

9. SOME APPLICATIONS OF TRIGONOMETRY

1. An observer 1.2 metres tall is 28.2 m away from the tower. The angle of elevation of the top of the tower from his eye is 60° . What is the height of the tower ?

[Ans : $(28.2\sqrt{3} + 1.2)m$]

2. A tower stands near an airport. The angle of elevation θ of the tower from a point on the ground is such that its tangent is $\frac{5}{12}$. Find the height of the tower, if the distance of the observer from the tower is 120 metres.

[Ans : 50 m]

3. A fire is reported in a building. There are two fire stations on either side of the building and in the same straight line with it. The angles of elevation of the top of the building from the stations A and B are 30° and 60° respectively. Which fire station is closer to the building ?

[Ans : Station B is closer to the building]

4. From the top of a 300 m high light-house, the angles of depression of two ships, which are due south of the observer and in a straight line with its base, are 60° and 30° . Find their distance apart.

[Ans : Distance between the ships is $200\sqrt{3}m$]

5. From the top of a multistoreyed building, 90 m high, the angles of depression of the top and the bottom of a tower are observed to be 30° and 60° respectively. Find the height of the tower

[Ans : Height of the tower is 60 m]

6. A peacock is sitting on the top of a tree. It observes a serpent on the ground making an angle of depression of 30° . The peacock with the speed of 300 m/minute catches the serpent in 12 seconds. What is the height of the tree ?

[Ans : Height of the tree is 30 m]

7. If the angles of elevation of the tops of two statues of heights m_1 and m_2 are 60° and 30° respectively from the mid-point of the line segment joining their feet, then find the ratio $m_1 : m_2$.

[Hint : $m_1 : m_2 = 3 : 1$]

8. The angle of elevation of the top B of a tower AB from a point X on the ground is 60° . At a point Y, 40 m vertically above X, the angle of elevation of the top is 45° . Find the height of the tower AB and the distance XB

[Ans : $AB = 20(3 + \sqrt{3})m$, $XB = 40(\sqrt{3} + 1)m$]

9. The angle of elevation of the top of an unfinished tower from a point at a distance of 90 m from its base is 30° . How much higher must the tower be raised so that the angle of elevation of its top from the same point be 60° ?

[Ans : it must be raised by $60\sqrt{3}m$]

10. The angle of elevation of a cloud from a point 100 metres above the surface of a lake is 30° and the angle of depression of the reflection of the cloud in the lake is 60° . Find the height of the cloud

[Ans : Height of the cloud is 200 m]

11. From a point on level ground, the angle of elevation of the top of a tower is found to be such that its tangent is $\frac{5}{12}$. On walking 192 m towards the tower, the tangent of the angle of elevation is found to

be $\frac{3}{5}$. Find the height of the tower .

[Ans : Height of the tower is $\frac{2880}{11}m$]

12. From a point on a cricket ground , the angle of elevation of the top of a tower is found to be 30° at a distance of 225 m from the tower. On walking 150 m towards the tower, again the angle of elevation is found. Find the new angle of elevation and the height of the tower.

[Sol : Height of the tower is $75\sqrt{3}m$ and new angle of elevation is 60°]

13. From the top of a tower, the angle of depression of an object on the horizontal ground is found to be 60° . On descending 20 m vertically downwards from the top of the tower, the angle of depression of the object is found to be 30° . Find the height of the tower.

[Ans : Height of the tower is 30 m]

14. An adult and a minor boy, standing on the ground, are from two metres apart. The height of the adult is 4 times the height of minor boy. If the mid-point of the line segment joining their feet, the angles of elevation of their tops are complementary, then find the height of the minor boy

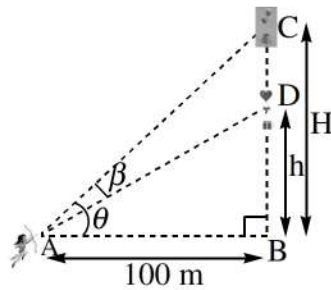
[Sol : Height of the minor boy is $\frac{1}{2}m$]

15. **Case Study :**

At an archery academy, Guru Drona had floated a gift box with two balloons at a height of H metres from the table. As part of his practice, Arjuna was given the task to bring the gift box to the table placed below. Arjuna was standing on the ground at a horizontal distance of 100 metres from the table at point B. He aimed at the balloons with an elevation angle of θ and shot the arrow to burst one of the balloons.

When Arjuna burst the first balloon, the box came down to the height of h metres from the table. He now reduced his angle of elevation by β and shot his arrow at the second balloon. The second balloon burst and the gift box landed safely on the table. Assume that Arjuna's arrows travelled in straight lines and did not curve down.

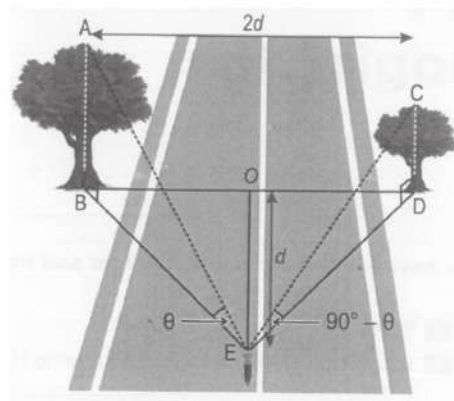
(Use $\sqrt{3} = 1.73, \sqrt{2} = 1.41$)



- i) If $\theta = 45^\circ$ and $\beta = 15^\circ$, what is the difference between the box's initial height and its height after the first shot?
- ii) If $\theta = 45^\circ$ and $\beta = 15^\circ$, what is the distance that the arrow has to travel to burst the second balloon?
- iii) For Ashwatthama, Guru Drona raised the gift box further higher such that the angles θ and β were 60° and 30° respectively. What is the value of the ratio $\frac{H}{h}$ now?
- iv) When the initial angle of elevation, θ , was 45° , Arjuna felt uncomfortable as it strained his neck. From his original spot, approximately how much should he retreat away from the balloons, so that the new angle of elevation, θ , becomes 30° ?

[Ans : i) $\left(100 - \frac{100}{\sqrt{3}}\right)m$, ii) $\frac{200}{\sqrt{3}}m$, iii) 3, iv) 73 m]

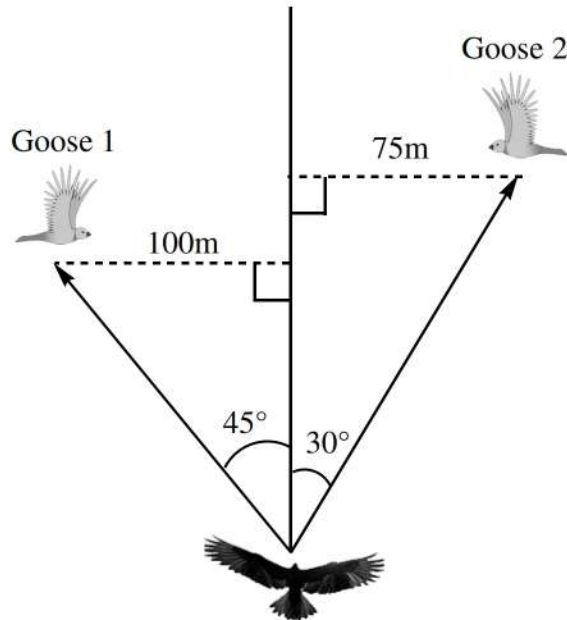
16. Two trees are $2d$ meters apart. Ajay stood at a point midway between them and started walking in a direction perpendicular to the line connecting the two trees. After walking d metres, he observed the angle of elevations to the tops of the two trees and found them to be complementary.



If one of the trees is thrice as tall as the other, find the height of the shorter tree, in terms of d . Show your work.

[Ans : $\sqrt{\frac{2}{3}} d$]

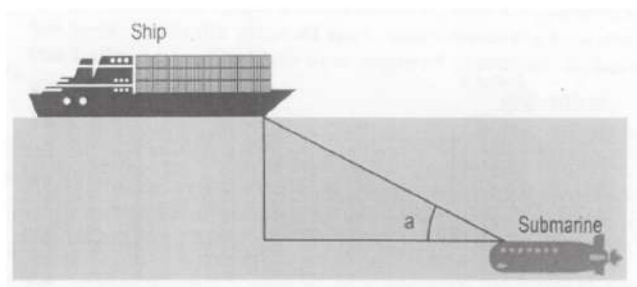
17. The position of an eagle and two identical geese are shown in the figure below. all the birds are at the same height from the ground. Assume that the Eagle can fly at the same speed in all directions and that the geese are unaware of the Eagle's intention and will not move from their positions.



If the eagle wants to attack the goose that is nearer to it, which one should it attack? Show your steps.

(Note : Use $\sqrt{2} = 1.41$, $\sqrt{3} = 1.73$)

18. Shown below is a submarine scouting an enemy ship in the ocean using a sonar device. Sonar devices send out a sound pulse from a transducer, and then precisely measure the time it takes for the sound pulses to be reflected back to the transducer.



A sonar wave sent by the submarine hits the ship and returns back in 2 seconds. The speed of a sonar wave underwater is 1500 m/s and the submarine is diving at a depth of 750 m below sea level.

Find the angle of elevation 'a' of the ship from the submarine. Show your steps.