I.G.C.S.E. Trigonometry

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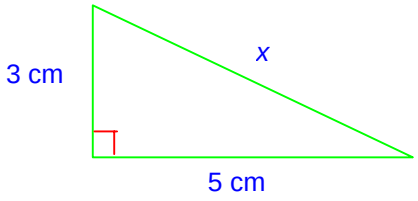
You can access the solutions from the end of each question

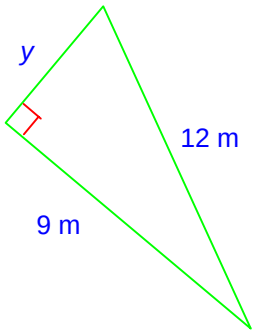
Question 1

1. For the triangles below calculate the missing lengths.

a.



b.



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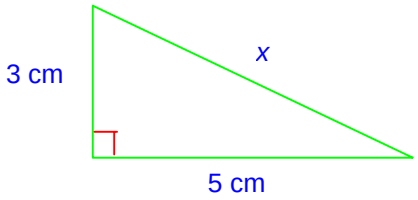
Solution to question 1

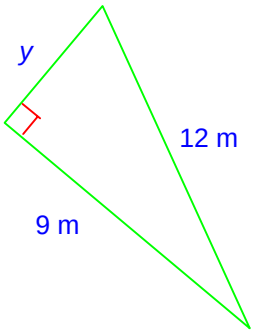
a.



Using Pythagoras' theorem we have

$$x^2 = 3^2 + 5^2$$
$$x = \sqrt{3^2 + 5^2}$$
$$= \sqrt{9 + 25}$$
$$= \sqrt{34}$$
$$= 5.83\,\text{cm}$$

b.



Using Pythagoras' theorem, remembering that 12 m is the hypotenuse.

$$12^2 = y^2 + 9^2$$
$$y^2 = 12^2 - 9^2$$
$$y = \sqrt{144 - 81}$$
$$= \sqrt{63}$$
$$= 7.94\,\text{m}$$

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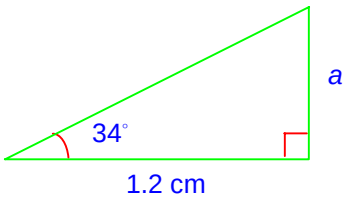
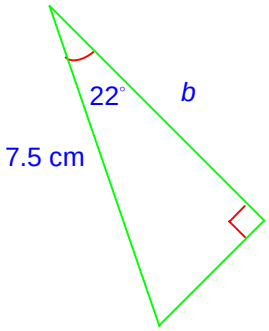
Question 2

For the triangles below find the missing letters.

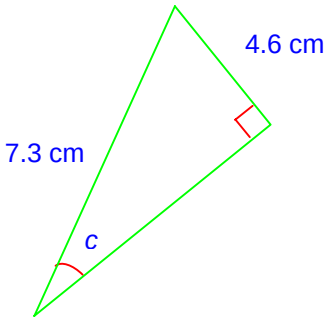
a.



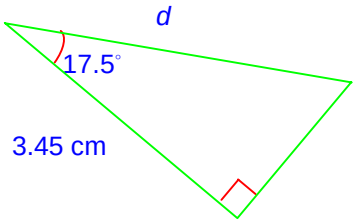
b.



c.



d.



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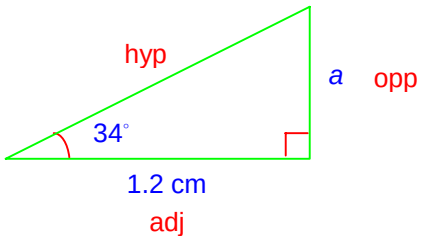
Solution to question 2

First label the sides of each triangle, adjacent, opposite and hypotenuse.

a.

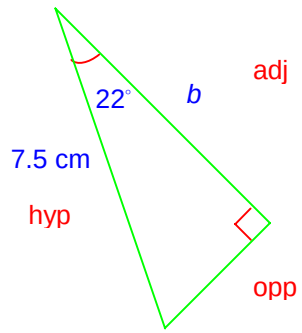


The missing side is the opposite side and we have the adjacent and angle hence

$$\tan\theta = \frac{\text{opp}}{\text{adj}} \Rightarrow \tan 34^\circ = \frac{a}{1.2}$$

$$\Rightarrow a = 1.2 \times \tan 34^\circ = 0.809\,\text{cm}$$

b.

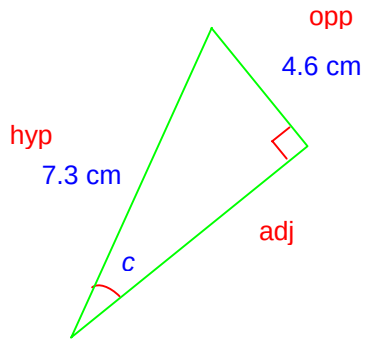


The missing side is the adjacent side and we have the hypotenuse and angle hence

$$\cos\theta = \frac{\text{adj}}{\text{hyp}} \Rightarrow \cos 22^\circ = \frac{b}{7.5}$$

$$\Rightarrow b = 7.5 \times \cos 22^\circ = 6.95\,\text{cm}$$

c.

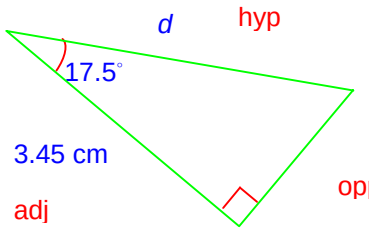


The angle is and we know the opposite side and hypotenuse hence

$$\sin\theta = \frac{\text{opp}}{\text{hyp}} \Rightarrow \sin c = \frac{4.6}{7.3}$$

$$\Rightarrow c = \sin^{-1}\left(\frac{4.6}{7.3}\right) = 39.1^\circ$$

d.



The missing side is the hypotenuse side and we have the adjacent side and angle hence

$$\cos\theta = \frac{\text{adj}}{\text{hyp}} \Rightarrow \cos 17.5^\circ = \frac{3.45}{d}$$

$$\Rightarrow d = \frac{3.45}{\cos 17.5^\circ} = 3.62\,\text{cm}$$

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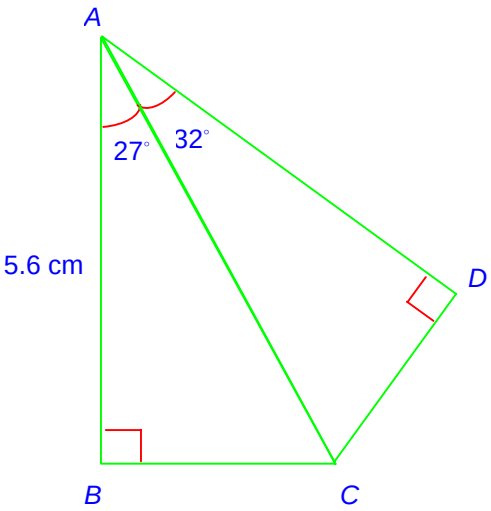
Question 3

In the diagram below find the following lengths
a. *AC* **b.** *AD* **c.** *CD*.



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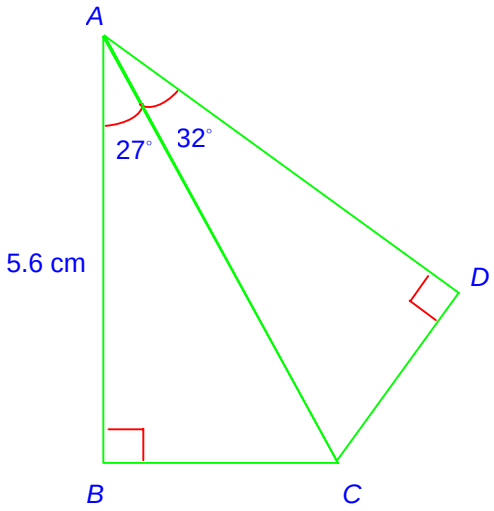
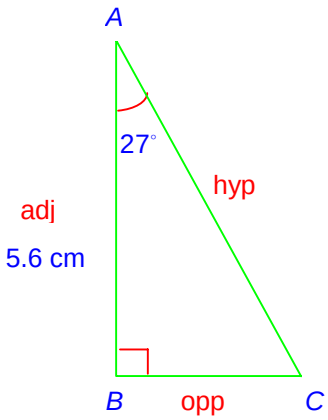
Solution to question 3



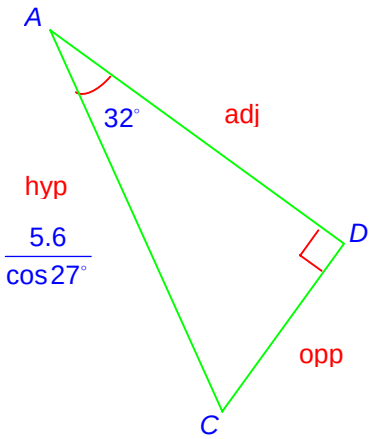
a. First draw out triangle *ABC* separately



$$\cos\theta = \frac{\text{adj}}{\text{hyp}} \Rightarrow \cos 27^\circ = \frac{5.6}{AC}$$

$$AC = \frac{5.6}{\cos 27^\circ} = 6.29\,\text{cm}$$

b. First draw out triangle *ACD* separately



$$\cos\theta = \frac{\text{adj}}{\text{hyp}} \Rightarrow \cos 32^\circ = \frac{AD}{\dfrac{5.6}{\cos 27^\circ}}$$

$$\Rightarrow AD = \frac{5.6 \times \cos 32^\circ}{\cos 27^\circ} = 5.33\,\text{cm}$$

c. Considering triangle *ACD*.

$$\sin\theta = \frac{\text{opp}}{\text{hyp}} \Rightarrow \sin 32^\circ = \frac{CD}{\dfrac{5.6}{\cos 27^\circ}}$$

$$\Rightarrow AD = \frac{5.6 \times \sin 32^\circ}{\cos 27^\circ} = 3.33\,\text{cm}$$

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Question 4

A ship sails from Porthampton on a bearing of 120° towards a buoy marker for 60 km and then changes course to a bearing of 150° for another 80 km until it reaches Littlehampton.

a. Draw a scale diagram using a scale of 1 cm to 10 km and find the distance and bearing of Littlehampton from Porthampton.

b. Using trigonometry, calculate how far east and how far south the ship has travelled.

c. Calculate the distance and bearing of Littlehampton from Porthampton.

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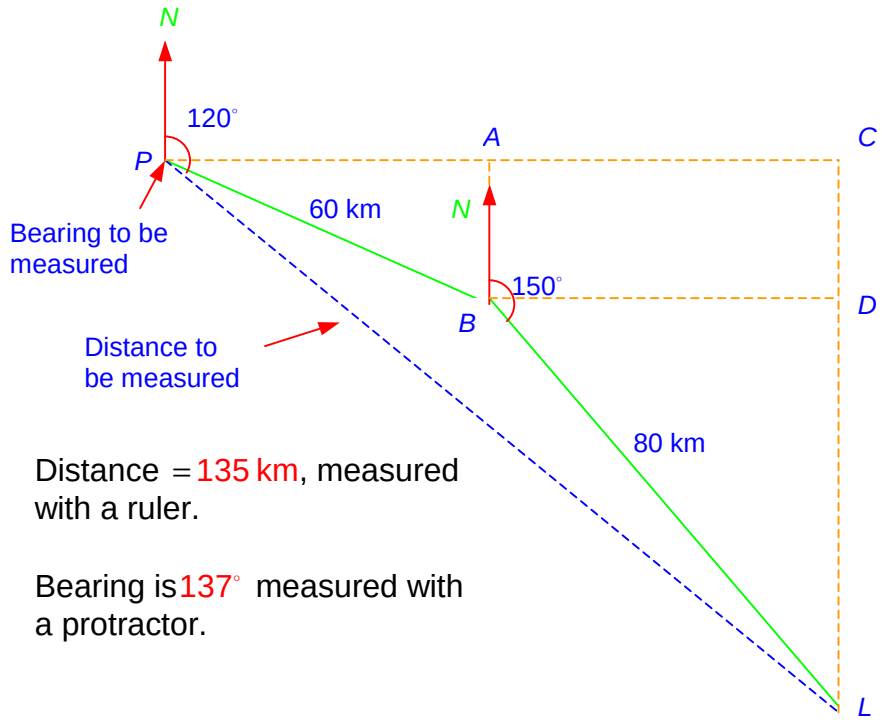
Solution to question 4

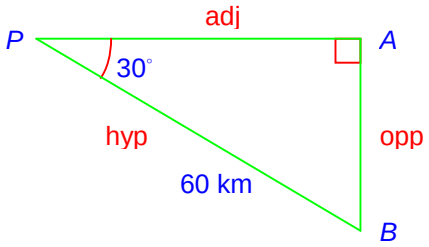
a. Scale drawing scale 1 cm to 10 km.

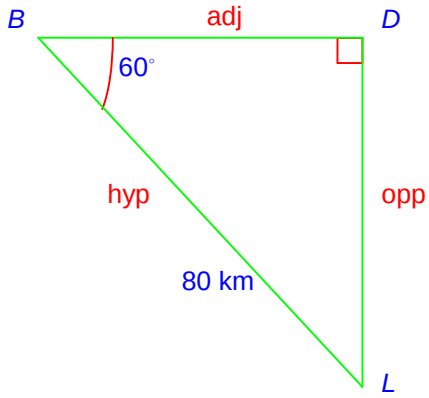


Distance $= 135$ km, measured with a ruler.

Bearing is 137° measured with a protractor.

b. Drawing out triangles PAB and BDL separately we have





$$\cos\theta = \frac{\text{adj}}{\text{hyp}} \Rightarrow \cos 30^\circ = \frac{PA}{60}$$

$$\Rightarrow PA = 60 \times \cos 30^\circ \quad \text{(East)}$$

$$\sin\theta = \frac{\text{opp}}{\text{hyp}} \Rightarrow \sin 30^\circ = \frac{AB}{60}$$

$$\Rightarrow AB = 60 \times \sin 30^\circ \quad \text{(South)}$$

$$\cos\theta = \frac{\text{adj}}{\text{hyp}} \Rightarrow \cos 60^\circ = \frac{PA}{80}$$

$$\Rightarrow PA = 80 \times \cos 60^\circ \quad \text{(East)}$$

$$\sin\theta = \frac{\text{opp}}{\text{hyp}} \Rightarrow \sin 60^\circ = \frac{AB}{80}$$

$$\Rightarrow AB = 80 \times \sin 60^\circ \quad \text{(South)}$$

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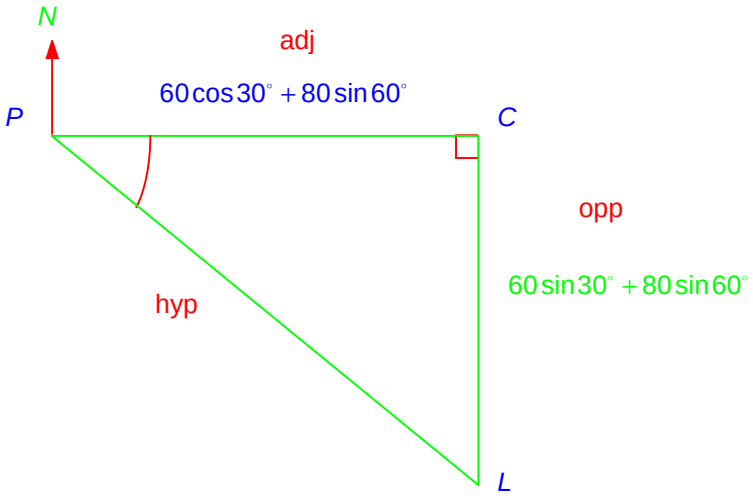
The total distance east is $= 60\cos 30^\circ + 80\cos 60^\circ = 91.961\ldots = 92.0\,\text{km}$

The total distance south is $= 60\sin 30^\circ + 80\sin 60^\circ = 99.282\ldots = 99.3\,\text{km}$

c. The distance PL is found by Pythagoras' theorem

$$PL = \sqrt{\left(60\cos 30^\circ + 80\cos 60^\circ\right)^2 + \left(60\sin 30^\circ + 80\sin 60^\circ\right)^2}$$
$$= 135.328\ldots$$
$$= 135\,\text{km}$$

We need to find angle $C\hat{P}L$ so we use triangle CPL



$$\tan\theta = \frac{\text{opp}}{\text{adj}} \Rightarrow C\hat{P}L = \tan^{-1}\left(\frac{60\sin 30^\circ + 80\sin 60^\circ}{60\cos 30^\circ + 80\cos 60^\circ}\right)$$
$$= 47.2^\circ$$

But we need to find the bearing of Littlehampton from Portshampton, which is given by

$$90^\circ + 47.2^\circ = 137.2^\circ$$

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Question 5

The height of an eye of a man is 175 cm. He is standing 20 m from a building, which has a flagpole on it. He looks up at an angle of elevation 23° and sees the top of the building. He then looks up at the top of the flagpole, which has an angle of elevation of 28°.

a. Calculate the height of the building.

b. Calculate the height of the flagpole.

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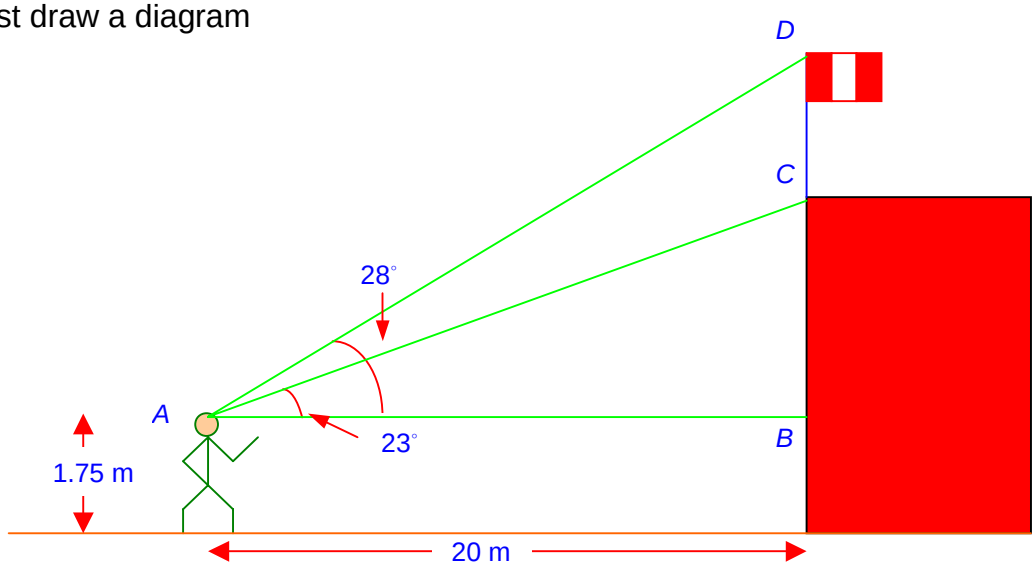
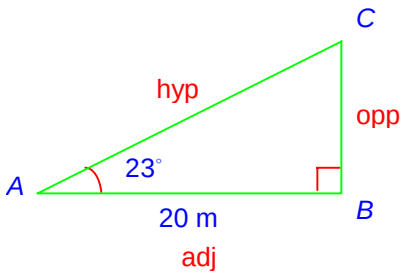
Solution to question 5

First draw a diagram



a. Consider triangle *ABC*

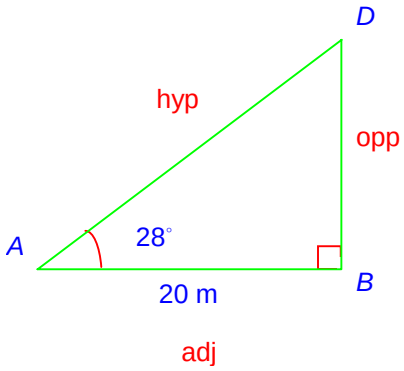


$$\tan\theta = \frac{\text{opp}}{\text{adj}} \Rightarrow \tan 23^\circ = \frac{BC}{20}$$

$$BC = 20 \times \tan 23^\circ = 8.49\,\text{m}$$

The height of the wall is
$= 1.75 + 8.49 = 10.239\ldots = 10.2\,\text{m}$

b. Consider triangle *ABD*



$$\tan\theta = \frac{\text{opp}}{\text{adj}} \Rightarrow \tan 28^\circ = \frac{BC}{20}$$

$$BC = 20 \times \tan 28^\circ = 10.63\,\text{m}$$

The height of the flagpole from the ground is
$= 1.75 + 10.63 = 12.384\,\text{m}$

Height of flagpole is *CD*
$= 12.38 - 10.24 = 2.14\,\text{m}$

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Question 6

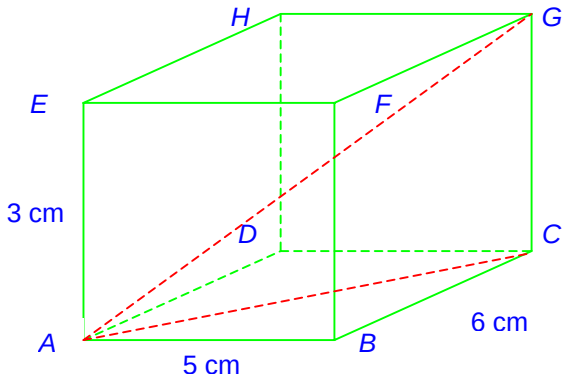
A rectangular box *ABCDEFGH* has $AB = 5\,\text{cm}$, $BC = 6\,\text{cm}$ and $AE = 3\,\text{cm}$

Calculate

a. *AC*,

b. *AG*,

c. The angle $C\hat{A}G$.



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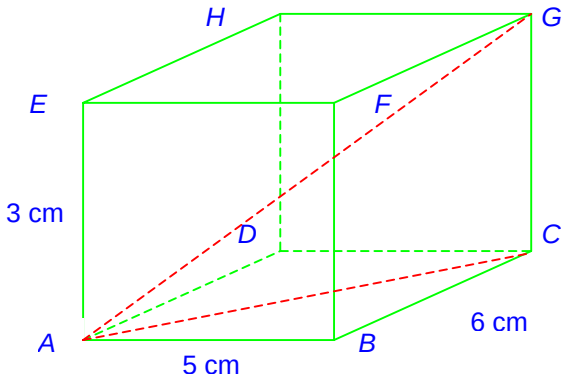
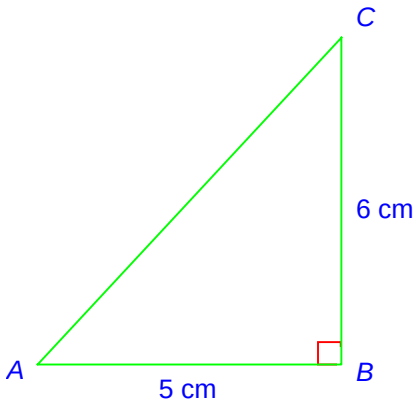
Solution to question 6



a. Consider triangle ABC



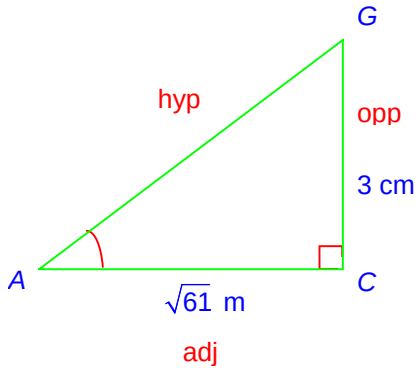
By Pythagoras' theorem

$$AC = \sqrt{5^2 + 6^2}$$
$$= \sqrt{61}$$
$$= 7.81\text{cm}$$

b. Consider triangle *ACG*.

By Pythagoras' theorem

$$AG = \sqrt{61 + 3^2} \quad \text{Note } \left(\sqrt{61}\right)^2 = 61$$
$$= \sqrt{70}$$
$$= 8.37\,\text{cm}$$



c. Consider triangle *ACG*. $\tan\theta = \dfrac{\text{opp}}{\text{adj}} \Rightarrow C\hat{A}G = \tan^{-1}\left(\dfrac{3}{\sqrt{61}}\right) = 21.0^\circ$

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