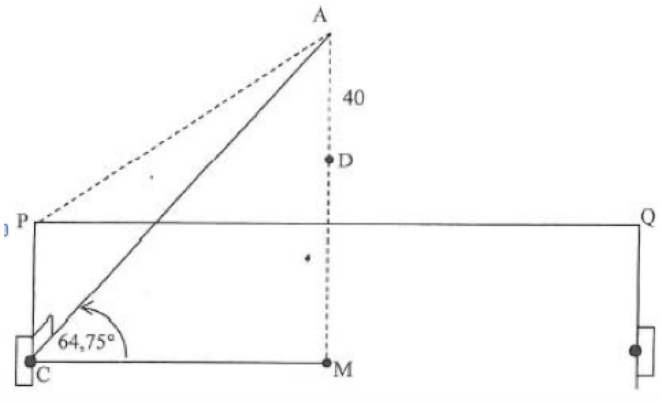
IN A SOCCER STADIUM

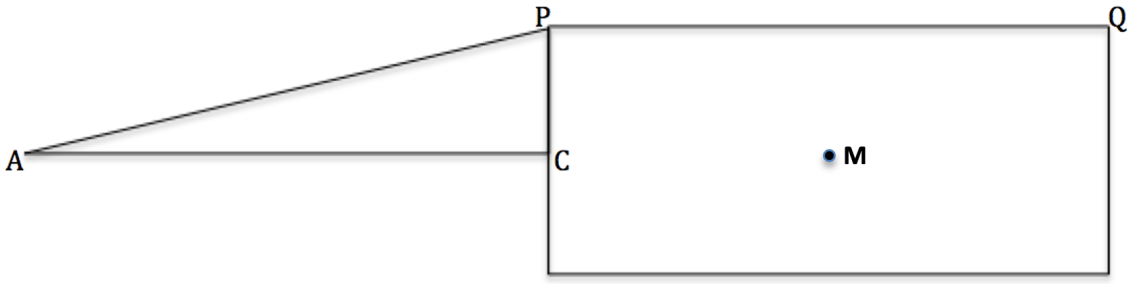


Moses Mahdiba Soccer Stadium built for the 2010 World Cup in South Africa

The angle of elevation from a point C on the ground at the centre of the goalpost is 64.75 degrees to the highest point A of the arc above the centre of the Moses Mahdiba Soccer Stadium in Durban. The soccer pitch is 100 metres long (PQ in the diagram) and 64 metres wide as prescribed by FIFA World Cup rules. The length PC = 32 metres, M is the point at the centre of the pitch directly below A and C, and AC is perpendicular to PC. A camera is positioned at D, 40 metres directly below A. By scale drawing or using trigonometry, find:

1. The distance AC.
2. The angle PAC.
3. The distance CD from C to the camera at D.

HELP



Draw and cut out a diagram like this. You can fold it along PC and raise the triangle so that point A is directly above M to demonstrate the 3D geometry involved in this activity.

NEXT

As an extension activity, find the distances PM and DP.

NOTES FOR TEACHERS

SOLUTION

South African National School Certificate (matric) November 2010 exam.
You are told that A is directly above the centre of the pitch so CM = 50 metres and angle CMA is a right angle.

CM =ACcos $64{,}75^0$
so AC = 50/cos $64{,}75^o$ = 117.21 m (rounded to 2 decimal places).

As triangle PAC is a right angled triangle then tan PAC = 32/AC = 0.2730
Angle PAC = 15.27^o
Height AM = AC x sin 64,75 = 106.01 m
DM = 106.01 – 40 = 60.01 m

$DC^2 = CM^2 + DM^2 = 2500 + 3600 = 6100$
so DC = 78.10 m

Why do this activity?

This activity shows a real life application of trigonometry. As it only uses right angled triangles it is relatively straightforward. It gives practice in visualising the geometry and deciding which right angled triangle to work on.

Learning objectives

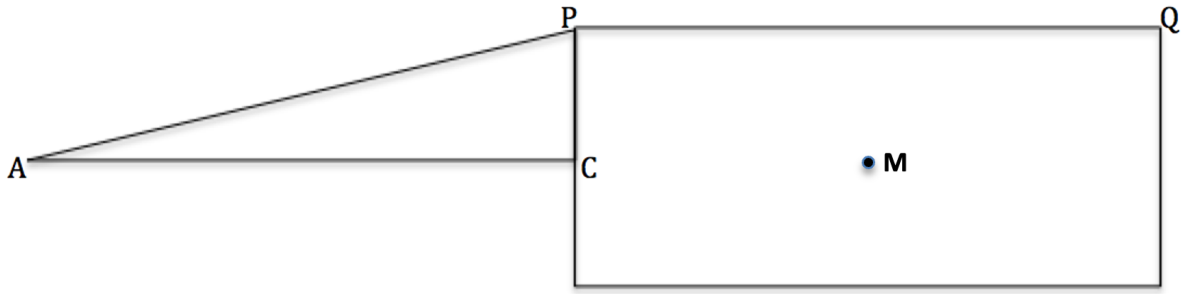
In doing this activity learners will have an opportunity to:

- practice in scale drawing (younger learners);
- practice in solving three dimensional trigonometry problems (older learners);
- develop skills needed to apply mathematics to solve real life problems.

Generic competences

In doing this activity learners will have an opportunity to develop visualization skills in 3 dimensions.

Suggestions for teaching



Draw and cut out a diagram like this. You can fold it along PC and raise the triangle so that point A is directly above M to demonstrate the 3 D geometry involved in solving this problem.

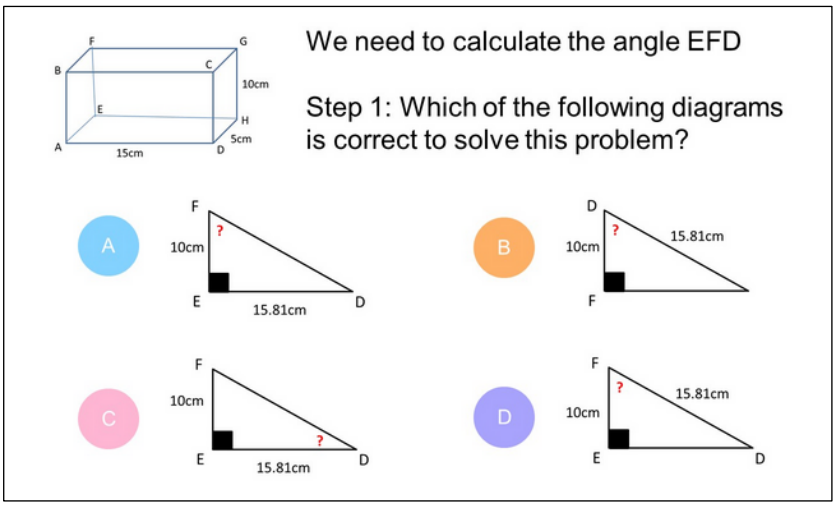
Then the learners should try to do the problem for themselves. The One-Two-Four-More strategy works well here. Allow learners some time to work individually then tell them to share their ideas in pairs. When they find a solution they should discuss it with another pair. Tell them that you will choose one learner from a group to present the group's solution to the class, so the learners should help each other so that everyone understands the solution and can explain it to the class.

Finish the lesson with the learners presenting their solutions to the problem at the chalkboard and class discussion of the methods.

DIAGNOSTIC ASSESSMENT This should take about 5–10 minutes.

Write the question on the board, say to the class:

"Put up 1 finger if you think the answer is A, 2 fingers for B, 3 fingers for C and 4 for D".



1. Notice how the learners respond. Ask a learner who gave answer A to explain why he or she gave that answer. DO NOT say whether it is right or wrong but simply thank the learner for giving the answer.
2. It is important for learners to explain the reasons for their answers. Putting thoughts into words may help them to gain better understanding and improve their communication skills.
3. Then do the same for answers B, C and D. Try to make sure that learners listen to these reasons and try to decide if their own answer was right or wrong.
4. Ask the class to vote for the right answer by putting up 1, 2, 3 or 4 fingers. Notice if there is a change and who gave right and wrong answers.
5. If the concept is needed for the lesson to follow, explain the right answer or give a remedial task.

A. is the correct answer.

Common Misconceptions

B. Here learners have worked out $\sqrt{250}$ (the length of ED) but are confused about triangle EFD .

C. Here learners have identified the correct triangle and length of ED but have marked angle EDF and not EFD.

D. Here learners have worked out $\sqrt{250}$ (the length of ED) but have wrongly labelled FD with this length. https://diagnosticquestions.com

Key questions

- What can you say about angle AMC?
- Knowing AMC is a right angle, what else do you know about triangle ACM?
- Can you draw triangle ACM to scale (question for younger learners).
- Can you draw triangle ACP to scale (question for younger learners).
- Knowing the angles of right-angled triangle and one of the edge lengths can you calculate the other edge lengths?
- Can you find the height AM?
- Can you use the height AM to find the distance DM?
- Knowing DM and CM can you find CD?

Follow up

Great Pyramid https://aiminghigh.aimssec.ac.za/great-pyramid/

Go to the **AIMSSEC AIMING HIGH** website for lesson ideas, solutions and curriculum links: http://aiminghigh.aimssec.ac.za

Subscribe to the **MATHS TOYS YouTube Channel**
https://www.youtube.com/c/MathsToys/videos

Download the whole AIMSSEC collection of resources to use offline with the **AIMSSEC App** see https://aimssec.app or find it on Google Play.

Note: The Grades or School Years specified on the AIMING HIGH Website correspond to Grades 4 to 12 in South Africa and the USA, to Years 4 to 12 in the UK and school years up to Secondary 5 in East Africa.
New material will be added for Secondary 6.
For resources for teaching A level mathematics (Years 12 and 13) see https://nrich.maths.org/12339
Mathematics taught in Year 13 (UK) & Secondary 6 (East Africa) is beyond the SA CAPS curriculum for Grade 12

	Lower Primary Approx. Age 5 to 8	Upper Primary Age 8 to 11	Lower Secondary Age 11 to 15	Upper Secondary Age 15+
South Africa	Grades R and 1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
East Africa	Nursery and Primary 1 to 3	Primary 4 to 6	Secondary 1 to 3	Secondary 4 to 6
USA	Kindergarten and G1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
UK	Reception and Years 1 to 3	Years 4 to 6	Years 7 to 9	Years 10 to 13