CHAPTER 9: SOME APPLICATIONS OF TRIGONOMETRY

Introduction

Trigonometry is not just about formulas and ratios—it has practical uses in real life. In this chapter, we learn how to use trigonometric concepts to calculate **heights and distances** without directly measuring them.

In ancient times, astronomers used trigonometry to determine distances between celestial bodies like stars and planets. Today, it is widely used in:

- Navigation
- Surveying
- Architecture
- Engineering
- Geography (latitude & longitude)

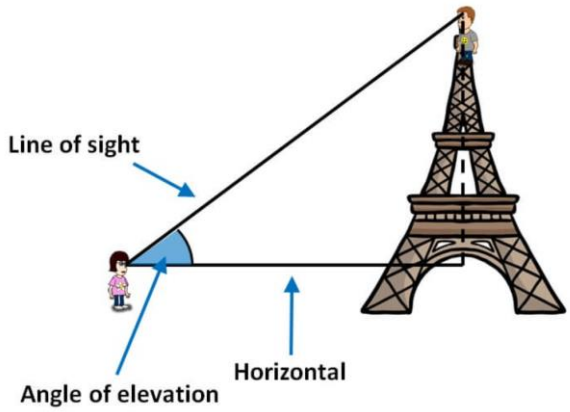
This chapter mainly focuses on solving real-life problems using **angles and trigonometric ratios**.

Basic Concepts

1. Line of Sight

The **line of sight** is the straight line drawn from the observer's eye to the object being viewed.

Example: When you look at the top of a building, the line joining your eye to the top is the line of sight.



2. Horizontal Level

The **horizontal level** is the straight horizontal line passing through the observer's eye.

It helps us determine whether the object is:

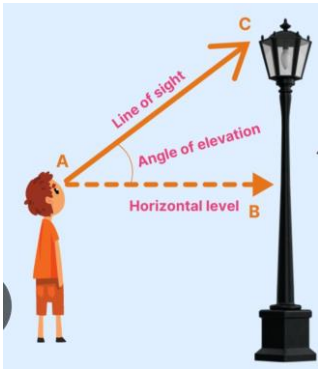
- Above eye level → Angle of elevation
- Below eye level → Angle of depression

Angle of Elevation

The **angle of elevation** is the angle formed when the observer looks **upwards** at an object.

It is the angle between:

- Line of sight
- Horizontal level



Occurs when the object is **above** the observer.

Example:

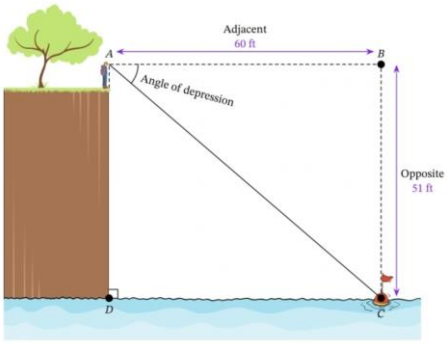
- Looking at a tower
- Watching a kite in the sky

Angle of Depression

The **angle of depression** is the angle formed when the observer looks **downwards** at an object.

It is the angle between:

- Line of sight
- Horizontal level



Occurs when the object is **below** the observer.

Example:

- Looking down from a building
- Seeing a car from a bridge

Heights and Distances

This is the most important part of the chapter.

Using trigonometric ratios, we can find:

- Height of buildings, towers, trees
- Distance between objects

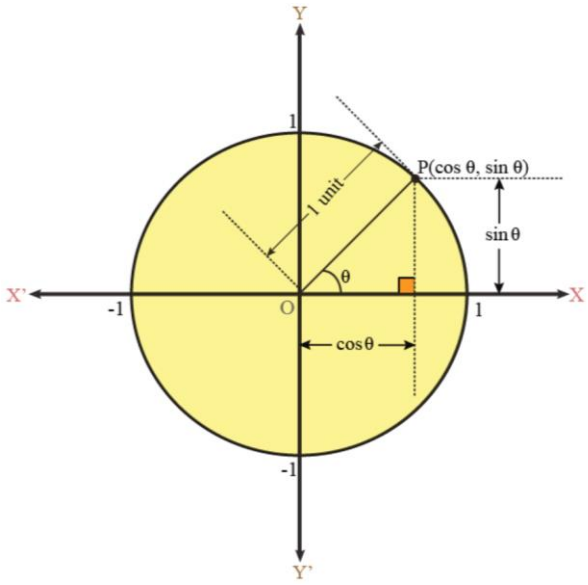
- Length of shadows
- Length of ladders or ropes

Trigonometric Ratios Used

We mainly use:

- **sin θ =** Opposite / Hypotenuse
- **cos θ =** Adjacent / Hypotenuse
- **tan θ =** Opposite / Adjacent

Most commonly used:
tan θ = height / distance



Standard Trigonometric Values

Angle	sin θ	cos θ	tan θ
0°	0	1	0
30°	1/2	√3/2	1/√3
45°	1/√2	1/√2	1
60°	√3/2	1/2	√3
90°	1	0	∞

Steps to Solve Heights & Distance Problems

Follow these steps carefully:

Step 1: Draw a Diagram

Convert the question into a triangle.

Step 2: Label Known Values

Mark:

- Height
- Distance
- Angles

Step 3: Choose Correct Ratio

Use:

- sin θ
- cos θ
- tan θ

Step 4: Solve Equation

Find the unknown value.

Solved Examples

Example 1: Height of a Tower

A tower is 15 m away from a point. Angle of elevation = 60°.

Solution:

tan 60° = height / distance
√3 = h / 15

h = 15√3

Answer: Height = **15√3 m**

Example 2: Ladder Problem

Pole height = 5 m
Point of work = 1.3 m below top
Angle = 60°

Height to reach = 5 – 1.3 = 3.7 m

sin 60° = 3.7 / ladder

Ladder ≈ **4.28 m**

Example 3: Chimney Height

Distance = 28.5 m
Angle = 45°
Observer height = 1.5 m

tan 45° = height / distance

height = 28.5

Total height = 28.5 + 1.5 = **30 m**

Example 4: Building and Flagstaff

Building height = 10 m

tan 30° = 10 / distance
distance = $10\sqrt{3}$

Using tan 45°:
Total height = distance

Flagstaff height = **7.32 m**

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Example 5: Shadow Problem

Let height = h

Using:
tan 60° and tan 30°

After solving:
height = **$20\sqrt{3}$ m**

Example 6: Two Buildings

Given:

- Small building = 8 m
- Angles = 30°, 45°

Using alternate angles and trig:

Height of building = **$(4\sqrt{3} + 3)$ m**
Distance = same value

Example 7: River Width

Height = 3 m
Angles = 30° and 45°

Using tan:

Width = **$3(1 + \sqrt{3})$ m**

Real-Life Applications

Trigonometry is used in:

- Measuring building heights
- Finding distances across rivers
- Designing bridges
- Satellite positioning
- Navigation systems (GPS)