1.6 Angles of elevation and depression

1 Four drones are flying directly over a clinometer.

a 5 minutes later one of them could be seen at an angle of elevation of 63° from a point on the floor 70 m away from the clinometer. If the angle was measured 1.60m above the ground and the speed and the altitude of the drone were constant, find:

i how high the drone was flying

ii how far away it was from the clinometer

iii the angle of elevation after 5 more minutes

b The second drone flies vertically until it reaches a height of 2m then 60m on an angle of elevation of 40°

i calculate:

how far vertically it is placed from the floor

how far horizontally it is placed from the clinometer

ii It then flies back on an angle of depression of 60° until it lands on the floor. Calculate how far from the clinometer it lands

iii It was supposed to land 10m away from the clinometer, calculate the angle of depression it should have taken.

c A third drone is flying directly over the clinometer, 10 minutes later it is at angle of elevation of 20 degrees. If we assume it travelled at a constant speed and on the same altitude, calculate what his angle of elevation was after 5 minutes.

d A fourth drones can see an object at an angle of depression is 22° If it moves 500m closer at the same altitude the angle of depression to the object is 41°.

i Calculate how high the drone flies

ii Find how much the drone would need to fly horizontally to be situated over the object.

iii Calculate the shortest distance to the object.

iv There is unfortunately an obstacle which prevents the drone to fly directly. He thus flies 12 more meters at the same altitude before going down. Find the angle of depression to reach the object

2 The wheel of a bicycle has diameter 60 cm.

a The wheel makes a revolution of 100°. Find the distance the bicycle travels.

Turning the pedals on a bicycle through one revolution causes the causes the wheel to make 3 revolutions.

b The bicycle travels 1 m. Find the angle of revolution made by the

i wheel **ii** pedals.

c The bicycle is moving at a speed of 8 metres per second.

i Find the number of revolutions the wheel makes in 1 second.

ii Find the time taken for the pedal to make one revolution.

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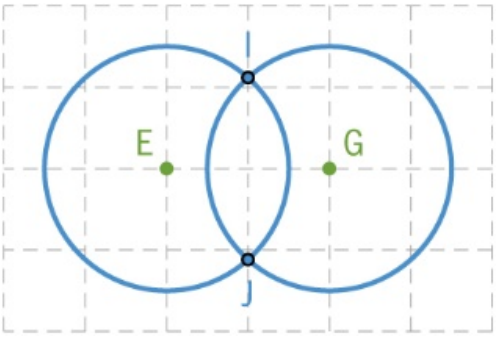
3 Two projectors are placed 3 m above the scene 4 m away from each other. Their diameter is 20 cm and the angle they make with the vertical is $45°$



a Calculate the diameter of the circle light a projector makes on the floor

b Calculate $\widehat{JGE}$

c Calculate the area of the sector IGJ

d Calculate the area of ΔIGJ

e Hence find the overlapping area.

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Answers

1 a i $70 \times \tan 63 + 1.60 = 139\text{m}$

ii $\dfrac{70}{\cos 63} = 154.2\ \text{m}$

iii $\theta = \tan^{-1}\left(\dfrac{137.4}{2 \times 70}\right) = 44.46$

b i $\text{v} = 60\ \sin 40 + 2 = 40.6\text{m};\ h = 60 \cos 40 = 46\text{m}$

ii $46 - \dfrac{40.6}{tan60} = 22.56\text{m}$

iii $46 - \dfrac{40.6}{tan\theta} = 10 \quad \theta = \tan^{-1}\dfrac{40.6}{36} = 48.4°$

c Let x be the horizontal distance travelled by the drone, h be the height, θ the angle of elevation $\dfrac{h}{x} = \tan 20$ and $\dfrac{h}{2x} = \tan\theta$ so $\tan 20 = 2\tan\theta \quad \theta = 10.31$

d i $\tan 43 = \dfrac{h}{x}$ and $tan23 = \dfrac{h}{500 + x}$ so $x = \dfrac{h}{\tan 43} = \dfrac{h}{\tan 23} - 500$ so $h = 389.56m$

ii $\dfrac{389.56}{tan43} = 44.66m$

iii $\dfrac{389.56}{\sin 43} = 571.2m$

iv $\tan^{-1}\dfrac{389.56}{44.66 - 12} = 85.2m$

2 a 52.4 cm

b i 191.0°

ii 63.7°

c i 4.24

ii 0.707s

3 a $0.02 + 2(3\tan 45) = 6.02\text{m}$

b let M the midpoint between E and G EG = 4, ΔMGJ is a right angle triangle, MG = 2, IG = 6.02 so $0.02 + 2(3\tan 45) = 6.02\text{m}$ $\widehat{JGE} = \cos^{-1}\dfrac{2}{6.02} = 70.6°$

c $\dfrac{141.2 \times \pi \times 6.02^2}{360} = 44.66\text{m}^2$

d The area of ΔIGJ is twice ΔMGJ $MJ = \sqrt{GI^2 - MG^2} = 5.68$

so Area $= 5.68 \times 2 = 11.36\ \text{m}^2$

e $2 \times (44.66 - 11.36) = 66.6\text{m}^2$

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