



4. Power on Ari and open the distance app. Measure the distance from Ari to the student and record it in the table on the Student Activity Sheet.
5. Using a protractor (or a protractor app), students should find the angle from Ari to the top of their head. To make it easier to see the angle, students can use yarn with the protractor.



6. Repeat steps 4 and 5 for the other students in the group.

Ari Tells Height

Activity 2 - Calculating the Height

1. For this activity, students will calculate their heights using the trig functions covered in the Direct Instruction portion of the lesson.
2. Use the appropriate trig function to calculate the height of each student.
3. Use a measuring tape to find the student's actual height (or the student's height if they know it). Calculate the percent error.

Percentage Error

$$\left| \frac{\text{Measured} - \text{True}}{\text{True}} \right| \times 100$$

Evaluate: Exit Ticket

Students will fill out and submit their Exit Tickets (The last page of the Student Activity Sheet).