

# Quad Quandary

## Optimisation/Trigonometry Investigative Task

### How Can I Use This Material?

In summary, if you work in a school, you can copy and/or modify it and use it with your students. We hope that this material will help you write your tests, worksheets, exams, presentations and any other educational materials. You cannot claim copyright over the material or present it as your own work.

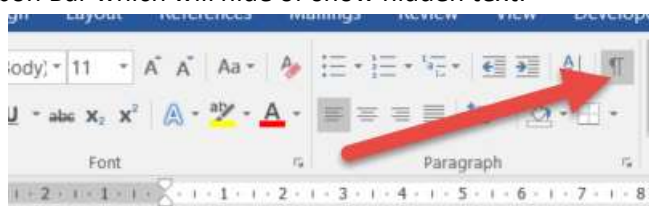
A full Acceptable Use FAQ is available on our website ([Acceptable Use FAQ](#)).

### How Do I Use The Videos?

1. Copy the link into your web browser.
2. Left clicks have a quiet click sound.
3. Right clicks have a loud click sound.

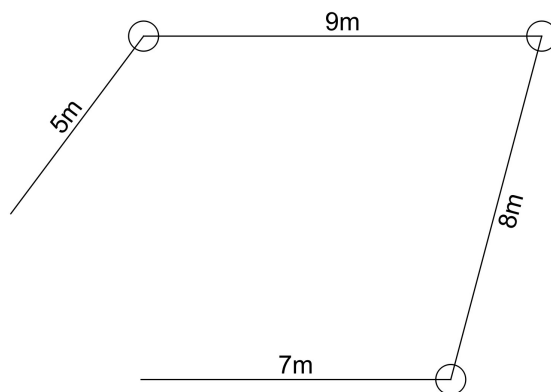
### Where Are The Solutions?

Solutions are only available in the Word docx format of the resources. Press this button on the Home Tab of the Ribbon Bar which will hide or show hidden text.



## Quad Quandary

A farmer has portable fence made of four sections that are joined together. The sections are 5m, 9m, 8m and 7m long IN THAT ORDER. **It is important to note that the order cannot be changed.**

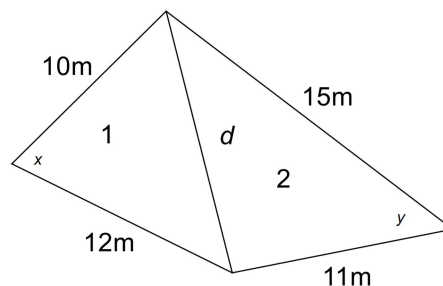


The sections are hinged together so that the shape can be changed and the 5m and 7m section can be joined to enclose a quadrilateral.

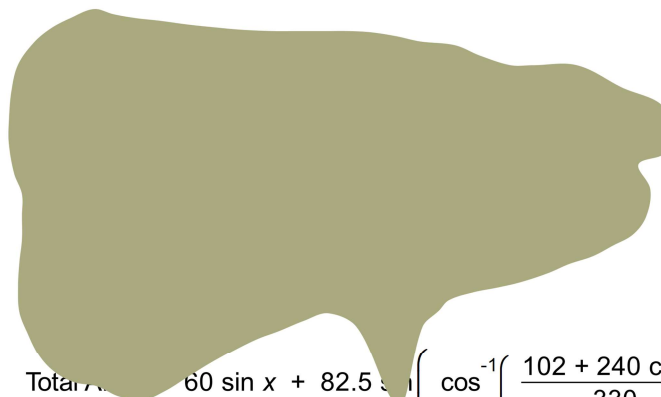
When the quadrilateral is formed, the sides can be moved to change the shape of the quadrilateral.

**Determine how the sections should be placed so that the area of the quadrilateral is maximised and what is the maximum possible area. You will need to calculate the angles between the sides.**

This is not as simple a problem as it first looks. You will need to perform multiple mathematical steps to find the maximum area and the angles that produce it. To help you, I have found part of a calculation a mathematical specialist performed for a different set of sections. Unfortunately, most of the important stuff has been obscured by a misplaced coffee stain but at least you should have something to work towards.

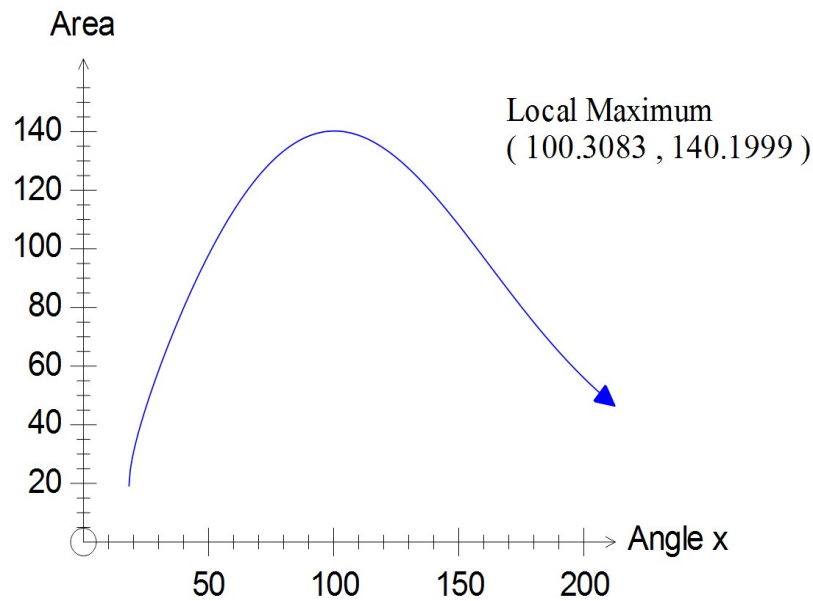


In triangle 1  $d^2 = 10^2 + 12^2 - 2 \times 10 \times 12 \cos x$

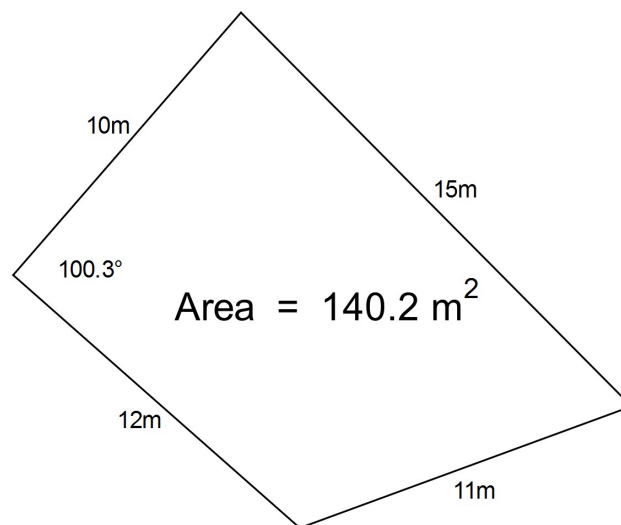


Total Area =  $60 \sin x + 82.5 \sin \left( \cos^{-1} \left( \frac{102 + 240 \cos x}{330} \right) \right)$

I also found this graph that the mathematical specialist has used. They must have used a graphics calculator to get it.



They also left this diagram as the design for the maximum area quadrilateral.



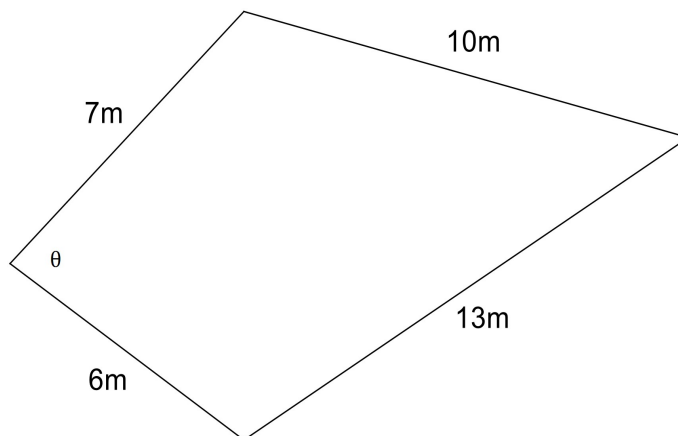
Use this information to determine the best quadrilateral for your farmer... Good luck!

There will be a validation test for this investigation.

# Quad Quandary – Validation Test

**Name:****/20**

A farmer had a different set of fence sections as shown below.



The farmer has found a formula for the area of this quadrilateral.

$$42\sin \theta + 130\sin \left( \cos^{-1} \left( \frac{184 + 84\cos \theta}{260} \right) \right)$$

but is getting answers that are twice as big as they should be

**1. What error has the farmer made?**

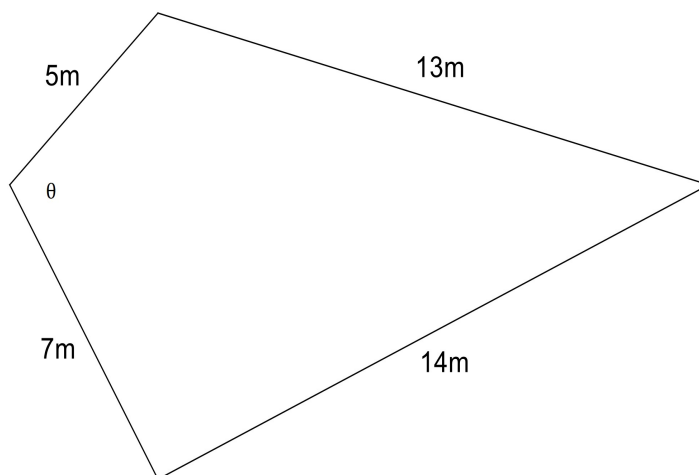
[1]

2. Write a corrected version of the formula.

[2]

---

Yet another farmer has found the following correct formula for yet another set of fences.



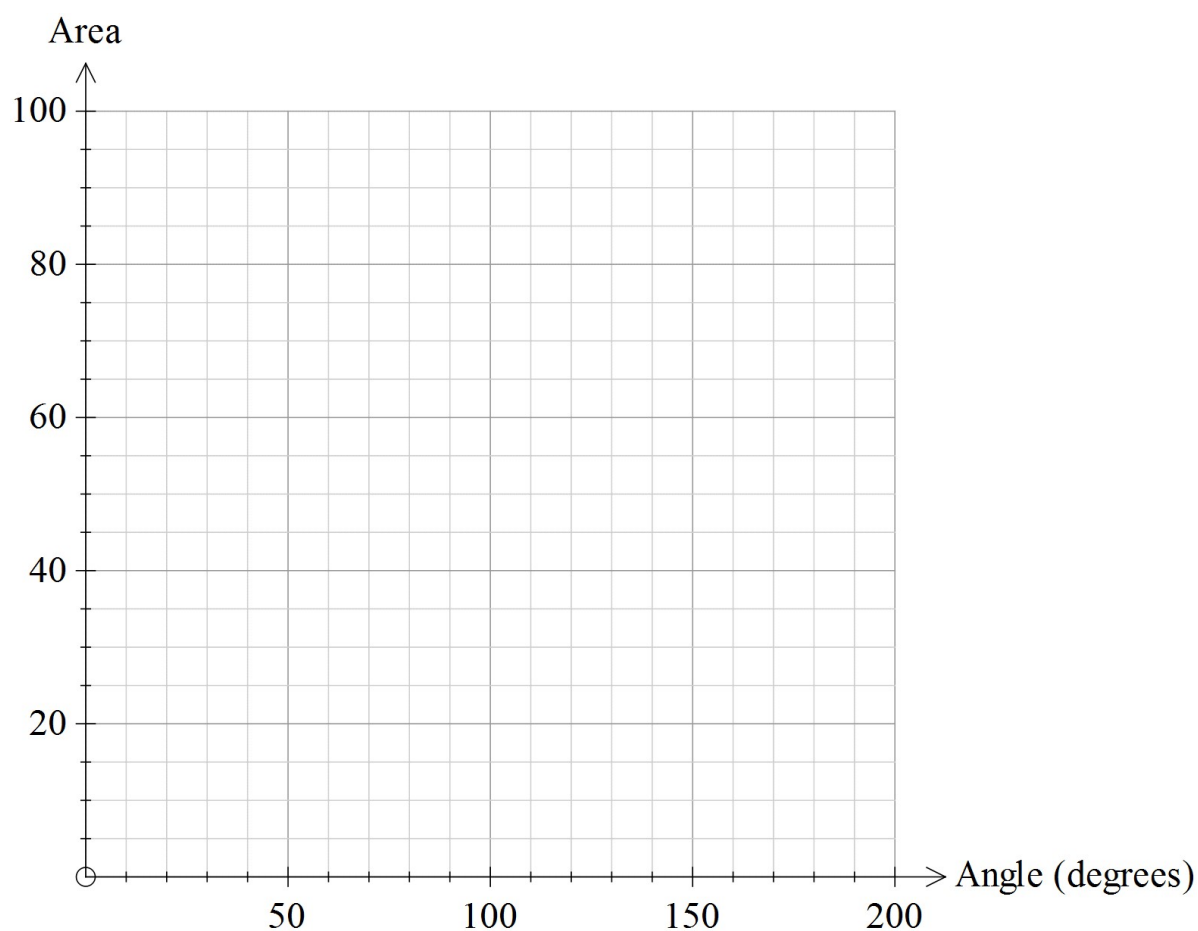
$$17.5\sin \theta + 91\sin \left( \cos^{-1} \left( \frac{291 + 70\cos \theta}{364} \right) \right)$$

3. Use the formula and your graphics calculator to complete this table of values for angles and areas.

Angle ( $\theta$ )	Area
$80^\circ$	
$100^\circ$	
$120^\circ$	
$140^\circ$	

[4]

4. Use your graphics calculator to help you sketch a graph of the angle/area curve on the set of axes below. Clearly show the coordinates of the maximum point.



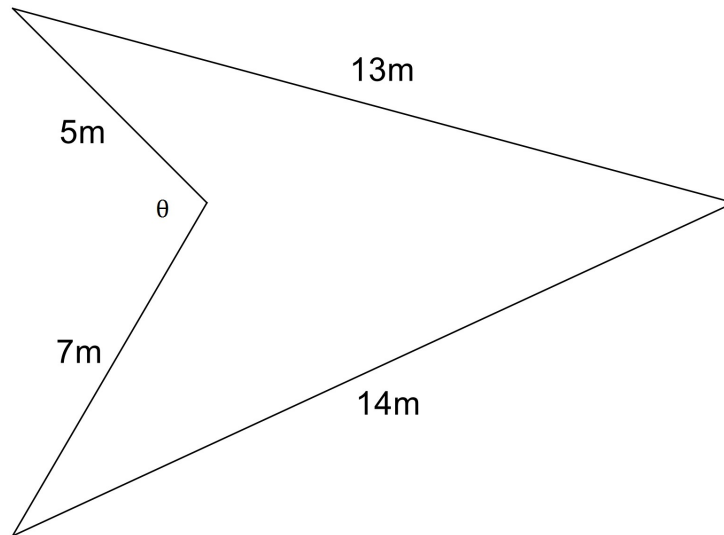
[5]

- 
5. *Translate what you have found into some meaningful instructions to the farmer that will allow them to set the fences correctly. Make sure that you clearly indicate the maximum area they can expect.*

[4]

6. *The farmer's worker misinterprets your instructions and sets the fences up as shown below – using your angle ( $\theta$ ) in the indicated location. What area will be enclosed by this arrangement?*

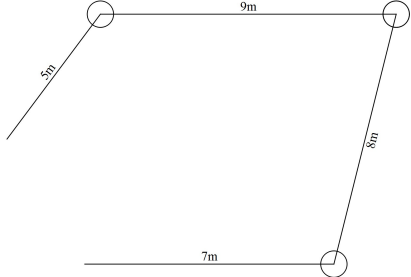
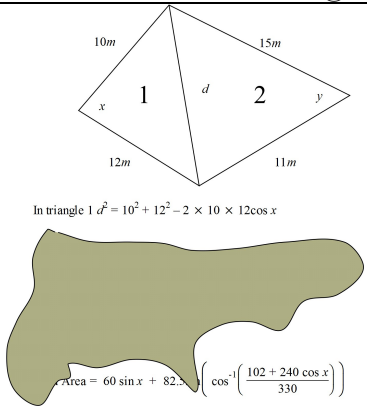
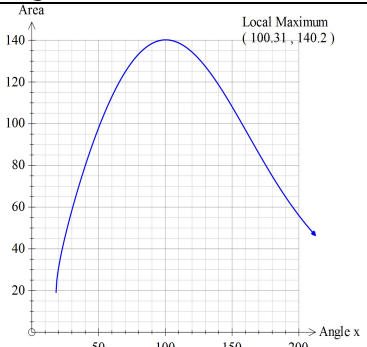
[4]



**End of Test**



## How We Drew the Diagrams

	<p><a href="http://www.youtube.com/v/Gc4l-Xxt3hU&amp;hd=1&amp;autoplay=1">http://www.youtube.com/v/Gc4l-Xxt3hU&amp;hd=1&amp;autoplay=1</a></p>
 <p>In triangle 1 <math>d^2 = 10^2 + 12^2 - 2 \times 10 \times 12 \cos x</math></p> <p>Area = <math>60 \sin x + 82.2 \left( \cos^{-1} \left( \frac{102 + 240 \cos x}{330} \right) \right)</math></p>	<p><a href="http://www.youtube.com/v/Utq2Fwsxadg&amp;hd=1&amp;autoplay=1">http://www.youtube.com/v/Utq2Fwsxadg&amp;hd=1&amp;autoplay=1</a></p>
	<p><a href="http://www.youtube.com/v/YqKwzWcTFDc&amp;hd=1&amp;autoplay=1">http://www.youtube.com/v/YqKwzWcTFDc&amp;hd=1&amp;autoplay=1</a></p>