



# MATHS

## BOOKS - ZEN MATHS (KANNADA ENGLISH)

### SOME APPLICATIONS OF TRIGONOMETRY

**Illustrative Examples**

1. A ladder leaning against a wall makes an angle of  $60^\circ$  with the horizontal. If the foot of the ladder is 2.5 m away from the wall, find the length of the ladder



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2. An observer 1.7 m tall is  $20\sqrt{3}$  m away from a tower. The angle of elevation from the eye of the observer of the top of the tower is  $30^\circ$ .

Find the height of the tower





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3. A flagstaff 7 m long is fixed on the top of a tower standing on the horizontal plane. From a point on the ground, the angles of elevation of the top and bottom of the flagstaff are  $60^\circ$  and  $45^\circ$  respectively. Find the height of the tower correct to one decimal place,



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4. A bird is sitting on the top of a tree 80 m high. From a point on the ground the angle of elevation of the bird is  $45^\circ$ . The bird flies horizontally such that it remains at a constant height from the ground. After 2 seconds the angle of elevation of the bird from the same point is  $30^\circ$ . Find the speed of the flying bird.



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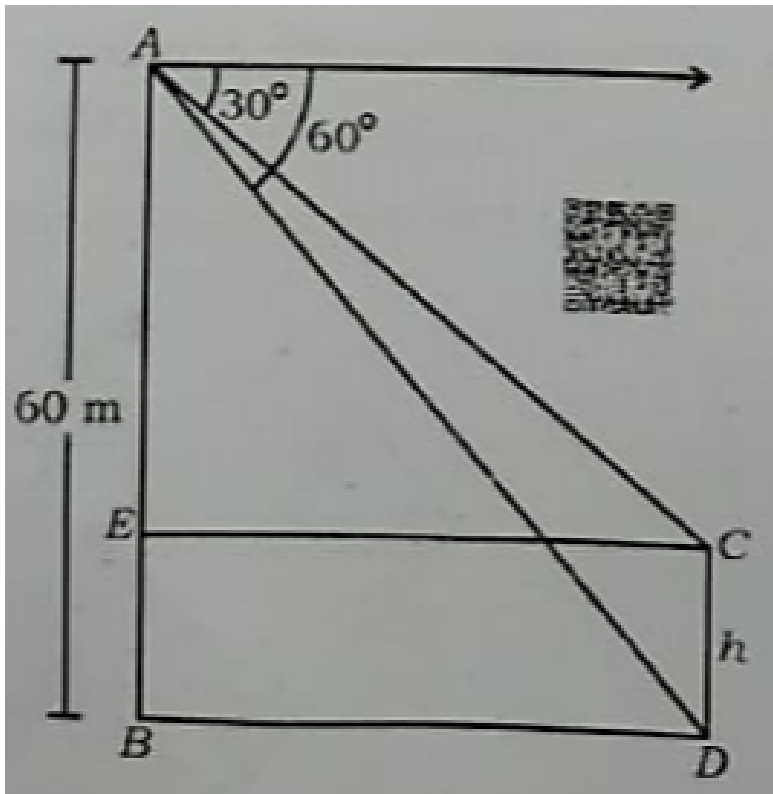
5. As observed from the top of a lighthouse 100 m high above sea level, the angles of depression of a ship, sailing directly towards it, changes from  $30^\circ$  to  $60^\circ$ . Find the distance travelled by the ship during the period of observation.



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6. A tower and a pole stand vertically on the same level ground. It is observed that the

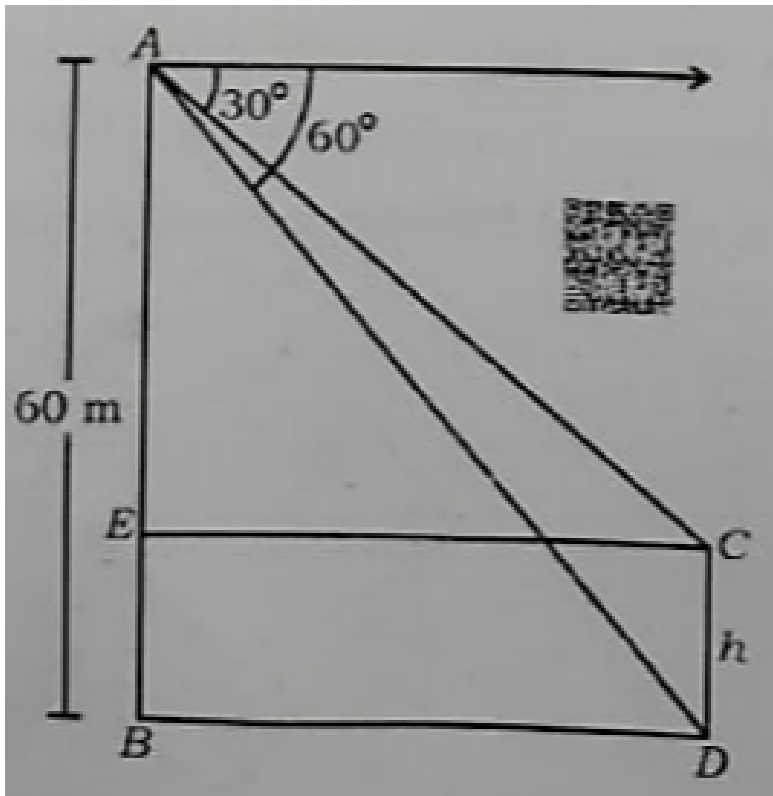
angles of depression of top and foot of the pole from the top of the tower of height 60m is  $30^\circ$  and  $60^\circ$  respectively. find the height of the pole.



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7. A tower and a pole stand vertically on the same level ground. It is observed that the angles of depression of top and foot of the pole from the top of the tower of height 60m are  $30^\circ$  and  $60^\circ$  respectively. Find the height of

the pole.



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8. From the top of a lighthouse, the angles of depression of two ships on the opposite sides of it are observed to be  $\alpha$  and  $\beta$ . If the height of the lighthouse is  $h$  metres and the line joining the ships passes through the foot of the lighthouse, show that the distance between the ships is

$$\frac{h(\tan \alpha + \tan \beta)}{\tan \alpha \tan \beta}$$



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**9.** A vertical tree 15 m high is broken by the wind such that its top just touches the ground and makes an angle of  $60^\circ$  with the ground. At what height from the ground did the tree break



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**10.** A tower is 50cm high. Its shadow is  $x$  mtrs shorter when the suns altitude is  $45^\circ$  than when it is  $30^\circ$ . Find the value of  $x$ .





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## Textual Exercises 12 1

1. A circus artist is climbing a 20m long rope, which is tightly stretched and tied from the top of a vertical pole to the ground. Find the height of the pole, if the angle made by the rope with the ground level is  $30^\circ$  ( see Figure)



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2. A tree breaks due to storm and the broken part bends so that the top of the tree touches the ground making an angle  $30^\circ$  with it. The distance between the foot of the tree to the point where the top touches the ground is 8m. Find the height of the tree.



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3. A contractor plans to install two slides for the children to play in a park. For the

children below the age of 5 years, she prefers to have slide whose top is at a height of 1.5m, and is inclined at an angle of  $30^\circ$  to the ground, whereas for elder children, she wants to have a steep slide at a height of 3m, and inclined at an angle of  $60^\circ$  to the ground. What should be the length of the slide in each case ?



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4. The angle of elevation of the top of a tower from a point on the ground, which is 30m away from the foot of the tower, is  $30^\circ$ . Find the height of the tower.



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5. A kite is flying at a height of 60m above the ground. The string attached to the kite is temporarily tied to a point on the ground. The inclination of the string with the ground is

$60^\circ$ . Find the length of the string, assuming that there is no slack in the string.



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6. A 1.5m tall boy is standing at some distance from a 30m tall building. The angle of elevation from his eyes to the top of the building increases from  $30^\circ$  to  $60^\circ$  as he walks towards the building. Find the distance he walked towards the building.



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7. From a point on the ground, the angles of elevation of the bottom and the top of a transmission tower fixed at the top of a 20m high building are  $45^\circ$  and  $60^\circ$  respectively. Find the height of the tower.



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8. A statue, 1.6m tall, stands on the top of a pedestal. From a point on the ground, the angle of elevation of the top of the statue is



$60^\circ$  and from the same point the angle of elevation of the top of the pedestal is  $45^\circ$ .

Find the height of the pedestal.



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9. The angle of elevation of the top of a building from the foot of the tower is  $30^\circ$  and the angle of elevation of the top of the tower from the foot of the building is  $60^\circ$ . If the tower is 50m high, find the height of the building.



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**10.** Two poles of equal heights are standing opposite each other on either side of the road, which is 80m wide. From a point between them on the road, the angles of elevation of the top of the poles are  $60^\circ$  and  $30^\circ$ , respectively . Find the height of the poles and the distances of the point from the poles.



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**11.** A TV tower stands vertically on a bank of a canal. From a point on the other bank directly opposite the tower, the angle of elevation of the top of the tower is  $60^\circ$ . From another point 20m away from this point on the line joining this point to the foot of the tower, the angle of elevation of the top of the tower is  $30^\circ$  (see Figure ). Find the height of the tower and the width of the canal.



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**12.** From the top of a 7m high building, the angle of elevation of the top of a cable tower is  $60^\circ$  and the angle of depression of its foot is  $45^\circ$ . Determine the height of the tower.



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**13.** As observed from the top of a 75m high lighthouse from the sea-level, the angles of depression of two ships are  $30^\circ$  and  $45^\circ$ . If one ship is exactly behind the other on the

same side of the lighthouse, find the distance between the two ships.



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**14.** A 1.2 m tall girl spots a balloon moving with the wind in a horizontal line at a height of 88.2 m from a ground. The angle of elevation of the balloon from the eyes of the girl at any instant is  $60^{\circ}$ . After some time, the angle of elevation reduces to  $30^{\circ}$ . Find the distance travelled by the balloon during the interval.



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15. A straight highway leads to the foot of a tower. A man standing at the top of the tower observes a car at an angle of depression of  $30^\circ$ , which is approaching the foot of the tower with a uniform speed. Six seconds later, the angle of depression of the car is found to be  $60^\circ$ . Find the time taken to reach the foot of the tower from this point.



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**16.** The angle of elevation of the top of a tower from two points at a distance of 4m and 9 m from the base of the tower and in the same straight line with it are complementary. Prove that the height of the tower is 6m.



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**Additional Questions Mcq**

1. The ratio of the length of a rod and its shadow is  $1 : \sqrt{3}$ . The angle of elevation of the sun is \_\_\_\_\_ .

A.  $30^\circ$

B.  $45^\circ$

C.  $60^\circ$

D.  $90^\circ$

**Answer: a**



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2. If the height and length of the shadow of a man are the same, the angle of elevation of the sun is

A.  $30^\circ$

B.  $60^\circ$

C.  $45^\circ$

D.  $15^\circ$

**Answer: c**



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3. In a rectangle, the angle between the diagonal and a side is  $30^\circ$  and the length of its diagonal is 8 cm. The area of the rectangle is

A.  $16\text{cm}^2$

B.  $\frac{16}{\sqrt{13}}\text{cm}^2$

C.  $16\sqrt{3}\text{cm}^2$

D.  $8\sqrt{3}\text{cm}^2$

**Answer: c**



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4. If the angle of elevation of the top of a tower from a distance of 100m from its foot is  $60^\circ$ , the height of the tower is

A.  $100\sqrt{3}m$

B.  $\frac{100}{\sqrt{3}}m$

C.  $50\sqrt{3}m$

D.  $\frac{200}{\sqrt{3}}m$

**Answer: a**



5. From the top of a cliff 25 m high the angle of elevation of a tower is found to be equal to the angle of depression of the foot of the tower. The height of the tower is

A. 25 m

B. 50 m

C. 75 m

D. 100 m

**Answer: b**



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6. On the same side of a tower 300 m high, the angles of depression of two objects are  $45^\circ$  and  $60^\circ$  respectively. The distance between the objects is \_\_\_\_\_m

A. 117

B. 127

C. 217

D. 473

**Answer: b**



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7. The angles of elevation of an aeroplane flying vertically above the ground as observed from two consecutive milestones 1 km apart are  $45^\circ$  and  $60^\circ$ . The height of the aeroplane from the ground is

A.  $(\sqrt{3} + 1)$  km

B.  $(3 + \sqrt{3})$  km

C.  $\frac{1}{2}(\sqrt{3} + 1)$  km

D.  $\frac{1}{2}(3 + \sqrt{3})$  km

**Answer: d**



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**8.** The height of two poles are 80 m and 65 m.

If the line joining their tops makes an angle of

$45^\circ$  with the horizontal, the distance between

the poles is \_\_\_\_\_

A. 75 m

B. 15m

C. 22.5 m

D. 30 m

**Answer: d**



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**9.** If the angle of elevation of a tower from two points distant  $a$  and  $b$  ( $a < b$ ) from its foot



and on the same straight line from it is  $30^\circ$

and  $60^\circ$ , the height of the tower is

A.  $\sqrt{a + b}$

B.  $\sqrt{ab}$

C.  $\sqrt{a - b}$

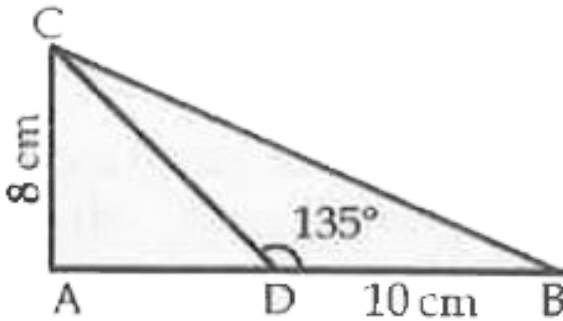
D.  $\frac{\sqrt{a}}{b}$

**Answer: b**



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10. In the given figure,  $DB = 10$  cm,  $CA = 8$  cm and  $\angle BDC = 135^\circ$ , then  $AB =$



- A. 10 cm
- B. 18 cm
- C. 12 cm
- D. 26 cm

**Answer: b**



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## Additional Questions Very Short Answer Type Questions

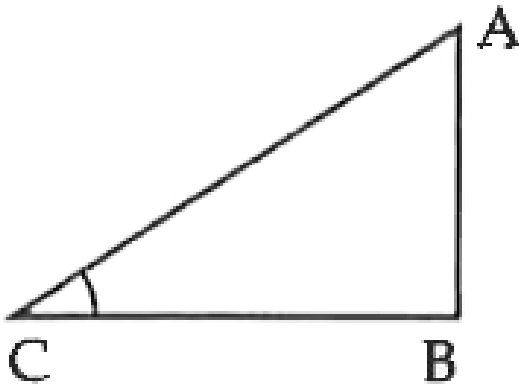
1. The tops of two towers of height  $x$  and  $y$  standing on a level ground subtend angles of  $30^\circ$  and  $60^\circ$  respectively at the centre of the line joining their feet. Find  $x:y$



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2. In the figure a tower AB is 20 m high and BC, its shadow on the ground is  $20\sqrt{3}$  m long.

Find the sun's altitude



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3. A pole casts a shadow of length  $2\sqrt{3}$  m on the ground when the sun's altitude is  $60^\circ$ . Find the height of the pole.



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## Additional Questions Short Answer Type 1 Questions

1. A window in a building is at a height of 10 m from the ground. The angle of depression of a point P on the ground from the window is  $30^\circ$

. The angle of elevation of the top of the building from the point P is  $60^\circ$ . Find the height of the building.



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2. Two men on either side of a building 75 m high and in line with the base of building observe the angles of elevation of the top of the building as  $30^\circ$  and  $60^\circ$ . Find the distance between the two men.



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3. An electrician has to repair an electric fault on a pole of height 4m. He needs to reach a point 1.3 m below the top of the pole to do the repair work. What should be the length of the ladder that he should use which when inclined at an angle of  $60^\circ$  to the horizontal, enables him to reach the required position?



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4. The shadow of a flagstaff is three times as shadow when the sun's rays meet the ground of  $60^\circ$ . Find the angle between the sun's rays and the ground at the time of longer shadow.



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5. A verticle pole of height 6m casts a shadow 4m long on the ground, and at the same time a tower on the same ground casts a shadow 28m long. Find the height of the tower.







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## Additional Questions Short Answer Type 2 Questions

1. From the top of a tower 100 m high, a man observes two cars on the opposite sides of the tower with angle of depression  $30^\circ$  and  $45^\circ$  respectively. Find the distance between the cars



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2. From the top of a vertical tower, the angle of depression of two cars on the same straight line with the base of the tower, at an instant, is found to be  $45^\circ$  and  $60^\circ$ . If the cars are 100 m apart and are on the same side of the tower, find the height of the tower



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3. A ladder of length 6 m makes an angle of  $45^\circ$  with the floor while leaning against one wall of a room. If the foot of the ladder is kept

fixed on the floor and it is made to lean against the opposite wall of the room, it makes an angle  $60^\circ$  with the floor. Find the distance between these two walls of the room.



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4. From the top of a tower 50 m high, the angle of depression of the top of a pole is  $45^\circ$  and from the foot of the pole, the angle of elevation of the top of the tower is  $60^\circ$ . Find

the height of the pole if the pole and tower stand on the same plane.



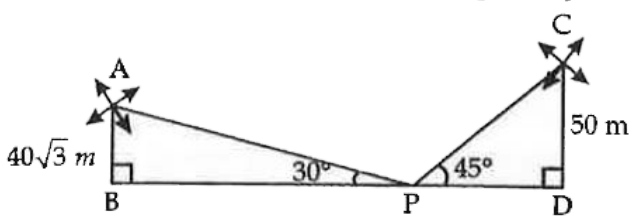
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5. From the top of a vertical building of  $50\sqrt{3}m$  height on a level ground the angle of depression of an object on the same ground is observed to be  $60^\circ$ . Find the distance of the object from the foot of the building.



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6. Two windmills of height  $50\text{ m}$  and  $40\sqrt{3}\text{ m}$  are on either side of the field. A person observes the top of the windmills from a point in between them. The angle of elevation was found to be  $45^\circ$  and  $30^\circ$ . Find the distance between the windmills.



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## Additional Questions Long Answer Type Questions

1. The angle of elevation of the top  $Q$  of a vertical tower  $PQ$  from a point  $X$  and the ground is  $60^\circ$ . From a point  $Y$ , 40m vertically above  $X$ , the angle of elevation of the top  $Q$  of the tower is  $45^\circ$ . Find the height of the tower  $PQ$  and the distance  $PX$ . (use  $\sqrt{3} = 1.73$ ).



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2. The angle of elevation of an aeroplane from a point on the ground is  $60^\circ$ . After a flight of 30 seconds the angle of elevation becomes  $30^\circ$ . If the aeroplane is flying at a constant height of  $3000\sqrt{3}$  m. Find the speed of the aeroplane.



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3. The angle of elevation of a cloud from a point 60 m above a lake is  $30^\circ$  and the angle

of depression of the reflection of the cloud on the lake is  $60^\circ$ . Find the height of the cloud from the surface of the lake.



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4. A 1.5 m tall boy is standing at some distance from a 30 m tall building. The angle of elevation from his eyes to the top of the building increases from  $30^\circ$  to  $60^\circ$  as he walks towards the building. Find the distance he walked towards the building.





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5. Two poles of equal height are standing opposite to each other on the either side of the road which is 80 m wide. From a point P between them on road, the angle of elevation of the top of a pole is  $60^\circ$  and the angle of depression from the top of another pole at point P is  $30^\circ$ .

Find the heights of the poles and distances of the point P from the poles.



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6. A fire in a building B is reported on telephone to two fire stations P and Q, 20 km apart from each other on a straight road. P observes that the fire is at an angle of  $60^\circ$  to the road and Q observed that it is at an angle of  $45^\circ$  to the road. Which station should it send its team and how much will that team have to travel?



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7. At the foot of the mountain the elevation of its summit is  $45^\circ$ , after ascending 1000 m towards the mountain up a slope of 30 degree inclination, the elevation found to be  $60^\circ$ . Find the height of the mountain.



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**Additional Questions Hots Higher Order Thinking Skills Questions**

1. The angle of elevation of the top of a hill from the foot of a tower is  $60^\circ$  and the angle of elevation of the top of the tower from the foot of the hill is  $30^\circ$ . If the height of the tower is 50 m, what is the height of the hill?

A. 180 m

B. 150 m

C. 100 m

D. 120 m

**Answer: b**



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2. The angle of depression of the top and bottom of a building 7 m tall from the top of a tower is  $45^\circ$  and  $60^\circ$  respectively. Find the height of the tower in metres.

A.  $7(3 + \sqrt{3})$

B.  $\frac{7}{2}(3 - \sqrt{3})$

C.  $\frac{7}{2}(3 + \sqrt{3})$

D.  $7(3 - \sqrt{3})$

**Answer: c**



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3. A circus artist climbs from the ground along a rope which is stretched from the top of a vertical pole and tied at the ground at a certain distance from the foot of the pole. The height of the pole is 12 m and the angle made by the rope with the ground is  $30^\circ$ . Find the distance covered by the artist in reaching the top of the pole.

A. 24 m

B. 6m

C. 12 m

D. none of the above

**Answer: a**



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4. If a sun ray's inclination increases from  $45^\circ$  to  $60^\circ$ , the length of the shadow of a tower

decreases by 50m. Find the height of the tower (in m).

A.  $50(\sqrt{3} - 1)$

B.  $75(3 - \sqrt{3})$

C.  $100(\sqrt{3} + 1)$

D.  $25(3 + \sqrt{3})$

**Answer: d**



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5. The angles of depression of two points from the top of a tower are  $30^\circ$  and  $60^\circ$ . If the height of the tower is 30 m, find the maximum possible distance between the two

A.  $40\sqrt{3}$  m

B.  $30\sqrt{3}$  m

C.  $20\sqrt{3}$  m

D.  $10\sqrt{3}$  m

**Answer: a**



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6. person observes the angle of elevation of the top of a building as  $30^\circ$ . He proceeds towards the building with a speed of,  $25(\sqrt{3} - 1)$  m/hour. After two hours, he observes the angle of elevation as  $45^\circ$ . What is the height of the building, in metres?

A. 50 m

B.  $50\sqrt{3} + 1$  m

C.  $50\sqrt{3}$  m

$$D. 50(\sqrt{3} - 1) \text{ m}$$

**Answer: a**



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7. If the angles of depression of the upper and lower ends of a lamp post from the top of a hill of height  $h$  metres are  $\alpha$  and  $\beta$  respectively, the height of the lamp post (in metres) is

A. a. 
$$\frac{h \sin(\beta + \alpha)}{\cos \alpha \sin \beta}$$

B. b.  $\frac{h \sin(\beta - \alpha)}{\cos \alpha \sin \beta}$

C. c.  $\frac{\cos \alpha \sin \beta}{h \sin(\beta + \alpha)}$

D. d.  $\frac{\cos \alpha \sin \beta}{h \sin(\beta - \alpha)}$

**Answer: b**



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**8.** A tower,  $x$  metres, has a flagstaff at its top. The tower and the flagstaff subtend equal angles at a point distant  $y$  metres from the

foot of the tower. The length of the flagstaff  
(in metres) is

A.  $x \frac{y^2 - x^2}{y^2 - x^2}$

B.  $x \frac{y^2 + x^2}{y^2 + x^2}$

C.  $x \frac{y^2 + x^2}{y^2 - x^2}$

D.  $x \frac{x^2 + y^2}{x^2 + y^2}$

**Answer: c**



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9. An observer 1.5 m tall is 28.5m away from a chimney. The angle of elevation of the top of the chimney from her eyes is  $45^\circ$ . The height of the chimney is \_\_\_\_ .

A. 10 m

B. 20 m

C. 30 m

D. 40 m

**Answer: c**



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10. Two persons are 'a' metres apart and the height of one is double that of the other. If, from the middle point of the line joining their feet, an observer finds the angular elevation of their tops to be complementary, the height of the shorter person in metre is \_\_\_\_\_ .

A.  $\frac{a}{4}$

B.  $\frac{2}{\sqrt{2}}$

C.  $a\sqrt{2}$

D.  $\frac{a}{2\sqrt{2}}$

**Answer: d**



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**11.** A round balloon of radius  $r$  subtends an angle  $\alpha$  at the eye of the observer while the angle of elevation of its centre is  $\beta$ . Prove that the height of the centre of the balloon  $B$  is  $r \sin \beta \operatorname{cosec} \frac{\alpha}{2}$ .



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## Additional Questions Value Based Questions

1. The angle of elevation of the top of a chimney from the foot of a tower is  $60^\circ$  and the angle of depression of the foot of the chimney from the top of the tower is  $30^\circ$ . If the height of the tower is 40m, find the height of the chimney. According to pollution control norms, the minimum height of a smoke-emitting chimney should be 100m. State if the height of the above mentioned chimney meets

the pollution control norms. What value is discussed in this question?



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2. An army pilot flying an aeroplane at an altitude of 1800 m observes two ships sailing towards it in the same direction and immediately reports it to the navy chief. The angle of depression of the ships as observed from the aeroplane is  $60^\circ$  and  $30^\circ$  respectively.

[a] Find the distance between two ships.

[b] What value has the pilot shown?



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