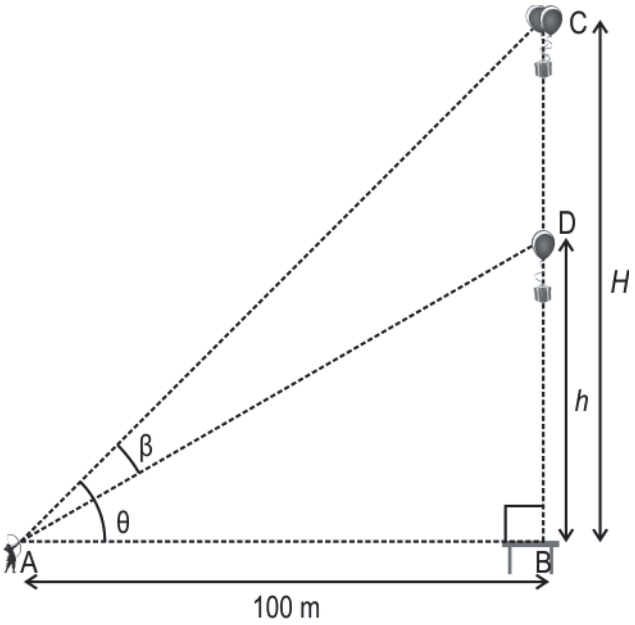
# Chapter - 9
# Some Applications of Trigonometry

Answer the questions based on the information given below.

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.




*(Note: The figure is not to scale.)*

(Use √3 = 1.73, √2 = 1.41)

**Q: 1** **If θ = 45° and β = 15°, what is the difference between the box's initial height and its height after the first shot?**

**1** 100 - $\frac{100}{\sqrt{3}}$ m
**2** $\frac{100}{\sqrt{3}}$ m
**3** 100√3 - 100 m
**4** (cannot be calculated without knowing H.)

**Q: 2** **If θ = 45° and β = 15°, what is the distance that the arrow has to travel to burst the second balloon?**

**1** $\frac{100\sqrt{3}}{2}$ m
**2** $\frac{200}{\sqrt{3}}$ m
**3** 100√2 m
**4** 100√3 m

**Q: 3** **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?**

**1** $\frac{1}{\sqrt{3}}$ **2** $\sqrt{3}$ **3** 2 **4** 3

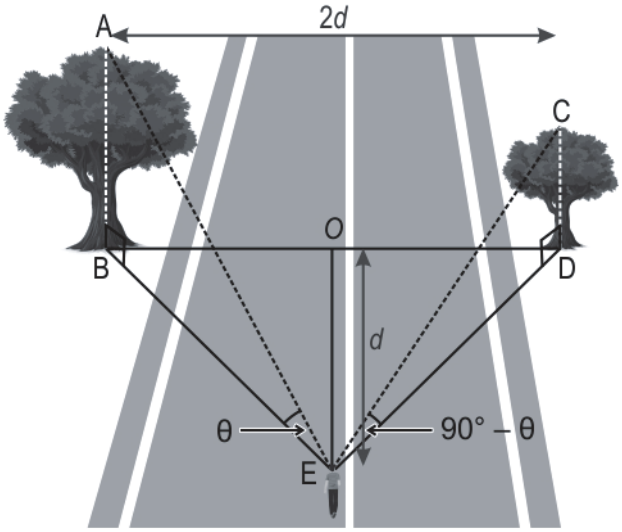
**Q: 4** **When the initial angle of elevation, θ, was 45°, Arjuna felt uncomfortable as it strained his neck. From his original spot, approximately how much should he retreat away from the balloons, so that the new angle of elevation, θ, becomes 30°?**

**1** 73 m
**2** 100 m
**3** 173 m
**4** (cannot be calculated without knowing H.)

**Q: 5** **Arjuna measured that θ = 45°. Right before he could shoot the first arrow, a gust of wind pushed the balloons 15 m higher. What should Arjuna do to ensure that he doesn't miss?**

**1** Move towards the table by 15 m but keep the arrow at the same angle of elevation.
**2** Move away from the table by 15 m but keep the arrow at the same angle of elevation.
**3** Increase the arrow's angle of elevation by 15° but stay at the same place.
**4** Move away from the table by 15 m and increase the arrow's angle of elevation by 15°.

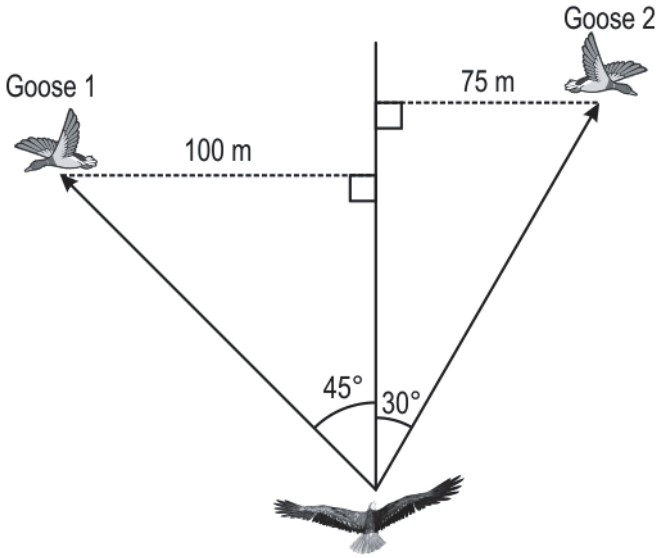
**Q: 6** **Two trees are 2 *d* meters apart. Ajay stood at a point midway between them and started walking in a direction perpendicular to the line connecting the two trees. After walking *d* metres, he observed the angle of elevations to the tops of the two trees and found them to be complementary.** **[3]**




***(Note: The figure is not to scale.)***

**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.**

**Q: 7** **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.** **[2]**

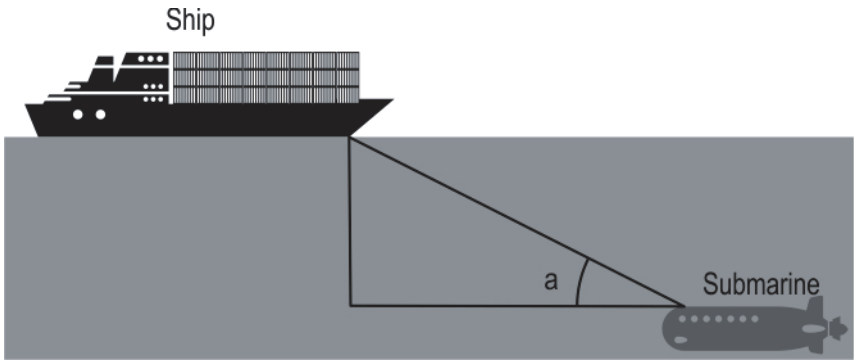



***(Note: The figure is not to scale.)***

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

***(Note: Use √2 = 1.41, √3 = 1.73)***

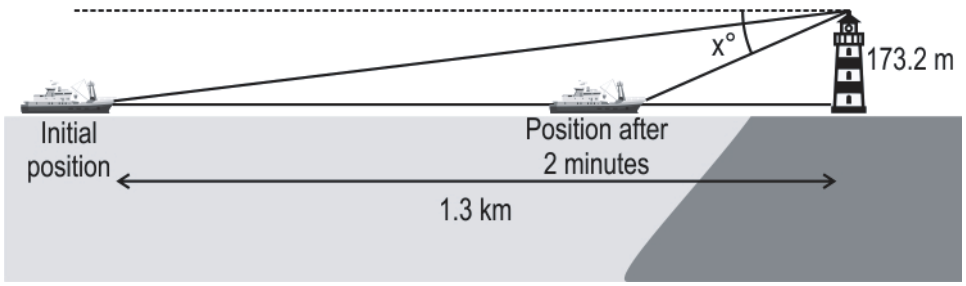
**Q: 8** **Shown below is a submarine scouting an enemy ship in the ocean using a sonar device. Sonar devices send out a sound pulse from a transducer, and then precisely measure the time it takes for the sound pulses to be reflected back to the transducer.** **[2]**




**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.**

**Q: 9** **A ship was moving towards the shore at a uniform speed of 36 km/h. Initially, the ship was 1.3 km away from the foot of a lighthouse which is 173.2 m in height.** **[3]**



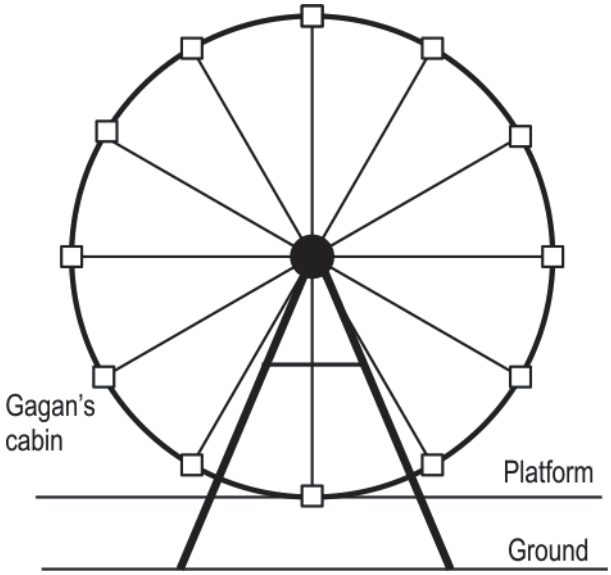

**(Note: The figure is not to scale.)**

**Find the angle of depression, *x*, of the top of the lighthouse from the ship after the ship had been moving for 2 minutes.**

**Show your steps and give reasons.**

***(Note: Take √3 as 1.732 and √2 as 1.414.)***

**Q: 10** **In the giant wheel shown below, Gagan is sitting in one of the cabins which is 12 m high from the platform. Jyoti and Karan are sitting in the lowest and the highest cabins from the platform respectively.** **[5]**




***(Note: The figure is not to scale.)***

**From Gagan, the angle of depression of Jothi and the angle of elevation of Kiran is 30° and 60° respectively.**

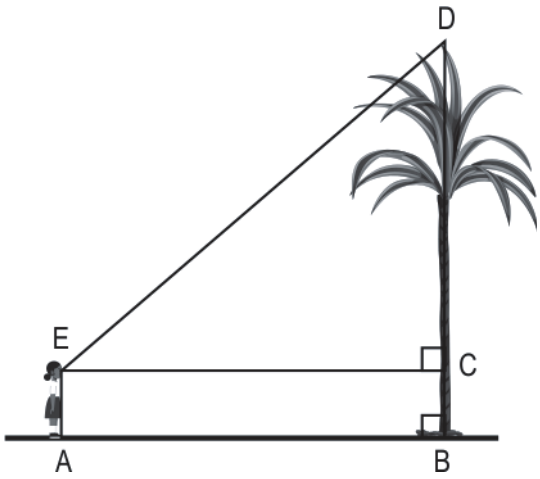
**i) What will be the angle of elevation of Gagan from Jothi?**

**ii) What will be the angle of depression of Gagan from Kiran?**

**iii) Find the diameter of the giant wheel.**

**Show your steps with a diagram.**

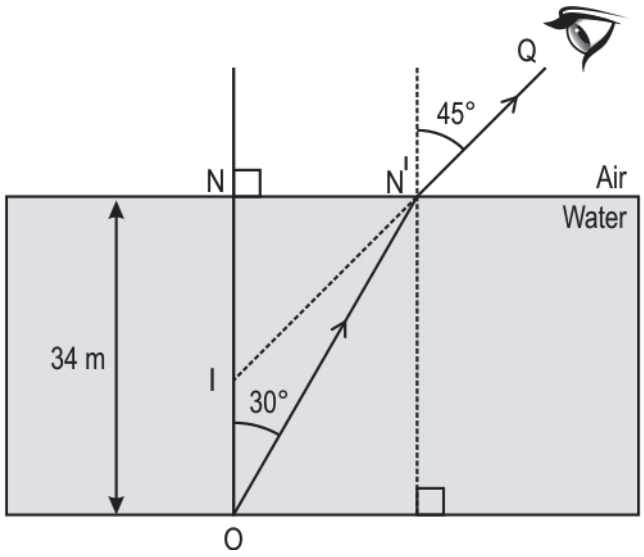
**Q: 11** **In the figure below, the height of the girl is 1.5 m and the height of the tree is 13.5 m.** **[1]**




***(Note: The figure is not to scale.)***

**If AB = 12√3 m, what is the angle of elevation of the top of the tree from her eyes? Show your steps.**

**Q: 12** **Shown below is a rectangular tub of water of depth 34 cm. An object O is at the bottom of the tub. The image of the object is formed at I for an observer at Q.** **[2]**




***(Note: The figure is not to scale.)***

**Find the distance by which the object seem to be moved for the observer. Show your work and give valid reasons.**

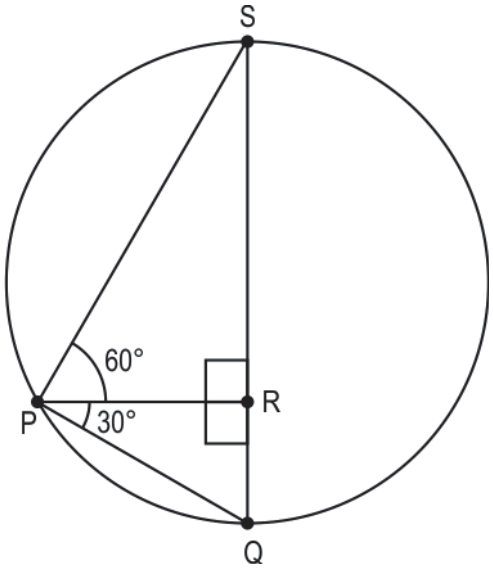
***(Note: Take √2 = 1.4, √3 = 1.7)***

**The table below gives the correct answer for each multiple-choice question in this test.**

| Q.No | Correct Answers |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 1 |
| 5 | 2 |

| Q.No | Teacher should award marks if students have done the following: | Marks |
|---|---|---|
| 6 | **Applies Pythagoras' theorem in either of the two triangles ΔEOB or ΔEOD and finds Ajay's distance from each tree as $\sqrt{(d^2 + d^2)} = \sqrt{2}\,d$.** | **0.5** |
| | **Assumes the height of shorter tree as *h* metres and taller tree as 3 *h* metres.**<br>**Takes the angle of elevation of shorter tree as θ and the taller tree as (90° - θ).**<br>**(Award full marks if h and $\frac{h}{3}$ are used instead of h and 3h.)** | **0.5** |
| | **Uses trigonometric ratios in the two triangles ΔEDC and ΔEBA respectively and writes:**<br>$\frac{h}{d\sqrt{2}} = \tan\theta$<br>$\frac{3h}{d\sqrt{2}} = \tan(90° - \theta) = \cot\theta$ | **1** |
| | **Solves the equations in step 3 for *h* and finds the height, *h*, of the shorter tree, in metres, as:**<br>$\frac{h}{d\sqrt{2}} \times \frac{3h}{d\sqrt{2}} = \tan\theta \times \cot\theta$<br>$\Rightarrow \frac{3h^2}{2d^2} = 1$<br>$\Rightarrow h = d \times \sqrt{\frac{2}{3}}$ | **1** |
| 7 | **i) Applies trigonometric ratio to determine the distance of the first goose from Eagle as 100√2 m or 141 m** | **1** |
| | **Applies trigonometric ratio to determine the distance of the second goose from Eagle as 150 m.**<br>**Argues that since goose 1 is closer, the Eagle would attack it.** | **1** |

| Q.No | Teacher should award marks if students have done the following: | Marks |
|---|---|---|
| 8 | Writes that the distance traveled by the sonar wave is 1500 × 2 = 3000 m. | 0.5 |
| | Writes that since 3000 m is the distance traveled by the sonar wave to the ship and back, the distance between the ship and the sonar = $\frac{3000}{2}$ or 1500 m. | 0.5 |
| | Writes that sin *a* = $\frac{750}{1500}$ or $\frac{1}{2}$ . | 0.5 |
| | Writes *a* as 30° since sin 30° = $\frac{1}{2}$ . | 0.5 |
| 9 | Finds the distance covered by the ship in 2 minutes as 36 × $\frac{1}{30}$ = 1.2 km (2 min = $\frac{1}{30}$ h). | 0.5 |
| | Calculates the distance of the ship from the foot of the lighthouse as 1.3 - 1.2 = 0.1 km or 100 m. | 0.5 |
| | Assumes that the angle of elevation from the ship to the top of the lighthouse as *a* and writes tan *a* = $\frac{173.2}{100}$ or 1.732. | 1 |
| | Calculates *a* as 60° since tan 60° = √3 or 1.732. | 0.5 |
| | Writes that alternate interior are equal and hence finds the angle of depression as *x* = *a* = 60°. | 0.5 |

| Q.No | Teacher should award marks if students have done the following: | Marks |
|---|---|---|
| 10 | **Draws a rough diagram. The figure may look as follows:**<br>  <br><br>***(Note: The figure is not to scale.)*** | **1** |
| | **i) Writes that the angle of elevation of Gagan from Jothi is 30°.** | **0.5** |
| | **ii) Writes that the angle of depression of Gagan from Kiran is 60°.** | **0.5** |
| | **iii) Writes the length of RQ as 12 m.** | **0.5** |
| | **Uses tan ratio for ΔPQR and finds the length of PR as:**<br>**tan 30° = $\frac{12}{PR}$**<br>**=> PR = 12√3 m.** | **1** |
| | **Uses tan ratio for ΔPSR and finds the length of SR as:**<br>**tan 60° = $\frac{SR}{12\sqrt{3}}$**<br>**=> SR = 36 m.** | **1** |
| | **Finds the diameter of the giant wheel as SR + RQ = 12 + 36 = 48 m.** | **0.5** |

| Q.No | Teacher should award marks if students have done the following: | Marks |
|---|---|---|
| 11 | Writes that tan DEC = $\frac{13.5-1.5}{12\sqrt{3}} = \frac{1}{\sqrt{3}}$ . | 0.5 |
| | Finds the angle of elevation of the top of the tree from her eyes as ∠DEC = 30°. | 0.5 |
| 12 | Finds the length NN' in ΔNON' as 34tan 30° = $\frac{34}{\sqrt{3}}$ cm. | 0.5 |
| | Writes that corresponding angles are equal and finds the measure of ∠NIN' as 45°. | 0.5 |
| | Finds the depth NI in ΔNIN' as $\frac{34}{\sqrt{3}}$ ÷ tan 45° = $\frac{34}{\sqrt{3}}$ cm. | 0.5 |
| | Finds the distance by which the object seemed to be moved for the observer as 34 - $\frac{34}{\sqrt{3}}$ = 34 × $\frac{0.7}{1.7}$ = 14 cm. | 0.5 |