Name: _____ Date: _____

UNIT 4

4.4.5 — Trigonometric Ratios

SOH CAH TOA • Opposite / Adjacent / Hypotenuse • Missing Sides • Missing Angles • Applications

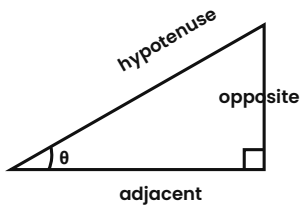
A. COMPLETE SOH CAH TOA

Write each ratio as a fraction, then state what the letters mean.

Ratio	Complete the definition	Sides used
Sine	$\sin\theta = \frac{O}{H}$	Opposite and hypotenuse
Cosine	$\cos\theta = \frac{A}{H}$	Adjacent and hypotenuse
Tangent	$\tan\theta = \frac{O}{A}$	Opposite and adjacent

1. The hypotenuse is always the side _____.
2. The labels opposite and adjacent are defined relative to _____.

B. IDENTIFY THE SIDES AND SELECT A RATIO



1. If the known sides are opposite and hypotenuse, select _____.
2. If the known sides are adjacent and hypotenuse, select _____.
3. If the known sides are opposite and adjacent, select _____.
4. Explain why changing the marked acute angle can change which leg is called “opposite.”

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C. DETERMINE MISSING SIDE LENGTHS

Give answers to 3 significant figures. Show the ratio before calculating.

1. θ = 35°, H = 12 cm. Determine O. $x = 12\sin 35^\circ$

2. θ = 40°, H = 8 m. Determine A. $x = 8\cos 40^\circ$

3. θ = 27°, A = 14 m. Determine O. $x = 14\tan 27^\circ$

4. θ = 52°, O = 9.5 cm. Determine H. $\sin 52^\circ = \frac{9.5}{h}$

D. DETERMINE MISSING ANGLES

Use inverse trigonometric functions and ensure the calculator is in degree mode.

Given sides	Set-up	θ
O = 5, A = 12	$\theta = \tan^{-1}\left(\frac{5}{12}\right)$	_____
A = 7, H = 9	$\theta = \cos^{-1}\left(\frac{7}{9}\right)$	_____
O = 11, H = 15	$\theta = \sin^{-1}\left(\frac{11}{15}\right)$	_____
rise = 1.8 m, run = 6 m	$\theta = \tan^{-1}\left(\frac{1.8}{6}\right)$	_____

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E. ERROR CORRECTION AND RATIO CHOICE

Identify the error, correct it, and explain why the correction is valid.

1. A student writes **tan θ = hypotenuse ÷ adjacent**. Correct the definition and explain which side should replace the hypotenuse.

   _____

   _____

2. A student wants an angle using O = 12 and H = 5, so enters **$\sin^{-1}(12/5)$**. Explain why this cannot represent a right-triangle sine ratio, and state what should be checked.

   _____

   _____

3. A student finds a side opposite 30° to be 14 cm when the hypotenuse is 10 cm. Explain immediately why the result is unreasonable.

   _____

F. MIXED RATIO PRACTICE

For each item, identify the ratio before calculating.

1. A 9–12–15 right triangle has θ opposite the 9-unit side. Determine sin θ, cos θ and tan θ. _____
2. Hence determine θ to 1 decimal place. _____
3. A right triangle has θ = 63° and adjacent side 4.8 cm. Determine the opposite side. _____
4. A right triangle has θ = 24° and opposite side 7.2 m. Determine the hypotenuse.

   _____

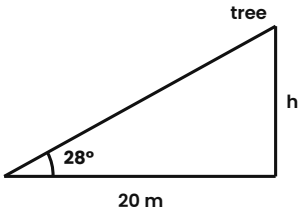
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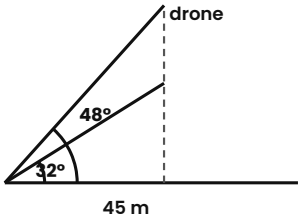
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G. TRIGONOMETRY IN CONTEXT



1. A point on level ground is 20 m from a tree. The angle of elevation to the top is 28°. Determine the vertical height from the observation level to the top of the tree.
2. A 6 m ladder makes a 68° angle with level ground. Determine the vertical height reached.
3. A cable is anchored 18 m from the base of a vertical tower and makes a 52° angle with the ground. Determine the height at which the cable meets the tower.

H. MULTI-STEP APPLICATION: CHANGING ANGLE OF ELEVATION



1. A drone is horizontally 45 m from an observer. Its angle of elevation is 32°. Determine its altitude above the observer's level.
2. The drone rises vertically while remaining 45 m away horizontally until the angle of elevation is 48°. Determine its new altitude and the vertical distance it has risen.
3. Explain why tangent is the natural ratio in both parts.

_____
_____

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I. EXPLAIN AND JUSTIFY

A numerical answer alone is not sufficient.

1. Explain why the same physical side of a right triangle can be “opposite” for one acute angle and “adjacent” for the other acute angle.
2. Explain why the calculator must be in degree mode for the problems in this worksheet.
3. Explain why the opposite side is not necessarily the longest side of a right triangle.
4. State one modelling assumption required when using a building-height or tree-height diagram as a right triangle.

J. EXTENDED IB-STYLE CHALLENGE

Set up two tangent equations before solving.

From point A on level ground, the angle of elevation to the top of a vertical tower is 35°. After moving 20 m directly toward the tower to point B, the angle of elevation is 50°. Let x be the original horizontal distance from A to the tower and h the tower height.

$$x\tan 35^\circ = (x - 20)\tan 50^\circ$$

1. Determine x.
2. Hence determine h.
3. Explain why this method is stronger than measuring the height from a scale drawing.

_____

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K. MEASUREMENT AND MODEL VALIDATION

Interpret how measurement error affects a trigonometric result.

A wheelchair ramp is modelled as a right triangle. Its length is 5.00 m and its vertical rise is measured as 0.60 m.

1. Use $\theta = \sin^{-1}\left(\frac{0.6}{5}\right)$ to determine the ramp angle.
2. If the rise were actually 0.65 m, determine the new angle.
3. Calculate the change in angle and explain why accurate measurement matters when the angle is being checked against a design limit.

L. DESIGN CHECK

Use trigonometry to make and justify a decision.

A proposed ramp is 7.20 m long and must rise 0.80 m. The design requirement is that its angle to the horizontal must not exceed 7.0°.

$\theta = \sin^{-1}\left(\frac{0.8}{7.2}\right)$

1. Determine the ramp angle to 1 decimal place.
2. Decide whether the design satisfies the requirement.
3. State the right-triangle assumption that makes the calculation valid.

_____

ANSWER KEY

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ANSWER KEY — 4.4.5 Trigonometric Ratios

Answers are rounded as stated; equivalent clear explanations are acceptable.

A. SOH CAH TOA

1. $\sin\theta = \frac{O}{H}$; $\cos\theta = \frac{A}{H}$; $\tan\theta = \frac{O}{A}$.
2. **opposite the right angle.**
3. **the chosen acute angle θ.**

B. SIDE LABELS AND RATIO CHOICE

1. **sine.**
2. **cosine.**
3. **tangent.**
4. The two legs exchange the labels opposite/adjacent when the reference angle changes; the **hypotenuse stays fixed**.

C. MISSING SIDES

1. **6.88 cm**
2. **6.13 m**
3. **7.13 m**
4. **12.1 cm**

D. MISSING ANGLES

1. **22.6°**
2. **38.9°**
3. **47.2°**
4. **16.7°**

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UNIT 4

ANSWER KEY — Applications and Reasoning (E–I)

Reasons should refer to side roles, right-triangle structure, or calculator mode where relevant.

E. ERROR CORRECTION

1. **tan θ = opposite/adjacent.** Tangent does not use the hypotenuse.
2. A sine ratio must lie between 0 and 1 for an acute right-triangle angle. Since 12/5 > 1, the sides are mislabeled or the numerator/denominator is wrong.
3. The hypotenuse is the longest side, so an opposite side of 14 cm cannot occur when H = 10 cm.

F. MIXED RATIO PRACTICE

1. **sin θ = 9/15 = 0.6; cos θ = 12/15 = 0.8; tan θ = 9/12 = 0.75.**
2. **θ ≈ 36.9°.**
3. **4.8 tan 63° ≈ 9.42 cm.**
4. **7.2/sin 24° ≈ 17.7 m.**

G. CONTEXT

1. **20 tan 28° ≈ 10.6 m.**
2. **6 sin 68° ≈ 5.56 m.**
3. **18 tan 52° ≈ 23.0 m.**

H. CHANGING ANGLE OF ELEVATION

1. **45 tan 32° ≈ 28.1 m.**
2. New altitude: **45 tan 48° ≈ 50.0 m**; rise ≈ **21.9 m**.
3. Tangent directly relates the **opposite vertical height** and the **adjacent horizontal distance**.

I. EXPLAIN AND JUSTIFY

1. Opposite/adjacent are named relative to the chosen acute angle.
2. The given angles are in degrees, so degree mode matches the units.
3. The hypotenuse, not the opposite side, is always the longest side.
4. Examples: level ground and a vertical object; or the geometry truly forms a right angle.

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UNIT 4

ANSWER KEY — Extended Problems (J–L)

Extended solutions should include set-up, calculation, and a contextual conclusion.

J. EXTENDED CHALLENGE

$$x\tan 35^\circ = (x - 20)\tan 50^\circ$$

1. **x ≈ 48.5 m.**
2. **h = x tan 35° ≈ 34.0 m.**
3. Trigonometric equations use the geometric constraints directly; a scale drawing can introduce measurement and drawing error.

K. MEASUREMENT AND VALIDATION

1. $\theta = \sin^{-1}\left(\frac{0.6}{5}\right)$ gives **θ ≈ 6.89°.**
2. **$\sin^{-1}(0.65/5) \approx 7.47°$.**
3. Change ≈ **0.58°.** A small rise error can alter whether the ramp passes or fails a design limit.

L. DESIGN CHECK

1. $\theta = \sin^{-1}\left(\frac{0.8}{7.2}\right)$ gives **θ ≈ 6.4°.**
2. **Yes.** 6.4° < 7.0°.
3. The ramp, horizontal ground, and vertical rise are assumed to form a **right triangle**.

TEACHER NOTE

Accept equivalent correct methods that use the appropriate right-triangle ratio, degree mode, sensible rounding, and a contextual conclusion where required.