STAGE 1 MATHEMATICAL APPLICATIONS

INVESTIGATION 1

Communication of Mathematical Information
The introduction points to appropriate communication of mathematical reasoning and ideas, as it outlines the problem to be explored and the application of the results of the investigation (although briefly).

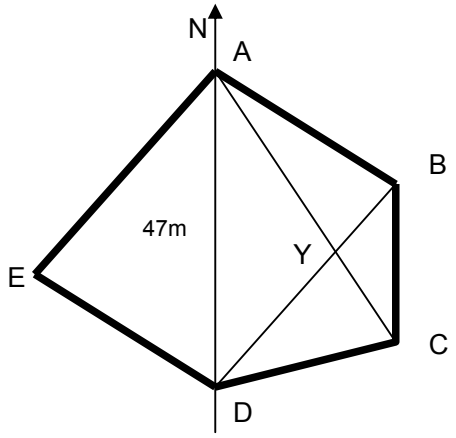
INTRODUCTION:

In this project, our aim is to mark out a hexagonal shaped block of land and measure a number of angles and distances within the shape. From this we calculate the approximate values of the area and the perimeter of the land using trigonometry formulae. After this, we will construct a scale diagram of our findings and compare our results with everyone else's the class. This is to minimise random errors. A real life application will then be used on the block e.g. calculating the cost of fencing the perimeter, or covering the area with grass.

Mathematical Knowledge and Skills and Their Application
Points to a first impression of limited effectiveness when applying knowledge and skills in this context – inaccurate application of knowledge of random errors.

RESULTS AND INTERPRETATION:

Firstly, a block of land was marked out on the oval using string and pegs to mark out the vertices, which were labelled A, B, C, D and E. Using a tape measure, the longest length between two corners within the shape was measured. This was called the base line, which was measured to be 47m. The shape of this block was as follows:



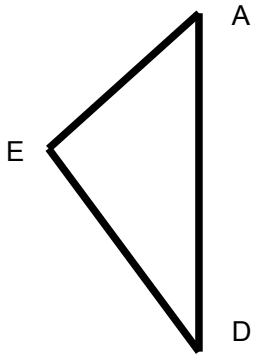
After this, 6 angles were measured using a theodolite. The first angle was the angle between the truth north line, and the line AB. The theodolite was placed on point A, with the 0 degree value pointing the same direction as the true north line. The string that went from point A to point B was pulled tight by one person, while the other person measured the angle using the theodolite. The string was pulled as tightly as possible so that accurate measurements could be recorded. This was measured to be 120 degrees. From the same position, the theodolite was used in the same manner to measure the angle between the true north line AC. From the same position again, the theodolite was used to measure the angle EAD. Except for this time, the 0 degree value was placed facing the line AE. From here, the theodolite was moved to point D, where 3 further angles were measured – ADB, ADC and the angle between the true north line and DE.

After these measurements were recorded by all groups, we then drew scale diagrams of our findings. The purpose of this was to minimise random errors. The scale used in our diagrams was 1cm = 5m. From this diagram we calculated the perimeter and area of the block.

Angle Degree
NAC 152
NAB 120
EAD 31
NDE 127
CDN 72
BDN 26

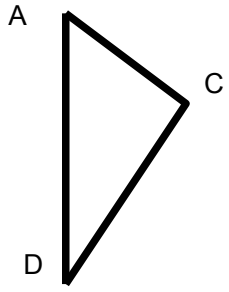
PERIMETER

For the perimeter, the left hand side of the shape was found first.

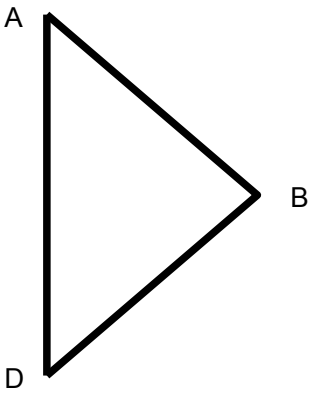


For side EA, the sine rule was used (Area = ½ a.b.sinC) as there were two angles and one side. For the side ED the sine rule was used again.

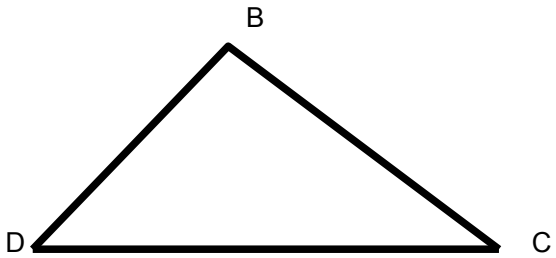
From this, the right side of the triangle was solved.



For DC, the sine rule was used as there were two angles and one side.



For side AB the sine rule was used once again as there were two angles and one side. The length of DB was then found as this was necessary to find the length of BC.



The length of BC was found using the cosine rule ($a^2 = b^2 + c^2 – 2.b.c.\cos A$) as there were two sides and the included angle.

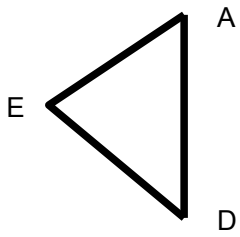
From this. all of the separate sides were added together to produce a total perimeter of 145.16m

Side Len gth
AB 20.65
BC 40.02
CD 22.41
DE 24.34
EA 37.74

Communication of Mathematical Information
Evidence of an attempt to use appropriate notation, but not consistently. Other evidence throughout the task needs to be considered as this may be just an omission from the heading of the table.

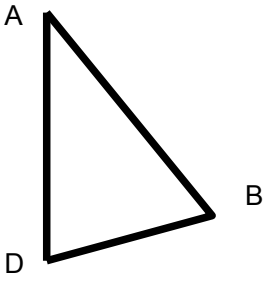
AREA

For the area, the hexagon was divided into three separate triangles.



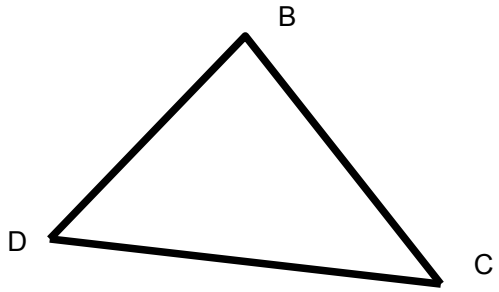
For the first triangle, the formula (A = ½ a.b.sinC) was used because there were two sides and the included angle of the triangle that was used.

Secondly, the triangle ABD was calculated.



The formula used was the same on that was used previously for triangle EAD.

Finally for triangle DBC the same formula was used again.



Following this, all three areas were added together to produce a total area of 1205.95 m^2.

RESULTS ANALYSIS

My answer

Area = 1205.95 m^2
Perimeter = 145.16 m

Teachers answer

Area = 1209.38 m^2
Perimeter = 145.16m

Margin of Error

For Area = 3.43 m^2
For Perimeter = 11.95 m

Percentage error

For Area = 0.28%
For Perimeter = 8.23%

Mathematical Modelling and Problem-solving
Displays evidence of generally appropriate interpretation of the mathematical results in the context of this problem.

My answer for the perimeter was quite far from the teacher yet my area was almost exactly the same. This indicates that I made an error when calculating my perimeter on paper, not outside when measuring.

There were also other factors that could have contributed to the differences in answers.

These include:

- Errors in judging angles on the theodolite. Also, errors in where the theodolite was placed.
- Instruments may not have been calibrated correctly
- The tape measure may have been twisted, saggy, or pulled too tight.

Mathematical Modelling and Problem-solving
Demonstrates some understanding of the reasonableness and possible limitations of the results, but provides little supporting evidence to substantiate the statements.

The results of the other groups were as follows:

Group 1:
Area = 1170.76 m^2
Perimeter = 135.64 m

Group 2:
Area = 1205.95 m^2
Perimeter = 145.16 m

Group 3:
Area = N/A m^2
Perimeter = N/A m

Group 4:
Area = 992.53 m^2
Perimeter = 128.24 m

Group 5:
Area = 992.35 m^2
Perimeter = 128.61m

Group 6:
Area = 148.87 m^2
Perimeter = 1423.36 m

APPLICATION

For the application, I chose to tile my block of land using stone tiles from Eureka Tiles Australia. The going rate for stone tiles is $14 per m^2, plus installation fee of $12 per m^2.

Altogether my area was 1205.95 m^2
Each square metre will cost $26.

26 x 1205.95
=
31,354.7

Therefore it will cost $31,354.70 to cover the hexagonal block of land with stone tiles.

CONCLUSION

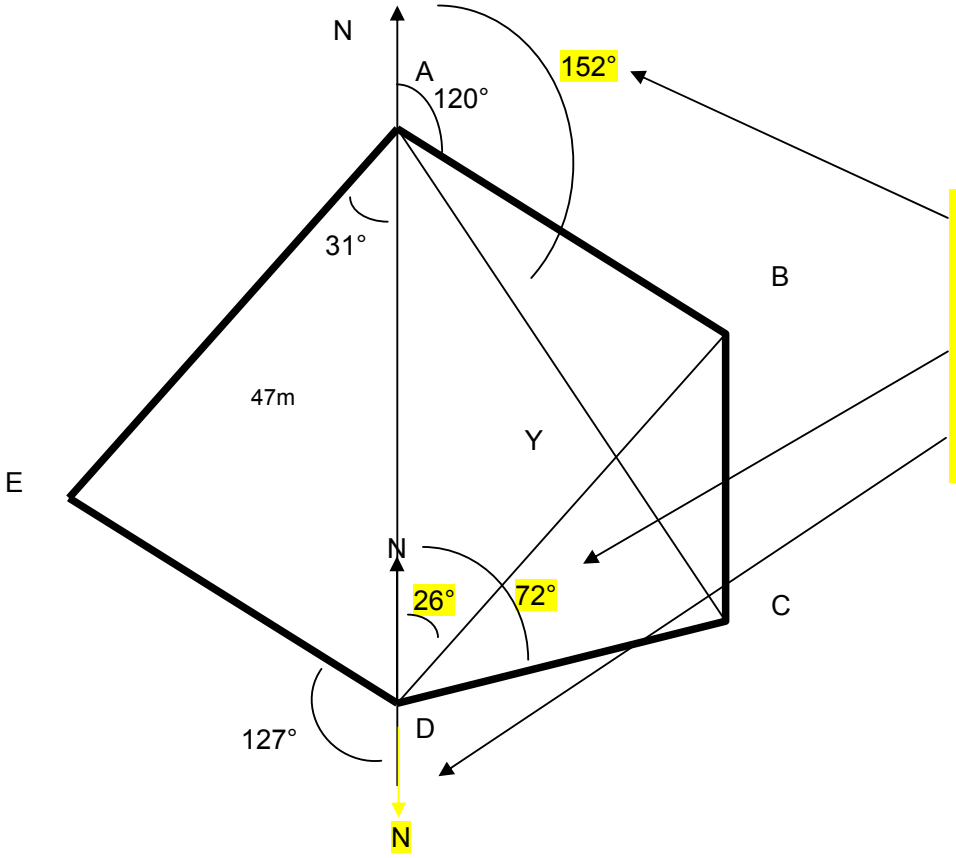
In conclusion, I believe that I have fulfilled all parts of this project. I have successfully calculated the perimeter and area of the block of land, with only a small margin on error. I have drawn a scale diagram and compared my results to other results in the class. I have also found out how much it would cost to pave the area of land. I have conveyed my understanding of the mathematical formulae needed to figure out the area and perimeter of this shape, and communicated my results in a tidy, organised manner.

Communication of Mathematical Information
Evidence of an attempt to summarise the steps undertaken in this investigation, but limited mathematical reasoning and ideas is used.

Triangulation Survey

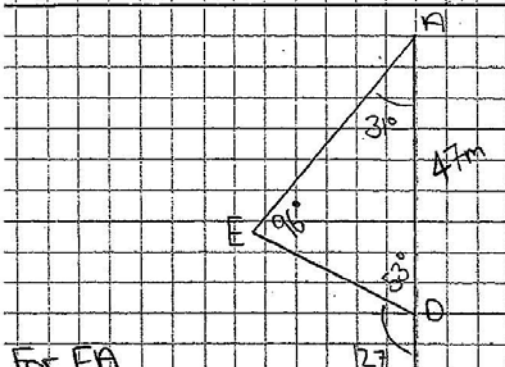
1cm = 5 m

$\frac{47}{5}$ = 9.4 cm



Communication of Mathematical Information
Mostly accurate use of appropriate notation, but the clarity of the representation of angles and the north arrow is inconsistent.

PERIMETER.



For EA

$$\frac{\sin E}{e} = \frac{\sin D}{d}$$

$$\frac{\sin 96}{47} = \frac{\sin 53}{d}$$

$$d = \frac{47 \times \sin 53}{\sin 96}$$

$$d = 37.74\text{m}.$$

For ED

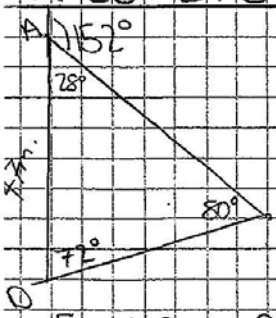
$$\frac{\sin E}{e} = \frac{\sin A}{a}$$

$$\frac{\sin 96}{47} = \frac{\sin 31}{a}$$

$$a = \frac{47 \times \sin 31}{\sin 96}$$

$$a = 24.34\text{m}.$$

$\therefore$ ED = 24.34m.



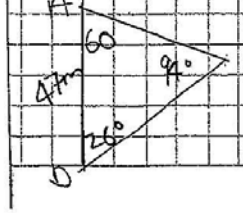
For DC. $\frac{\sin C}{c} = \frac{\sin A}{a}$

$$\frac{\sin 80}{47} = \frac{\sin 28}{a}$$

$$a = \frac{47 \times \sin 28}{\sin 80}$$

$$a = 22.41\text{m}.$$

$\therefore$ DC = 22.41m.



for AB

$$\frac{\sin B}{b} = \frac{\sin D}{d}$$

$$\frac{\sin 94}{47} = \frac{\sin 26}{d}$$

$$d = \frac{47 \times \sin 26}{\sin 94}$$

AB = 20.65m

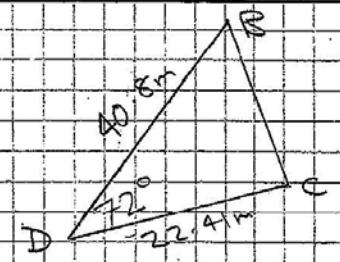
for DB (needed to find BC)

$$\frac{\sin D}{d} = \frac{\sin A}{a}$$

$$\frac{\sin 26}{20.65} = \frac{\sin 60}{a}$$

$$a = \frac{20.65 \times \sin 60}{\sin 26}$$

DB = 40.80m.



$$d^2 = b^2 + c^2 - 2bc \cdot \cos D$$

$$d^2 = 22.41^2 + 40.8^2 - 2 \times 22.41 \times 40.8 \times \cos$$

$$d^2 = 1601.76$$

$$d = 40.02\text{m}.$$

$\therefore$ BC = 40.02m.

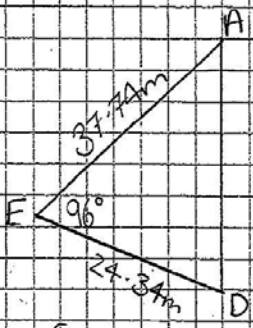
total perimeter

= 40.02 + 20.65 + 22.41 + 24.34 + 37.74

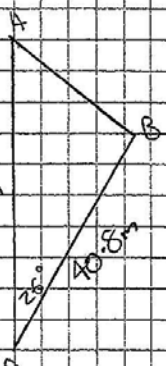
= 145.16m

$\therefore$ total perimeter = 145.16m.

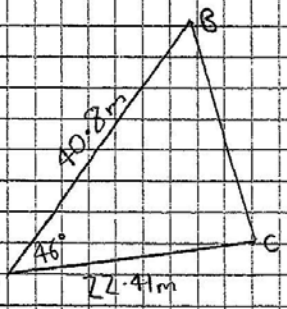
AREA.



$A = \frac{1}{2}absinC$
$A = \frac{1}{2} \times 24.34 \times 37.74 \times \sin 96$
$A = 456.78m^2$



$A = \frac{1}{2}absinC$
$A = \frac{1}{2} \times 40.8 \times 47 \times \sin 26$
$A = 420.31m^2$



$A = \frac{1}{2}absinC$
$A = \frac{1}{2} \times 22.41 \times 40.8 \times \sin 46$
$A = 328.86m^2$

total area = 328.86 + 420.31 + 456.78
= 1205.95m²

Total area = 1205.95m²

Additional comments

Observation would be used to assess the effectiveness of the contribution to group work.

Review of the responses provides evidence of:

- generally appropriate notation, representation, and terminology, with some inaccuracies
- the ability to develop and appropriately apply a mathematical model that leads to mostly accurate mathematical solutions in the applied context of this investigation
- application of knowledge and skills in the applied context of this problem
- appropriate selection and use of mathematical algorithms and techniques to find correct solutions to routine and/or complex problems.

PERFORMANCE STANDARDS FOR STAGE 1 MATHEMATICAL APPLICATIONS

	Mathematical Knowledge and Skills and Their Application	Mathematical Modelling and Problem-solving	Communication of Mathematical Information
A	Comprehensive knowledge of content and understanding of concepts and relationships. Appropriate selection and use of mathematical algorithms and techniques (implemented electronically where appropriate) to find efficient solutions to complex questions. Highly effective and accurate application of knowledge and skills to answer questions set in applied and theoretical contexts.	Development and effective application of mathematical models. Complete, concise, and accurate solutions to mathematical problems set in applied and theoretical contexts. Concise interpretation of the mathematical results in the context of the problem. In-depth understanding of the reasonableness and possible limitations of the interpreted results, and recognition of assumptions made.	Highly effective communication of mathematical ideas and reasoning to develop logical arguments. Proficient and accurate use of appropriate notation, representations, and terminology.
B	Some depth of knowledge of content and understanding of concepts and relationships. Use of mathematical algorithms and techniques (implemented electronically where appropriate) to find some correct solutions to complex questions. Accurate application of knowledge and skills to answer questions set in applied and theoretical contexts.	Attempted development and appropriate application of mathematical models. Mostly accurate and complete solutions to mathematical problems set in applied and theoretical contexts. Complete interpretation of the mathematical results in the context of the problem. Some depth of understanding of the reasonableness and possible limitations of the interpreted results, and recognition of assumptions made.	Effective communication of mathematical ideas and reasoning to develop mostly logical arguments. Mostly accurate use of appropriate notation, representations, and terminology.
C	Generally competent knowledge of content and understanding of concepts and relationships. Use of mathematical algorithms and techniques (implemented electronically where appropriate) to find mostly correct solutions to routine questions. Generally accurate application of knowledge and skills to answer questions set in applied and theoretical contexts.	Appropriate application of mathematical models. Some accurate and generally complete solutions to mathematical problems set in applied and theoretical contexts. Generally appropriate interpretation of the mathematical results in the context of the problem. Some understanding of the reasonableness and possible limitations of the interpreted results and some recognition of assumptions made.	Appropriate communication of mathematical ideas and reasoning to develop some logical arguments. Use of generally appropriate notation, representations, and terminology, with some inaccuracies.
D	Basic knowledge of content and some understanding of concepts and relationships. Some use of mathematical algorithms and techniques (implemented electronically where appropriate) to find some correct solutions to routine questions. Sometimes accurate application of knowledge and skills to answer questions set in applied or theoretical contexts.	Application of a mathematical model, with partial effectiveness. Partly accurate and generally incomplete solutions to mathematical problems set in applied or theoretical contexts. Attempted interpretation of the mathematical results in the context of the problem. Some awareness of the reasonableness and possible limitations of the interpreted results.	Some appropriate communication of mathematical ideas and reasoning. Some attempt to use appropriate notation, representations, and terminology, with occasional accuracy.
E	Limited knowledge of content. Attempted use of mathematical algorithms and techniques (implemented electronically where appropriate) to find limited correct solutions to routine questions. Attempted application of knowledge and skills to answer questions set in applied or theoretical contexts, with limited effectiveness.	Attempted application of a basic mathematical model. Limited accuracy in solutions to one or more mathematical problems set in applied or theoretical contexts. Limited attempt at interpretation of the mathematical results in the context of the problem. Limited awareness of the reasonableness and possible limitations of the results.	Attempted communication of emerging mathematical ideas and reasoning. Limited attempt to use appropriate notation, representations, or terminology, and with limited accuracy.