Grade 10 Mathematics Lesson Plan

Angles of Elevation

Strand:	**Measurement and Geometry**
Sub-Strand:	Trigonometric Ratios to Angles of Elevation and Depression
Specific Learning Outcome:	Apply trigonometric ratios to angles of elevation and depression
Duration:	40 minutes
Key Inquiry Questions:	What is trigonometry? How do we use trigonometry in real-life situations?
Learning Resources:	CBC Grade 10 textbooks, clinometers, measuring tapes, calculators

Lesson Structure Overview

Phase	Duration	Focus
Problem-Solving and Discovery	15 minutes	Anchor activity: Measuring height using clinometer and angle of elevation
Structured Instruction	10 minutes	Formalizing angles of elevation and depression concepts
Practice and Application	10 minutes	Worked examples and guided practice
Assessment	5 minutes	Exit ticket to check understanding

Phase 1: Problem-Solving and Discovery (15 minutes)

Anchor Activity: Measuring Height Using Clinometer and Angle of Elevation

Students work in groups to use a clinometer to measure the angle of elevation from their eye level to the top of a tall object (tree, building, flagpole), measure the horizontal distance to the object, and use trigonometry to calculate the height of the object.

Materials Required:

- Measuring tape or meter stick
- Protractor or paper tube
- Calculator (or table of trigonometric ratios)

- Paper and pencil
- Clinometer (made from a string with a weight or rock attached)

Instructions for Students:

1. Find a tall object around your surroundings e.g tree, building, flagpole, etc.
2. Measure the distance from the base of the object to your position. Record this distance.
3. Use your clinometer to measure the angle of elevation from your eye level to the top of the object. Record the angle.
4. Draw a right triangle representing the situation. Label the distance you measured, the angle of elevation, and the unknown height of the object.
5. Decide which trigonometric ratio (sine, cosine, or tangent) you need to use to find the height.
6. Use the appropriate trigonometric ratio and the measured distance and angle to calculate the height of the object. Show your work.
7. Write down your calculated height. Compare your result with your partner or other groups results. Discuss any differences.

Recording Table for Student Observations:

Object Measured	Horizontal Distance (m)	Angle of Elevation (degrees)	Trigonometric Ratio Used	Calculated Height (m)
___	___	___	___	___

Teacher Role During Discovery:

- Circulate among groups, ensuring students understand how to use the clinometer correctly.
- Ask probing questions: "What triangle are you forming?" "Which side is opposite the angle?" "Which side is adjacent?"
- For struggling groups: "Let us draw the triangle together. Your eye level is here, the top of the object is here, and the base is here. What angle did you measure?"
- For early finishers: "Can you measure your eye height and add it to your calculation to get the total height from the ground?"
- Guide students to articulate: "The tangent ratio is most useful here because we have the adjacent side (horizontal distance) and we want to find the opposite side (height above eye level)."
- Identify 2-3 groups with clear calculations to share with the class.

Discovery Table: Linking Observations to Mathematical Significance

Student Observation	Mathematical Significance
We are looking UP from our eye level to the top of the object	This forms an angle of elevation (measured upward from a horizontal line)
The horizontal distance and height form a right triangle	We can use trigonometric ratios to solve for the unknown height
The tangent ratio works best: tan(angle) = height / distance	Tangent relates the opposite side (height) to the adjacent side (distance)
We need to add our eye height to get the total height from the ground	The calculated height is only the height above eye level
Different groups got slightly different answers	Measurement errors are normal; averaging results improves accuracy

Phase 2: Structured Instruction (10 minutes)

Connecting Student Discoveries to Formal Concepts

After students have completed the anchor activity and shared their findings, the teacher formalizes the concepts of angles of elevation and depression.

Key Takeaways:

A clinometer (or inclinometer) is a tool used to measure the angle of elevation (looking up) and the angle of depression (looking down).

The figure shows a person standing on the ground, looking at an object at the top. This forms an angle of elevation. When looking down from a higher point, it forms an angle of depression.

The dashed line is the horizontal line.

Definitions:

- Angle of Elevation: The angle measured upward from a horizontal line to an object above.
- Angle of Depression: The angle measured downward from a horizontal line to an object below.

Important Notes:

- The horizontal line is the reference line (usually at eye level).

- Angles of elevation and depression between two points are equal (alternate angles).
- The tangent ratio is most commonly used: tan(angle) = opposite / adjacent.
- Always account for eye level height when calculating total height of objects.
- Draw a clear diagram to identify the right triangle and label all known and unknown sides.

Scaffolding Strategies to Address Misconceptions:

- Misconception: "Angle of elevation is measured from the object." → Clarification: "No, it is measured from the horizontal line at your eye level, looking UP."
- Misconception: "The calculated height is the total height from the ground." → Clarification: "No, you must add your eye height to get the total height."
- Misconception: "I can use any trigonometric ratio." → Clarification: "Choose the ratio based on what you know and what you need to find. Tangent is most common for elevation problems."
- Misconception: "Angle of elevation and angle of depression are different." → Clarification: "They are equal when measured between the same two points (alternate angles)."

Phase 3: Practice and Application (10 minutes)

Worked Examples:

Example 1: Finding Tree Height (Textbook Example 2.4.33)

A person stands 20 m away from a tree. The angle of elevation from their eyes (1.6 m above the ground) to the top of the tree is 35 degrees. Find the height of the tree.

Solution:

Use tan(angle)

tan 35 degrees = (Tree height - 1.6 m) / 20 m

Tree height = (20 × tan 35 degrees) + 1.6

= (20 × 0.7002) + 1.6

= 14 + 1.6

= 15.6 m

Example 2: Finding Distance to Lighthouse (Textbook Example 2.4.34)

A lighthouse is 50 m tall. A sailor spots the top of the lighthouse at an angle of elevation of 25 degrees. How far is the ship from the base of the lighthouse?

Solution:

Use tan

tan 25 degrees = 50 m / Base

Base = 50 / tan 25 degrees

= 50 / 0.4663

= 107.2 m

Example 3: Angle of Depression from Hill (Textbook Example 2.4.35)

A hiker stands on top of a hill that is 120 cm high and looks down at a cabin in a valley. The angle of depression to the cabin is 40 degrees. Calculate the horizontal distance from the hiker to the cabin.

Solution:

Use tan:

tan 40 degrees = 120 cm / Cabin distance

Cabin distance = 120 / tan 40 degrees

= 120 / 0.8391

= 143 cm

Phase 4: Assessment (5 minutes)

Exit Ticket:

Students complete the following questions individually.

1. A ladder is leaning against a wall, forming an angle of 60 degrees with the ground. If the ladder is 10 meters long, how high does it reach on the wall? Draw a right-angled triangle to represent the situation.

2. If the angle of elevation is 30 degrees and the distance to the object is 50 m, then the height above eye level is:

3. A drone flies to a height of 80 meters above the ground. The angle of depression from the drone to a person standing on the ground is 30 degrees. Find the horizontal distance between the person and the drone projection on the ground. Sketch the problem.

4. A surveyor is standing 50 meters away from the base of a mountain. The angle of elevation to the peak of the mountain is 30 degrees. Calculate the height of the mountain above the surveyor eye level.

Answer Key:

1. Height up the wall = 8.666 m

2. The height above the eye level = 28.9 m

3. Horizontal distance = 138.6 m

4. The height above the eye level = 28.9 m

Differentiation Strategies

For Struggling Learners:

- Provide pre-drawn triangles with labels to help students visualize the problem.
- Use simpler angles (30 degrees, 45 degrees, 60 degrees) with known trigonometric ratios.
- Pair struggling students with confident problem solvers.
- Provide step-by-step calculation templates.

For On-Level Learners:

- Encourage students to draw their own diagrams from word problems.
- Ask students to explain which trigonometric ratio they chose and why.
- Provide mixed practice with both elevation and depression problems.

For Advanced Learners:

- Challenge students to solve problems involving both elevation and depression in sequence.
- Explore real-world applications: surveying, navigation, architecture.

- Investigate error analysis: How does a 1-degree error in angle measurement affect the calculated height?
- Apply angles of elevation to find distances that cannot be measured directly.

Extension Activity

Real-World Application: Surveying School Grounds

Students work in groups to create a map of the school grounds using angles of elevation and depression.

Materials: Clinometers, measuring tapes, calculators, graph paper

Tasks:

8. Identify 3-5 tall objects around the school (buildings, trees, flagpoles).
9. Measure the angle of elevation and horizontal distance to each object.
10. Calculate the height of each object using trigonometry.
11. Create a scale drawing of the school grounds showing the locations and heights of all measured objects.
12. Present your findings to the class, explaining your methods and calculations.
13. Discuss sources of error and how to minimize them.

Key Takeaway:

Students should understand how angles of elevation and depression are used in real-world professions such as surveying, architecture, navigation, and engineering.

Teacher Reflection Prompts

- Did students successfully use the clinometer to measure angles of elevation?
- Were students able to identify the correct trigonometric ratio to use?
- What misconceptions emerged during the lesson, and how were they addressed?
- Did students understand the difference between angles of elevation and depression?
- What adjustments would improve this lesson for future classes?