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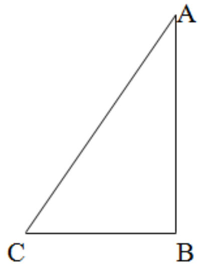
Class: X
Subject: Math's
Topic: Some Applications of trigonometry
No. of Questions: 20

Q.1 The angle of elevation of the top of a tower from a point on the ground, which is 30 m away from the foot of the tower, is 30^0. Find the height of the tower.

Sol: Let AB be the tower of height h meters, BC= 30m and
Angle of elevation ∠ACB=30^0
In ΔABC,
tan C= AB/BC
tan 30^0= AB/BC
$1/\sqrt{3} = h/30$
H= $30/\sqrt{3}$ m= $10\sqrt{3}$ m.



Q.2 A kite is flying at a height of 60 m 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 60^0. Find the length of the string assuming that there is no slack in the string.

Sol: Let A be the kite and CA be the string attached. The inclination of the string CA with the ground is 60^0.
In ΔABC,
sin C= AB/BC
sin 60^0= AB/AC
$\sqrt{3}/2$= 60/AC
AC= $120/\sqrt{3} = 40\sqrt{3}$ m

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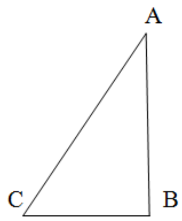


Q.3 A circus artist is climbing from the ground along a rope stretched from the top of a vertical pole and tied at the ground. The height of the pole is 12 m and the angle made by the rope with ground level is 30^0. Calculate the distance covered by the artist in climbing to the top of the pole.

Sol: Distance covered by the artist is equal to the length of the rope AC. Let AB be the vertical pole of height 12 m.

$\angle ACB = 30^0$

AC=?

$\sin 30^0 = AB/AC$

$1/2 = 12/AC$

AC= 24 m

Q.4 A circus artist is climbing a 20 m 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 30^0.

Sol: Let AB be the vertical pole and CA be the 20 m long rope such that its one end is tied from the top of the vertical pole AB and the other end C is tied to a point C on the ground.

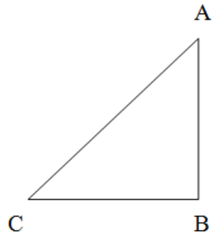
A

In ΔABC,

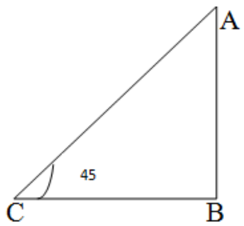
$\sin 30^0 = AB/AC$

$1/2 = AB/AC$

AB= 10 m



Q.5 A bridge across a river makes an angle of 45^o with the river bank as shown in the figure. If the length of the bridge across is 150m, what is the width of the river?



Sol: $\sin 45^o = AB/AC$

$1/\sqrt{2} = AB/150$

$AB = 150/\sqrt{2}$

$AB = 75\sqrt{2}$ m

Hence, the width of the river is $75\sqrt{2}$ metres.

Q.6 An observer 1.5m tall is 28.5m away from a tower. The angle of elevation of the top of the tower her eyes is 45^o. What is the height of the tower?

Sol: Let AB be the tower of height h and CD be the observer of height 1.5m at a distance of 28.5m from the tower AB.

In ΔAED, we have

$\tan 45^o = AE / DE$

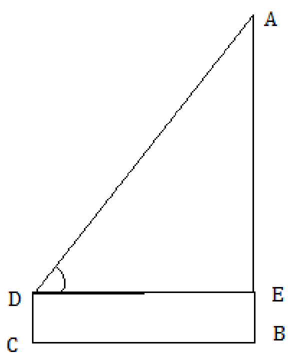
$1 = AE / 28.5$

$AE = 28.5$m

$h = AE + BE = AE + DC$

$= (28.5 + 1.5)$m $= 30$m

Hence, the height of the tower is 30m



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Q.7 A vertical tower stands on a horizontal plane and is surmounted by a vertical flag-staff of height h. At a point on the plane, the angles of elevation of the bottom and the top of the flag-staff are α and β respectively. Prove that the height of the tower is (h tan α) / (tan β – tan α)

Sol: Let AB be the tower and BC be the flag-staff. Let O be a point on the plane containing the foot of the tower such that the angles of elevation of the bottom B and top C of the flag-staff at O are α and β respectively. Let OA = × metres, AB = y metres and BC = h metres.

In ΔOAB, we have

tan α = AB / OA

tan α = y / x

x = y / tan α…….(i)

x = y cot α

In ΔOAC, we have

tan β = y + h / x

x = (y+h) / tan β……(ii)

x = (y + h)cot β

On equating the values of x given in equations (i) and (ii), we get

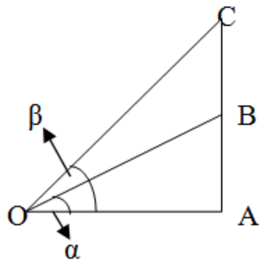
y cot α = (y + h)cot β

(y cot α – y cot β) = h cot β

y (cot α - cot β) = h cot β

y = (h cot β) / (cot α - cot β)

y = (h/tan β) / (1/tan α – 1/tan β) = (h tan α) / (tan β – tan α)



Hence, the height of the tower is (h tan α) / (tan β - tan α)

Q.8 A tree is broken by the wind. The top struck the ground at an angle of 30^o and at a distance of 30 metres from the root. Find the whole height of the tree.

Sol: Let AB the tree broken at a point C such that the broken part CB takes the position CO and strikes the ground at O. It is given that OA = 30 metres and $\angle AOC = 30^o$.

Let AC = x and CB = y. Then, CO = y.

In ΔOAC, we have

$\tan 30^o = AC/OA$

$1/\sqrt{3} = x/30$

$x = 30/\sqrt{3} = 10\sqrt{3}$

Again in Δ OAC, we have

$\cos 30^o = OA/OC$

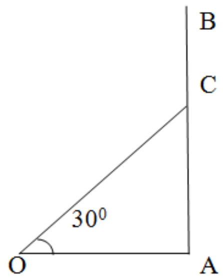
$\sqrt{3}/2 = 30/y$

$y = 60/\sqrt{3} = 20\sqrt{3}$

$\therefore$ Height of the tree = (x + y) metres

$= (10\sqrt{3} + 20\sqrt{3})$ metres

$= 30\sqrt{3}$ metres = 30 * 1.732 metres = 51.96 metres.



Q .9 The angles of elevation of the top of a tower from two points at distances a and b metres from the base and in the same straight line with it are complimentary. Prove that the height of the tower is $\sqrt{ab}$ metres.

(CBSE-2004)

Sol: Let AB be the tower. Let C and D be two points at distances a and b respectively from the base of the tower. Then, AC =a and AD = b. Let $\angle ACB = \theta$ and $\angle ADB = 90^o - \theta$.

Let h be the height of the tower AB.

In Δ CAB, we have

$\tan\theta = AB/AC$

$\tan\theta = h/a$…….(i)

In Δ DAB, we have

$\tan(90^o - \theta) = AB/AD$

$\cot\theta = h/b$…….(ii)

From (i) and (ii), we have

$\tan\theta \times \cot\theta = h^2/ab$

$1 = h^2/ab$

$h^2 = ab$

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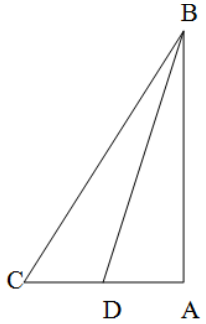
h = $\sqrt{ab}$ metres.

Hence, the height of the tower is $\sqrt{ab}$ metres



Q .10 At a point on level ground, the angles of elevation of a vertical tower are found to be such that its tangent is 5 / 12. On waling 192 metres towards the tower, the tangent of the angle of elevation is 3 / 4. Find the height of the tower.

Sol: Let AB be the tower and let the angle of elevation of its top at C be a. Let D be a point at a distance of 192 metres from C such that the angle of elevation of the top of the tower at D be β

Let h be the height of the tower and AD = x

It is given that

$\tan \alpha = 5 / 12$ and $\tan \beta = 3 / 4$

In Δ CAB, we have

$\tan \alpha = AB / AC$

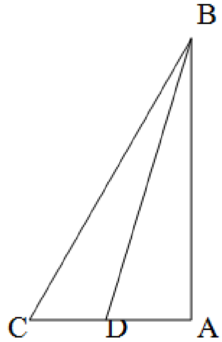
$5 / 12 = h / (x + 192)$……(i)

In Δ DAB, we have

$\tan \beta = AB / AD$

$\tan \beta = h / x$

$3 / 4 = h / x$



We have to find h. This means that we have to eliminate x from equations (i) and (ii).

From equation (ii), we have

$3x = 4h$

$x = 4h / 3$.......(ii)

Substituting this value of x in equation (i), we get

$5 / 12 = h / (192 + 4h / 3)$

$5 \{192 + 45 / 3\} = 12h$

$5 (576 + 4h) = 36 h$

$2880 + 20h = 36h$

$16h = 2880$

$h = 2880 / 16 = 180$

Hence the height of the tower is 180 metres.

Q .11 The shadow of a vertical tower on level ground increases by 10 metres, when the altitude of the sun changes from angle of elevation 45^o and 30^o. Find the height of the tower, correct to one place of decimal. (Take $\sqrt{3} = 1.73$)

Sol: Let AB be the tower and AC and AD be the shadows when the angles of elevation of the sun are 45^o and 30^o respectively. Then, CD = 10 metres. Let h be the height of the tower and let AC = x metres.

In ΔCAB, we have

$\tan 45^o = AB / AC$

$1 = h / x$

$x = h$.....(i)

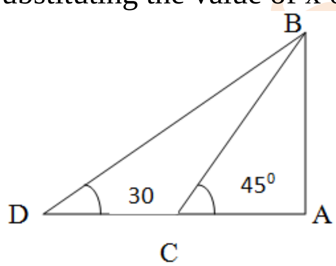
In ΔDAB, we have

$\tan 30^o = AB / AD$

$1 / \sqrt{3} = h / (x + 10)$

$X + 10 = \sqrt{3}\, h$.....(ii)

Substituting the value of x obtained from equation (i) and (ii), we get



$h + 10 = \sqrt{3}\, h$

$h (\sqrt{3} - 1) = 10$

$h = 10 / (\sqrt{3} - 1) = 10 / (\sqrt{3} - 1) * (\sqrt{3} + 1) / (\sqrt{3} + 1) = 10\{(\sqrt{3} + 1) / 2\} = 5(\sqrt{3} + 1)$

$h = 5 (1.73 + 1) = 13.65$ metres

Hence, the height of the tower is 13.65 metres.

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Q .12 From the top of a hill, the angles of depression of two consecutive kilometer stones due east are found to be 30^o and 45^o. Find the height of the hill.

Sol: Let AB be the hill of height h km. Let C and D be two stones due east of the hill at a distance of 1km from each other such that the angles of depression of C and D be 45^o and 30^o respectively. Let AC = x km.

In ΔCAB, we have

$\tan 45^o = AB / AC$

$1 = h/x$

$h = x$……(i)

In ΔDAB, we have

$\tan 30^o = AB / AD$

$1 / \sqrt{3} = h\ (x + 1)$

$\sqrt{3}\,h = x+1$…….(ii)

Substituting the value of x from equation (i) in equation (ii), we get

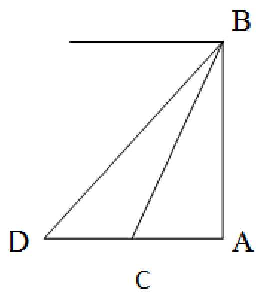
$\sqrt{3}\,h = h + 1$

$h\,(\sqrt{3} - 1) = 1$

$h = 1 / (\sqrt{3} - 1) = (\sqrt{3} + 1) / (\sqrt{3} - 1)\,(\sqrt{3} + 1)$

$h = (\sqrt{3} + 1) / 2 = 2.73 / 2 = 1.365$

Hence, the height of the hill is 1.365 km.



Q .13 An aeroplane at an altitude of 1200 metres finds that two slips are sailing towards it in the same direction. The angles of depression of the ships as observed from the aeroplane are 60^o and 30^o respectively. Find the distance between the two ships.

Sol: Let the aeroplane be at B and let the two ships be C and D such that their angles of depression from B are 30^o and 60^o respectively.

We have, AB = 1200 metres. Let AC = x and CD = y.

In ΔCAB , we have

$\tan 60^o = AB / CA$

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$\sqrt{3} = 1200 / x$

$X = 1200 / \sqrt{3} = 400\sqrt{3}$

In Δ BAD, we have

$\tan 30^o = AB / AD$

$1 / \sqrt{3} = 1200 / (x + y)$

$x + y = 1200\sqrt{3}$

$y = 1200\sqrt{3} - x$

$y = 1200\sqrt{3} - 400\sqrt{3} = 800\sqrt{3} = 800 * 1.732 = 1385.6$

Hence, the distance between the two ships is 1385.6 metres.

Q.14 The shadow of a flag staff is three times as long as the shadow of the flag staff when the sun rays meet the ground at an angle of 60^0. Find the angle between the sun rays and the ground at the time of longer shadow.

Sol: Let AB be the flag staff and let x=AC be the length of the shadow when the sun rays meet the ground at an angle of 60^0. Let θ be any angle between the sun rays and the ground when the length of the shadow of the flag staff is AD=3x. Let h be the height of the flag staff.

In ΔCAB,

$\tan 60^0 = AB/AC$

$\tan 60^0 = h/x$

$\sqrt{3} = h/x$

$h = \sqrt{3}\,x$

In ΔDAB,

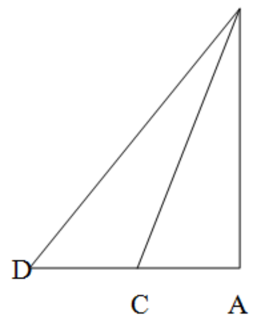
$\tan \theta = AB/AD$

$\tan \theta = h/3x$

$\tan \theta = \sqrt{3}\,x/3x = 1/\sqrt{3}$

$\tan \theta = \tan 30^0$

$\theta = 30^0$



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Q.15 An airplane at an altitude of 200 metres observes the angles of depression of opposite points on the two banks of a river to be 45^o and 60^o. Find the width of the river.

Sol: Let P be the position of the aeroplane and Let A and B be two points on the two banks of a river such that the angles of depression at A and B are 60^o and 45^o respectively. Let AM = x metres and BM = y metres. We have to find AB.

In ΔAMP, we have

$\tan 60^o = PM / AM$

$\sqrt{3} = 200 / x$

$200 = \sqrt{3}\, x$

$x = 200 / \sqrt{3}$ …..(i)

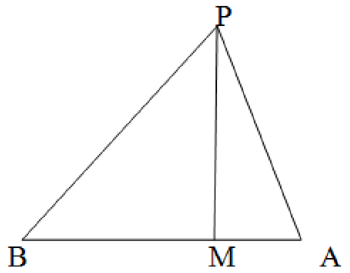
In ΔBMP, we have

$\tan 45^o = PM / BM$

$1 = 200 / y$

$y = 200$…..(ii)

From equation (i) and (ii), we get



$AB = x + y = 200 / \sqrt{3} + 200 = 200\{1/\sqrt{3} + 1\} = 315.4$ metres.

Hence, the width of the river is 315.4 metres.

Q .16 As observed from the top of a light house, 100m above sea level, the angle of depression of a ship, sailing directly towards it, changes from 30^o to 45^o. Determine the distance travelled by the ship during the period of observation.

(CBSE-2004)

Sol: Let A and B be the two positions of the ship. Let d be the distance travelled by the ship during the period of observation i.e. AB = d metres.

Let the observer be at O, the top of the light house PO.

It is given that PO = 100m and the angles of depression from O of A and B are 30^o and 45^o

respectively.

$\angle OAP = 30^o$ and $\angle OBP = 45^o$

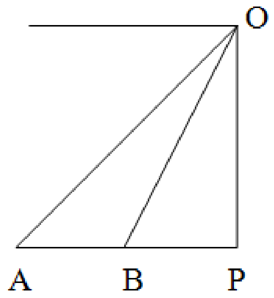
In ΔOPB, we have

$\tan 45^o = OP / AP$
$1 = 100 / BP$
$BP = 100m$

In ΔOPA, we have

$\tan 30^o = OP / AP$
$1/\sqrt{3} = 100 / (d + BP)$
$d + BP = 100\sqrt{3}$
$d + 100 = 100\sqrt{3}$
$d = 100\sqrt{3} - 100$
$d = 100(\sqrt{3} - 1) = 100(1.732 - 1) = 73.2m$

Hence, the distance travelled by the ship from A to B is 73.2m



Q.17 From the top of a building 60m high the angles of depression of the top and the bottom of a tower are observed to be 30^o and 60^o. Find the height of the tower.

(CBSE-2005)

Sol: Let AB be the building and CD be the tower. Let CD = h metres. Let DE be horizontal from D. It is given that the angles of depression of the top D and the bottom C of the tower CD are 30^o and 60^o respectively.

$\angle EDB = 30^o$ and $\angle ACB = 60^o$

Let AC = DE = x.

In ΔDEB, we have

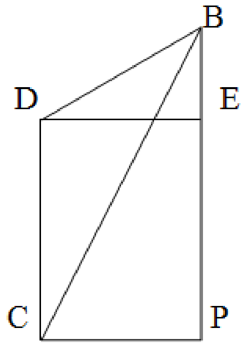
$\tan 30^o = BE / DE$
$1/\sqrt{3} = (60 - h) / x$
$x = (60 - h)\sqrt{3}$

In ΔCAB, we have

$\tan 60^o = AB / CA$
$\sqrt{3} = 60 / x$
$x = 60/\sqrt{3}$

From equations (i) and (ii), we have

$(60 - h)\sqrt{3} = 60/\sqrt{3}$
$3(60 - h) = 60$
$60 - h = 20$
$h = 40$



Thus, the height of the tower is 40 metres.

Q.18 The angles of elevation of a cloud from a point 60m above a lake is 30^o and the angle of depression of the reflection of cloud in the lake is 60^o. Find the height of the cloud.

Sol: Let AB be the surface of the lake and P be the point of observation such that AP = 60 metres. Let C be the position of the cloud and C' be its reflection in the lake. Then, CB = C'B. Let PM be perpendicular from P on CB. Then, $\angle CPM = 30^o$ and $\angle C'PM = 60^o$. Let CM = h. Then, CB = h + 60. Consequently, C'B = h + 60.

In ΔCMP, we have

$\tan 30^o = CM / PM$
$1/\sqrt{3} = h / PM$
$PM = \sqrt{3}h$.....(i)

In ΔPMC', we have

$\tan 60^o = C'M / PM$
$\tan 60^o = (C'B + BM) / PM$
$\sqrt{3} = (h + 60 + 60) / PM$
$PM = (h + 120)/\sqrt{3}$ ....(ii)

From equation (i) and (ii), we get

$\sqrt{3}h = (h + 120)/\sqrt{3}$
$3h = h + 120$
$2h = 120$
$h = 60$

Now, CB = CM + MB = h + 60 = 60 + 60 = 120.

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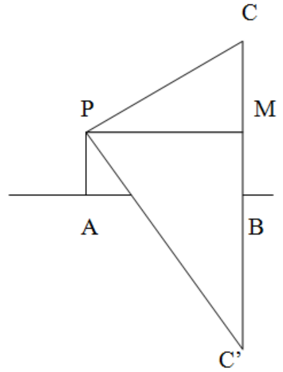

Hence, the height of the cloud from the surface of the lake is 120 metres.

Q.19 The horizontal distance between two towers is 140m. The angle of elevation of the top of the first tower when seen from the top of the second tower is 30^o. If the height of the second tower is 60m, find the height of the first tower.

Sol: Let AB and CD be two towers of height h metres and 60 metres respectively such that the distance AC between them is 140m. The angle of elevation of top B of tower AB as seen from D (top of tower CD) is 30^o.

In Δ DEB, we have

$\tan 30^o = BE / DE$

$1/\sqrt{3} = BE / 140$ [$\because$ DE = AC = 140m]

$BE = 140/\sqrt{3}$ m = 140 / 1.732m = 80.83m

AB = AE + BE = CD + BE = 60 + 80.83m = 140.83m

Hence, the height of the second tower is 140.83m.

Q.20 An aeroplane when flying at a height of 4000 m from the ground passes vertically above another aeroplane at an instant when the angles the angles of the elevation of two planes from the same point on the ground are 60^0 and 45^0 respectively. Find the vertical distance between them at that instant.

(CBSE-2009)

Sol: Let P and Q be the positions of two aeroplanes when Q is vertically below P and OP=4000 m. Let the angles of elevation of P and Q at a point A on the ground be 60^0 and 45^0 respectively.

In ΔAOP and ΔAOQ,

$\tan 60^0$=OP/OA and $\tan 45^0$=OQ/OA

$\sqrt{3}$ =4000/OA and 1=OQ/OA

OA=4000/$\sqrt{3}$ and AQ=OA

OQ=4000/ $\sqrt{3}$ m
Vertical distance PQ between the aeroplanes is given by
PQ=OP – OQ
PQ=(4000 – 4000/ $\sqrt{3}$)m=4000($\sqrt{3}$ - 1)/ $\sqrt{3}$ m= 1690.53 m