

CBC Grade 10 Mathematics Lesson Plan

Angles of Depression

Strand	Measurement and Geometry
Sub-Strand	Trigonometry 1
Specific Learning Outcome	Apply trigonometric ratios to angles of elevation and depression
Key Inquiry Questions	What is trigonometry? How do we use trigonometry in real-life situations?
Learning Resources	CBC Grade 10 textbooks, homemade clinometer, ruler or measuring tape, notebook and pen, calculator
Lesson Duration	40 minutes

Lesson Structure Overview

Phase	Activity	Duration
Phase 1	Problem-Solving and Discovery (Anchor Activity)	15 minutes
Phase 2	Structured Instruction (Key Takeaways)	10 minutes
Phase 3	Practice and Application (Worked Examples)	15 minutes
Phase 4	Assessment (Exit Ticket)	5 minutes

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

Anchor Activity: Measuring Angles of Depression with Clinometer

Individual Work

What you require:

- Your homemade clinometer
- A ruler or measuring tape
- A notebook and pen
- A friend (optional, but fun!)

Instructions:

1. Climb up to a higher place like a step, a balcony, or a small hill.
2. Hold the clinometer at eye level, and look through it toward an object on the ground (like a cone, stone, or your friend's shoes).

3. Watch the string and record the angle where it crosses the scale. That's your angle of depression!
4. Measure the height from your eyes to the ground (that's your vertical distance).
5. Calculate how far the object is from the base of your standing point using trigonometry.
6. Share and discuss your work with your classmates.

Teacher Guidance for Anchor Activity

This hands-on activity helps students understand angles of depression through direct measurement and calculation.

Facilitation Strategy:

- • Ensure all students have functional clinometers from previous lesson
- • Identify safe elevated positions (steps, balconies, small hills)
- • Guide students to select visible ground objects for measurement
- • Emphasize safety when climbing to elevated positions
- • Circulate and ask: "What angle did you measure?" "How will you calculate the distance?"
- • Probe: "How is angle of depression different from angle of elevation?"
- • Students should discover: Angle of depression is measured downward from horizontal

Phase 2: Structured Instruction (10 minutes)

Key Takeaways

After students have explored through the anchor activity, formalize their discoveries with these key concepts:

1. Definition of Angle of Depression

The angle of depression is the angle measured downward from a horizontal line to an object below. It is how far your head must tilt from eye-level to look down at an object.

2. Relationship Between Angles of Elevation and Depression

When you look down from a higher point at an object, you form an angle of depression. From the object looking up at you, that forms an angle of elevation. These two angles are equal due to alternate interior angles formed by parallel horizontal lines.

3. The Horizontal Reference Line

The angle of depression is always measured from a horizontal line (eye level when looking straight ahead). The horizontal line is parallel to the ground.

4. Using Trigonometry with Angles of Depression

To solve problems involving angles of depression:

- Step 1: Draw a diagram showing the situation with a right triangle
- Step 2: Identify the angle of depression from the horizontal line

- Step 3: Find the corresponding angle inside the right triangle (often 90° - angle of depression, or use alternate interior angles)
- Step 4: Identify which sides are opposite, adjacent, and hypotenuse relative to your working angle
- Step 5: Choose the appropriate trigonometric ratio (sin, cos, or tan)
- Step 6: Solve for the unknown distance or height

5. Common Strategy

For angles of depression problems:

- • The vertical height is often given (height of building, cliff, tower)
- • The horizontal distance is often unknown
- • Use tan ratio: $\tan(\text{angle}) = \text{opposite}/\text{adjacent}$
- • Rearrange to find the unknown side

6. Real-World Applications

Angles of depression are used in:

- • Aviation: Pilots calculating descent angles to runways
- • Maritime: Lighthouse keepers determining distances to ships
- • Surveying: Measuring depths of valleys or wells
- • Rescue operations: Helicopters locating people on the ground
- • Architecture: Determining sight lines from elevated structures

Scaffolding Strategies

Address common challenges revealed during the anchor activity:

- • Emphasize that angle of depression is measured FROM horizontal line DOWN
- • Use visual diagrams showing horizontal reference line clearly
- • Highlight the relationship: angle of depression = angle of elevation (alternate interior angles)
- • Practice identifying which angle to use inside the right triangle
- • Create step-by-step checklist for solving problems

Phase 3: Practice and Application (15 minutes)

Worked Example

Example: Hiker on a Hill

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

Solution:

Step 1: Draw a diagram showing the hill (vertical height 120 m), the horizontal distance (d), and the angle of depression (40°).

Step 2: The angle of depression from the horizontal is 40° .

Step 3: Inside the right triangle at the hiker's position, the angle between the line of sight and the vertical is $90^\circ - 40^\circ = 50^\circ$.

Step 4: Identify the sides:

- Horizontal distance d is opposite to the 50° angle
- Height 120 m is adjacent to the 50° angle

Step 5: Use the tangent ratio:

$$\tan(50^\circ) = \text{opposite/adjacent} = d/120$$

Step 6: Solve for d:

$$d = 120 \times \tan(50^\circ)$$

$$d = 120 \times 1.1918$$

$$d = 143 \text{ m}$$

Answer: The horizontal distance from the hiker to the cabin is 143 m.

Individual Practice (Students work independently)

Provide students with similar problems to solve:

7. Problem 1: A lifeguard sits in a tower that is 4.5 m above the beach. She spots a swimmer in distress at an angle of depression of 18° . How far is the swimmer from the base of the lifeguard tower?
8. Problem 2: A plane flies to a height of 80 m above the ground. The angle of depression from the plane to a radar on the ground is 30° . Find the horizontal distance between the radar and the plane's projection on the ground.

Phase 4: Assessment - Exit Ticket (5 minutes)

Students complete individually to demonstrate understanding:

Question 1: A lifeguard sits in a tower that is 4.5 m above the beach. She spots a swimmer in distress at an angle of depression of 18° . How far is the swimmer from the base of the lifeguard tower?

Question 2: A plane flies to a height of 80 m above the ground. The angle of depression from the plane to a radar on the ground is 30° . Find the horizontal distance between the radar and the plane's projection on the ground.

Exit Ticket Answer Key

Question 1:

Angle inside triangle: $90^\circ - 18^\circ = 72^\circ$

$$\tan(72^\circ) = d/4.5$$

$$d = 4.5 \times \tan(72^\circ) = 4.5 \times 3.0777 = 13.8 \text{ m}$$

Answer: The swimmer is 13.8 m from the base of the tower.

Question 2:

Angle inside triangle: $90^\circ - 30^\circ = 60^\circ$

$$\tan(60^\circ) = d/80$$

$$d = 80 \times \tan(60^\circ) = 80 \times 1.732 = 138.6 \text{ m}$$

Answer: The horizontal distance is 138.6 m.

Extension Activity

For advanced learners who finish early:

Challenge Problem:

A rescue helicopter is hovering at a height of 200 m above ground level. The pilot can see a stranded hiker on the ground 350 m horizontally from the helicopter. Calculate the angle of depression from the helicopter to the hiker.

Solution Approach:

This is a reverse problem where students must find the angle given both sides.

$$\tan(\text{angle}) = \text{opposite/adjacent} = 200/350 = 0.5714$$

$$\text{angle} = \tan^{-1}(0.5714) = 29.7^\circ$$

Answer: The angle of depression is approximately 30° .

Differentiation Strategies

For Struggling Learners:

- Provide pre-drawn diagrams with labeled parts

- • Create a step-by-step checklist for solving problems
- • Use color coding: horizontal line in one color, angle of depression in another
- • Provide trigonometric ratio reference cards
- • Allow use of calculators for all calculations
- • Pair with peer tutors for collaborative problem-solving

For Advanced Learners:

- • Solve reverse problems (finding angles given distances)
- • Explore problems involving both angles of elevation and depression
- • Investigate real-world applications (aviation, surveying)
- • Calculate angles of depression for multiple objects from same elevated point
- • Design their own angle of depression problems for classmates

Real-World Connections

Angles of depression are essential in:

- • Aviation: Pilots calculate descent angles to approach runways safely
- • Maritime: Lighthouse keepers determine distances to ships at sea
- • Surveying: Engineers measure depths of valleys, wells, and excavations
- • Rescue Operations: Helicopter pilots locate people on the ground for rescue
- • Architecture: Architects determine sight lines from elevated buildings
- • Wildlife Conservation: Rangers in observation towers spot animals on the ground