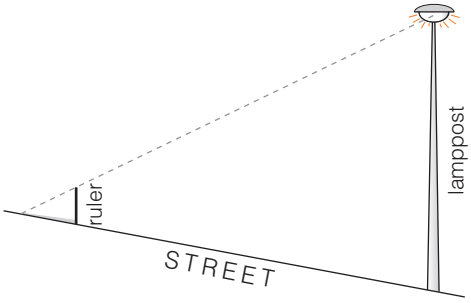
A Estimating Heights with Simple Tools

1 Ben wants to estimate the height of a lamppost in his street. The street is sloping up a hill with a constant steepness.

This is Ben's plan : At night when the streetlight is on, he will take a one metre ruler and place it upright on the street not too far from the pole because he needs to see a clear outline of the shadow of the ruler (see picture).
Ben will ask his brother to hold the ruler while he takes two measurements :

i) The distance over the street between tip of the shadow and ruler.
ii) The distance over the street between the ruler and the pole.



a) Redraw the picture as a diagram. Distance (i) = 82 cm, distance (ii) = 3.65 m.

b) Explain in detail why Ben's plan works. Calculate the height of the lamppost.

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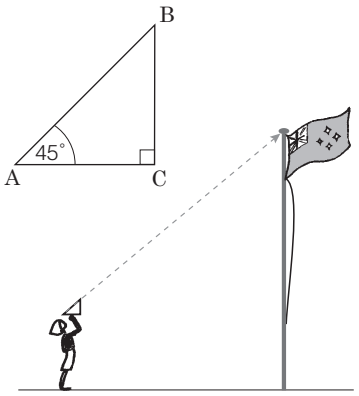
2a) Triangle ABC has a right angle at C and a 45° angle at A. What do you know about the sides of ΔABC?



Explain : ……

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b) Marie wants to find the height of a flagpole on the school's level play ground, so she took a large plastic triangle shaped like ΔABC above, raised the triangle to her eyes and walked slowly toward the flagpole, keeping side AC parallel to the ground. She stopped when the tip of the triangle was in line with the tip of the pole. She then measured the distance between the spot where she stopped and the base of the pole; it was 3.6 metres.
Redraw the picture as a diagram, indicating angle sizes and distances.

c) Explain what Marie needs to do to find the height of the flagpole.

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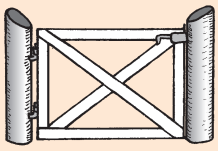
A Hidden Right-Angled Triangles

Pythagoras' rule and trig ratios can only be used in right-angled triangles. Sometimes this triangle is hidden in the diagram, you need to find it first, then draw the triangle and write the information on it.

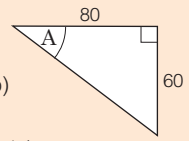
Example :

This gate is 80 cm wide and 60 cm high. Calculate the angle between the sloped piece of timber and the horizontal piece.



Working :

The gate is a rectangle so there is a right-angle in each corner.



$$\tan \angle A = \frac{60}{80}$$

$$\angle A = \tan^{-1}\left(\frac{60}{80}\right) = 36.9^\circ \text{ (1 dp)}$$

Answer : The required angle is 37° (nearest whole).

1 A TV dish is mounted on top of a flat roof. It is secured with 2.5 m long stays that are bolted 1.2 m from the pole.

How high up the pole do the stays reach?

Answer : .....

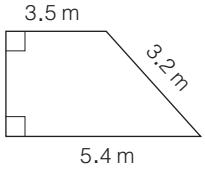
2 The navigator on a ship measures the angle of elevation to the top of a lighthouse to be 8°. His chart indicates that the top of the lighthouse is 70 m above sea level.

How far from the lighthouse is this ship?

Answer : .....

B Up in the Attic

1 This is a cross section of an attic. The floor is 5.4 m wide, the ceiling 3.5 m wide and the roofline 3.2 m long. How high is the ceiling?



Answer : .....

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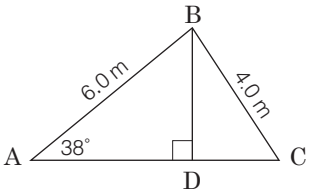

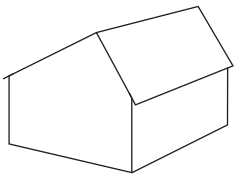

This diagram shows the cross-section of an attic.

a) Use ΔABD to calculate the height of the attic (length $\overline{BD}$).

Answer : .....

b) Use ΔBCD to calculate the size of angle C.
(hint : use the length of $\overline{BD}$ you calculated before).

Answer : .....

27 3D Applications 2

A Wiring

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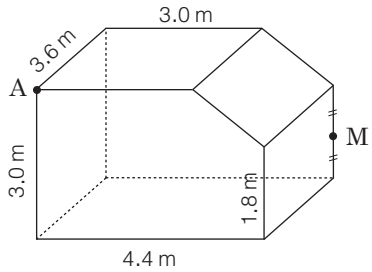

Donald has bought a modem for the computer in his bedroom. He now needs to connect the modem to a telephone line. The diagram shows a sketch of Donald's bedroom. The telephone wire enters the room at A, the modem is at M (M is halfway up the edge).

a) If Donald leads the telephone wire via the edges of the ceiling and walls, what length of wire will he need?

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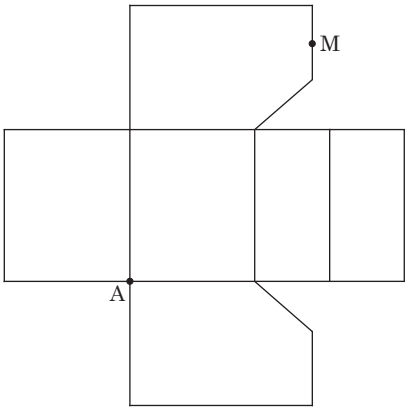

b) Donald has only 7 m of telephone wire. Investigate other ways of connecting A with M, the wire must be touching a wall or ceiling at all times. Show two different ways on the 'nets' of Donald's room. Can he make the connection with 7 m of wire?

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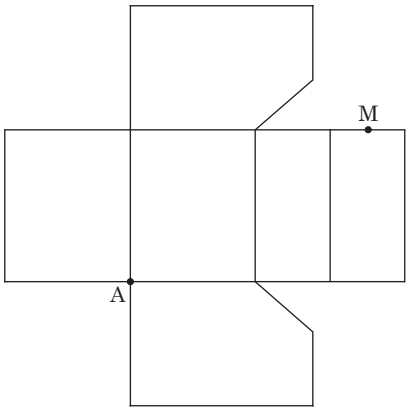
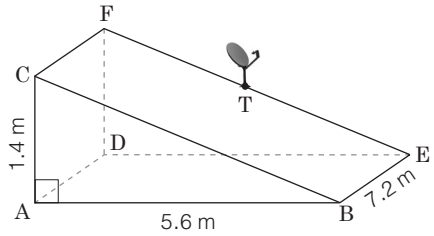


2 A television cable enters this attic halfway edge $\overline{EF}$ and disappears inside the house at A. ABED and ADFC are rectangles. Calculate the length of the shortest piece of wire needed in the attic.



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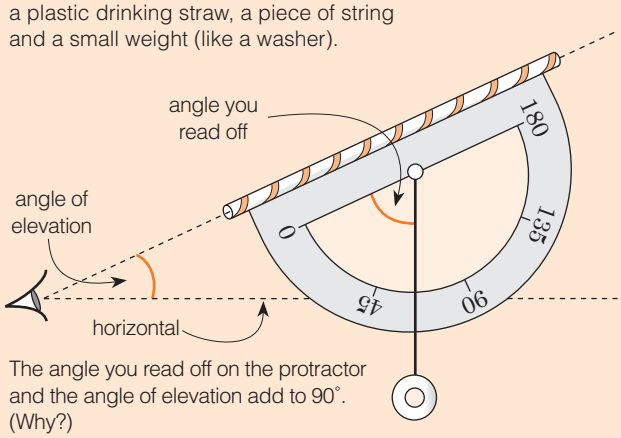
33 Accuracy of Measurements 2

A Measuring Angles of Elevation

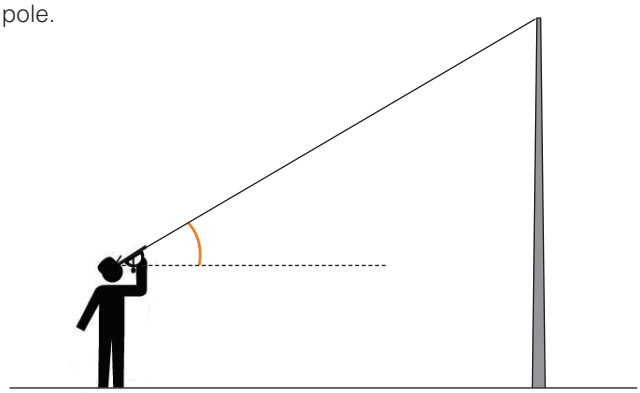
A **clinometer** is a device for measuring the angle of elevation above the horizontal. With this instrument and some basic trigonometric calculations we can work out the height of a tall object that is standing at a measurable distance from us.

You can make your own clinometer with a protractor, a plastic drinking straw, a piece of string and a small weight (like a washer).



The angle you read off on the protractor and the angle of elevation add to 90°. (Why?)

1 Jake and his mate Dylan made a clinometer and will use it to estimate the height of a telephone pole. Jake holds the clinometer up and looks through the straw to the tip of the pole.



a) On the protractor Dylan sees that the string hangs down at an angle of 52°. This angle is **not** the angle of elevation. What calculation do the boys need to do to find the angle of elevation?

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b) Dylan measures the distance from Jake's feet to the base of the pole to be 6.8 m. Jake's eye height is 1.71 m. Show how the height of the telephone pole can now be calculated. Round the answer to 2 sf.

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B Intervals

1 Jake took in fact several 'shots' from his position and each time he got a slightly different angle. Dylan said, *"the angles I read off are between 50 and 54 degrees."*

a) Calculate the smallest and largest angle of elevation.=

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b) The measurement from Jake's feet to the base of the pole is given as 6.8 m to the nearest 10 cm. What are the limits of accuracy on this distance?

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c) Give the limits of accuracy of Jake's eye height of 1.71 m.

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d) Work out an interval for the actual height of the telephone pole.

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e) Jake says : *"The height of the telephone pole is 7.0 metres plus or minus 0.4 metres"*.
Do you agree with this statement? Explain.

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