The diagram shows a triangle ABC in which AC = 17 cm. M is the midpoint of AC. Triangle ABM is equilateral.

1a. **Write down the size of angle MCB.**

**Markscheme**

30° (A1) (C3)

**Examiners report**

Part (a) was generally well answered with many candidates gaining full marks. Some candidates went on to make incorrect assumptions about triangle BMC being right angled and used Pythagoras theorem incorrectly. Those who used either the Sine rule or the Cosine rule correctly were generally able to substitute correctly and gain at least two marks.

1b. **Write down the length of BM in cm.**

**Markscheme**

8.5 (cm) (A1)

**Examiners report**

Part (a) was generally well answered with many candidates gaining full marks. Some candidates went on to make incorrect assumptions about triangle BMC being right angled and used Pythagoras theorem incorrectly. Those who used either the Sine rule or the Cosine rule correctly were generally able to substitute correctly and gain at least two marks.

1c. **Write down the size of angle BMC.**

**Markscheme**

120° (A1)

**Examiners report**

Part (a) was generally well answered with many candidates gaining full marks. Some candidates went on to make incorrect assumptions about triangle BMC being right angled and used Pythagoras theorem incorrectly. Those who used either the Sine rule or the Cosine rule correctly were generally able to substitute correctly and gain at least two marks.
Examiners report

Part (a) was generally well answered with many candidates gaining full marks. Some candidates went on to make incorrect assumptions about triangle BMC being right angled and used Pythagorus theorem incorrectly. Those who used either the Sine rule or the Cosine rule correctly were generally able to substitute correctly and gain at least two marks.

1d. Calculate the length of BC in cm. [3 marks]

Markscheme

\[
\text{BC} \quad \text{sin} \quad 120 \quad 8.5 \quad \text{sin} \quad 30
\]

\[
\text{BC} = 14.7 \left( \frac{\sqrt{3}}{2} \right) \quad \text{(AI)} \quad \text{(ft)}
\]

[3 marks]

Examiners report

Part (a) was generally well answered with many candidates gaining full marks. Some candidates went on to make incorrect assumptions about triangle BMC being right angled and used Pythagorus theorem incorrectly. Those who used either the Sine rule or the Cosine rule correctly were generally able to substitute correctly and gain at least two marks.

José stands 1.38 kilometres from a vertical cliff.

2a. Express this distance in metres. [1 mark]

Markscheme

1380 (m) \quad (AI) \quad (CI)

[1 mark]

Examiners report

This question was well answered by the majority of candidates although it was surprising to find some who could not express the given distance in metres. Where working was present, follow through marks could be awarded in the remainder of the question. Most candidates could give their answer correct to the nearest metre and find the percentage error correctly, using the formula. A common error was to use the calculated value in the denominator.

José estimates the angle between the horizontal and the top of the cliff as 28.3° and uses it to find the height of the cliff. [3 marks]

Find the height of the cliff according to José’s calculation. Express your answer in metres, to the nearest whole metre.
Markscheme

\[ 1380 \tan 28.3 \quad (MI) \]
\[ = 743.05 \ldots \quad (AI)(R) \]
\[ = 743 \quad (AI)(R) \quad (C3) \]

Notes: Award \((M1)\) for correct substitution in tan formula or equivalent, \((AI)(R)\) for their 743.05 seen, \((AI)(R)\) for their answer correct to the nearest m.

[3 marks]

Examiners report

This question was well answered by the majority of candidates although it was surprising to find some who could not express the given distance in metres. Where working was present, follow through marks could be awarded in the remainder of the question. Most candidates could give their answer correct to the nearest metre and find the percentage error correctly, using the formula. A common error was to use the calculated value in the denominator.

José estimates the angle between the horizontal and the top of the cliff as 28.3° and uses it to find the height of the cliff. \[2c.\]

The actual height of the cliff is 718 metres. Calculate the percentage error made by José when calculating the height of the cliff.

Markscheme

\[ \text{percentage error} = \frac{743.05 \ldots - 718}{718} \times 100 \quad (MI) \]

Note: Award \((M1)\) for correct substitution in formula.

\[ = 3.49 \% \quad (% \text{ symbol not required}) \quad (AI)(R) \quad (C2) \]

Notes: Accept 3.48 \% for use of 743.
Accept negative answer.

[2 marks]

Examiners report

This question was well answered by the majority of candidates although it was surprising to find some who could not express the given distance in metres. Where working was present, follow through marks could be awarded in the remainder of the question. Most candidates could give their answer correct to the nearest metre and find the percentage error correctly, using the formula. A common error was to use the calculated value in the denominator.
The diagram shows triangle ABC. Point C has coordinates (4, 7) and the equation of the line AB is \( x + 2y = 8 \).

3a. Find the coordinates of A. [1 mark]

**Markscheme**

A(0, 4)  \( \text{Accept } x = 0, y = 4 \)  \( \text{(AI) } (A1) \)

[1 mark]

**Examiners report**

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.

3b. Find the coordinates of B. [1 mark]

**Markscheme**

B(8, 0)  \( \text{Accept } x = 8, y = 0 \)  \( \text{(AI)(ft)} \)

**Note:** Award \( \text{(A1) } \) if coordinates are reversed in (i) and \( \text{(AI)(ft)} \) in (ii).

[1 mark]

**Examiners report**

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.

3c. Show that the distance between A and B is 8.94 correct to 3 significant figures. [2 marks]
Markscheme

AB = √(8² + 4²) = √80 \hspace{1cm} (M1)

AB ≈ 8.944 \hspace{1cm} (A1)

≈ 8.94 \hspace{1cm} (AG)

[2 marks]

Examiners report

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.

N lies on the line AB. The line CN is perpendicular to the line AB.

Find the gradient of CN.

Markscheme

y = –0.5x + 4 \hspace{1cm} (M1)

Gradient AB = –0.5 \hspace{1cm} (A1)

Note: Award (A2) if –0.5 seen.

OR

Gradient AB = \frac{(0-4)}{(8-0)} \hspace{1cm} (M1)

= –\frac{1}{2} \hspace{1cm} (A1)

Note: Award (M1) for correct substitution in the gradient formula. Follow through from their answers to part (a).

Gradient CN = 2 \hspace{1cm} (A1)(B1)(G2)

Note: Special case: Follow through for gradient CN from their gradient AB.

[3 marks]

Examiners report

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.

N lies on the line AB. The line CN is perpendicular to the line AB.

Find the equation of CN.

3d. [3 marks]

N lies on the line AB. The line CN is perpendicular to the line AB.

Find the gradient of CN.

Markscheme

y = –0.5x + 4 \hspace{1cm} (M1)

Gradient AB = –0.5 \hspace{1cm} (A1)

Note: Award (A2) if –0.5 seen.

OR

Gradient AB = \frac{(0-4)}{(8-0)} \hspace{1cm} (M1)

= –\frac{1}{2} \hspace{1cm} (A1)

Note: Award (M1) for correct substitution in the gradient formula. Follow through from their answers to part (a).

Gradient CN = 2 \hspace{1cm} (A1)(B1)(G2)

Note: Special case: Follow through for gradient CN from their gradient AB.

[3 marks]

Examiners report

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.
Markscheme

CN: $y = 2x + c$
$7 = 2(4) + c \quad (M1)$

**Note:** Award $(M1)$ for correct substitution in equation of a line.

$y = 2x - 1 \quad (A1)(ft)(G2)$

**Note:** Accept alternative forms for the equation of a line including $y - 7 = 2(x - 4)$. Follow through from their gradient in (i).

**Note:** If $c = -1$ seen but final answer is not given, award $(A1)(d)$.

**[2 marks]**

Examiners report

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.

3f. N lies on the line AB. The line CN is perpendicular to the line AB. Calculate the coordinates of N. 

**Markscheme**

$x + 2(2x - 1) = 8 \quad or \quad equivalent \quad (MI)$

N(2, 3) $(x = 2, \; y = 3) \quad (A1)(A1)(ft)(G3)$

**Note:** Award $(M1)$ for attempt to solve simultaneous equations or a sketch of the two lines with an indication of the point of intersection.

**[3 marks]**

Examiners report

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.

3g. It is known that $AC = 5$ and $BC = 8.06$. Calculate the size of angle ACB.

**[3 marks]**
Examiners report

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.

3h. It is known that $AC = 5$ and $BC = 8.06$. Calculate the area of triangle ACB.

Markscheme

\[ \text{Area } ACB = \frac{5 \times 8.06 \sin(82.9^\circ)}{2} \]  

\text{(AI)(G2)}

Note: Accept $82.8^\circ$ with use of 8.94.

[3 marks]

Examiners report

This question had many correct solutions, but a large number of candidates were unable to follow the logical flow of the question to the end and many gave up. It should be pointed out to future candidates that parts (e) and (f) could be attempted independently from the rest and that care must be taken not to abandon hope too early in the longer questions of paper 2.
4a. Write down the length of VA in metres. [1 mark]

**Markscheme**

22.5 (m) (A1)

[1 mark]

**Examiners report**

This question also caused many problems for the candidature. There seems to be a lack of ability in visualising a problem in three dimensions – clearly, further exposure to such problems is needed by the students. Further, as in question 2, the final two parts of the question were independent of those preceding them; many candidates did not reach these parts, though for some, these were the only parts of the question attempted. There is also a lack of awareness of the appropriate volume formula on the formula sheet to use.

4b. Sketch the triangle VCA showing clearly the length of VC and the size of angle VCA. [1 mark]

**Markscheme**

(A1)

[1 mark]

**Examiners report**

This question also caused many problems for the candidature. There seems to be a lack of ability in visualising a problem in three dimensions – clearly, further exposure to such problems is needed by the students. Further, as in question 2, the final two parts of the question were independent of those preceding them; many candidates did not reach these parts, though for some, these were the only parts of the question attempted. There is also a lack of awareness of the appropriate volume formula on the formula sheet to use.

4c. Show that the height of the pyramid is 18.0 metres correct to 3 significant figures. [2 marks]

The diagram shows an office tower of total height 126 metres. It consists of a square based pyramid VABCD on top of a cuboid ABCDPQRS.

V is directly above the centre of the base of the office tower.

The length of the sloping edge VC is 22.5 metres and the angle that VC makes with the base ABCD (angle VCA) is 53.1°.
Markscheme

\[ h = 22.5 \sin 53.1° \quad (MI) \]
\[ = 17.99 \quad (AI) \]
\[ = 18.0 \quad (AG) \]

Note: Unrounded answer must be seen for (AI) to be awarded. Accept 18 as (AG).

[2 marks]

Examiners report

This question also caused many problems for the candidature. There seems to be a lack of ability in visualising a problem in three dimensions – clearly, further exposure to such problems is needed by the students. Further, as in question 2, the final two parts of the question were independent of those preceding them; many candidates did not reach these parts, though for some, these were the only parts of the question attempted. There is also a lack of awareness of the appropriate volume formula on the formula sheet to use.

4d. Calculate the length of AC in metres. [3 marks]

Markscheme

\[ AC = 2\sqrt{22.5^2 - 17.99^2} \quad (MI)(MI) \]

Note: Award (MI) for multiplying by 2, (MI) for correct substitution into formula.

OR

\[ AC = 2(22.5)\cos 53.1° \quad (MI)(MI) \]

Notes: Award (MI) for correct use of cosine trig ratio, (MI) for multiplying by 2.

OR

\[ AC^2 = 22.5^2 + 22.5^2 - 2(22.5)(22.5) \cos 73.8° \quad (MI)(A1) \]

Note: Award (MI) for substituted cosine formula, (A1) for correct substitutions.

OR

\[ \frac{AC}{\sin(73.8°)} = \frac{22.5}{\sin(53.1°)} \quad (MI)(A1) \]

Note: Award (MI) for substituted sine formula, (A1) for correct substitutions.

\[ AC = 27.0 \quad (A1)(G2) \]

[3 marks]

Examiners report

This question also caused many problems for the candidature. There seems to be a lack of ability in visualising a problem in three dimensions – clearly, further exposure to such problems is needed by the students. Further, as in question 2, the final two parts of the question were independent of those preceding them; many candidates did not reach these parts, though for some, these were the only parts of the question attempted. There is also a lack of awareness of the appropriate volume formula on the formula sheet to use.
4e. Show that the length of BC is 19.1 metres correct to 3 significant figures.

**Markscheme**

\[ BC = \sqrt{13.5^2 + 13.5^2} \quad (MI) \]

\[ = 19.09 \quad (AI) \]

\[ = 19.1 \quad (AG) \]

**OR**

\[ x^2 + x^2 = 27^2 \quad (MI) \]

\[ 2x^2 = 27^2 \quad (AI) \]

\[ BC = 19.09\ldots \quad (AI) \]

\[ = 19.1 \quad (AG) \]

**Notes:** Unrounded answer must be seen for (AI) to be awarded.

[2 marks]

**Examiners report**

This question also caused many problems for the candidature. There seems to be a lack of ability in visualising a problem in three dimensions – clearly, further exposure to such problems is needed by the students. Further, as in question 2, the final two parts of the question were independent of those preceding them; many candidates did not reach these parts, though for some, these were the only parts of the question attempted. There is also a lack of awareness of the appropriate volume formula on the formula sheet to use.

4f. Calculate the volume of the tower.

**Markscheme**

Volume = Pyramid + Cuboid

\[ \frac{1}{3}(18)(19.1^2) + (108)(19.1^2) \quad (AI)(MI)(MI) \]

**Note:** Award (AI) for 108, the height of the cuboid seen. Award (MI) for correctly substituted volume of cuboid and (MI) for correctly substituted volume of pyramid.

\[ = 41588 \quad (41553 \text{ if } 2(13.5^2) \text{ is used}) \]

\[ = 41600 \text{ m}^3 \quad (AI)(ft)(G3) \]

[4 marks]

**Examiners report**

This question also caused many problems for the candidature. There seems to be a lack of ability in visualising a problem in three dimensions – clearly, further exposure to such problems is needed by the students. Further, as in question 2, the final two parts of the question were independent of those preceding them; many candidates did not reach these parts, though for some, these were the only parts of the question attempted. There is also a lack of awareness of the appropriate volume formula on the formula sheet to use.

4g. To calculate the cost of air conditioning, engineers must estimate the weight of air in the tower. They estimate that 90% of the volume of the tower is occupied by air and they know that 1 m$^3$ of air weighs 1.2 kg.

Calculate the weight of air in the tower.
Markscheme

Weight of air = 41,600 \times 1.2 \times 0.9 \quad (M1)(M1)
= 44,900 kg \quad (A1)(ft)(G2)

Note: Award (M1) for their part (e) \times 1.2, (M1) for \times 0.9.
Award at most (M1)(M1)(A0) if the volume of the cuboid is used.

[3 marks]

Examiners report

This question also caused many problems for the candidature. There seems to be a lack of ability in visualising a problem in three dimensions – clearly, further exposure to such problems is needed by the students. Further, as in question 2, the final two parts of the question were independent of those preceding them; many candidates did not reach these parts, though for some, these were the only parts of the question attempted. There is also a lack of awareness of the appropriate volume formula on the formula sheet to use.

The base of a prism is a regular hexagon. The centre of the hexagon is O and the length of OA is 15 cm.

5a. Write down the size of angle AOB.  

Markscheme

60° \quad (A1) \quad (C1)

[1 mark]

Examiners report

This question proved to be difficult for a number of candidates. Most were able find the size of the angle in part a), but many had problems finding the area of the triangle in part b). A significant number of candidates were unable to use the Pythagoras Theorem correctly to find the height of the triangle AOB. Those who used the formula for the area of a triangle \( A = \frac{1}{2}ab \sin C \) were more successful in this part of the question. It was surprising that a great number of candidates were unable to find the volume of the prism – many incorrectly used the formula for calculating volume of a pyramid rather than a hexagonal prism.

5b. Find the area of the triangle AOB.  

[3 marks]
**Markscheme**

\[
\frac{15 \times \sqrt{19^2 - 7.5^2}}{2} = 97.4 \text{ cm}^2 \quad (A1)(M1)(A1)
\]

**Notes:** Award \((A1)\) for correct height, \((M1)\) for substitution in the area formula, \((A1)\) for correct answer.

Accept 97.5 cm\(^2\) from taking the height to be 13 cm.

**OR**

\[
\frac{1}{2} \times 15^2 \times \sin 60^\circ = 97.4 \text{ cm}^2 
\]

**Notes:** Award \((M1)\) for substituted formula of the area of a triangle, \((A1)\) for correct substitution, \((A1)(R)\) for answer.

Follow through from their answer to part (a).

If radians used award at most \((M1)(A1)(A0)\).

**[3 marks]**

**Examiners report**

This question proved to be difficult for a number of candidates. Most were able find the size of the angle in part a), but many had problems finding the area of the triangle in part b). A significant number of candidates were unable to use the Pythagoras Theorem correctly to find the height of the triangle AOB. Those who used the formula for the area of a triangle \(A = \frac{1}{2}ab \sin C\) were more successful in this part of the question. It was surprising that a great number of candidates were unable to find the volume of the prism – many incorrectly used the formula for calculating volume of a pyramid rather than a hexagonal prism.

**5c.** The height of the prism is 20 cm.

Find the volume of the prism.

**Markscheme**

\[97.4 \times 120 = 11700 \text{ cm}^3 \quad (M1)(A1)(R) \quad (C2)\]

**Notes:** Award \((M1)\) for multiplying their part (b) by 120.

**[2 marks]**
**Examiners report**

This question proved to be difficult for a number of candidates. Most were able find the size of the angle in part a), but many had problems finding the area of the triangle in part b). A significant number of candidates were unable to use the Pythagoras Theorem correctly to find the height of the triangle AOB. Those who used the formula for the area of a triangle \( A = \frac{1}{2}ab \sin C \) were more successful in this part of the question. It was surprising that a great number of candidates were unable to find the volume of the prism – many incorrectly used the formula for calculating volume of a pyramid rather than a hexagonal prism.

In the diagram below A, B and C represent three villages and the line segments AB, BC and CA represent the roads joining them. The lengths of AC and CB are 10 km and 8 km respectively and the size of the angle between them is 150°.

6a. Find the length of the road AB. [3 marks]

**Markscheme**

\[
AB^2 = 10^2 + 8^2 - 2 \times 10 \times 8 \times \cos 150° \quad (MI)(A1)
\]

\[
AB = 17.4 \text{ km} \quad (A1)(G2)
\]

**Note:** Award (MI) for substitution into correct formula, (AI) for correct substitution, (AI) for correct answer. [3 marks]

**Examiners report**

The weak students answered parts (a) and (b) using right-angled trigonometry. Different types of mistakes were seen in (a) when applying the cosine rule: some forgot to square root their answer and others calculated each part separately and then missed the 2 minuses. Part (b) was better done than (a). Follow through was applied from (a) to (c). Part (d) was not well done. Most of the students lost one mark in this part question as they did not show the unrounded answer (2.0550...). Part (e) was fairly well done by those who attempted it. In (f) there were very few correct answers. Students found it difficult to find the time when the average speed and distance were given.

6b. Find the size of the angle CAB. [3 marks]

**Markscheme**

\[
\frac{8}{\sin \angle CAB} = \frac{17.4}{\sin 150°} \quad (MI)(A1)
\]

\[
\angle CAB = 13.3° \quad (AI)(R)(G2)
\]

**Notes:** Award (MI) for substitution into correct formula, (AI) for correct substitution, (AI) for correct answer. Follow through from their answer to part (a). [3 marks]
Examiners report

The weak students answered parts (a) and (b) using right-angled trigonometry. Different types of mistakes were seen in (a) when applying the cosine rule: some forgot to square root their answer and others calculated each part separately and then missed the 2 minuses. Part (b) was better done than (a). Follow through was applied from (a) to (c). Part (d) was not well done. Most of the students lost one mark in this part question as they did not show the unrounded answer (2.0550...). Part (e) was fairly well done by those who attempted it. In (f) there were very few correct answers. Students found it difficult to find the time when the average speed and distance were given.

Village D is halfway between A and B. A new road perpendicular to AB and passing through D is built. Let T be the point where this road cuts AC. This information is shown in the diagram below.

![Diagram not to scale](image)

Write down the distance from A to D.

Markscheme

AD = 8.70 km (8.7 km)  

Note: Follow through from their answer to part (a).

[1 mark]

Examiners report

The weak students answered parts (a) and (b) using right-angled trigonometry. Different types of mistakes were seen in (a) when applying the cosine rule: some forgot to square root their answer and others calculated each part separately and then missed the 2 minuses. Part (b) was better done than (a). Follow through was applied from (a) to (c). Part (d) was not well done. Most of the students lost one mark in this part question as they did not show the unrounded answer (2.0550...). Part (e) was fairly well done by those who attempted it. In (f) there were very few correct answers. Students found it difficult to find the time when the average speed and distance were given.

Show that the distance from D to T is 2.06 km correct to three significant figures.

Markscheme

DT = \tan (13.29...°) \times 8.697... = 2.0550...  

= 2.06  

[1 mark]

[2 marks]
Examiners report

The weak students answered parts (a) and (b) using right-angled trigonometry. Different types of mistakes were seen in (a) when applying the cosine rule: some forgot to square root their answer and others calculated each part separately and then missed the 2 minuses. Part (b) was better done than (a). Follow through was applied from (a) to (c). Part (d) was not well done. Most of the students lost one mark in this part question as they did not show the unrounded answer (2.0550...). Part (e) was fairly well done by those who attempted it. In (f) there were very few correct answers. Students found it difficult to find the time when the average speed and distance were given.

6e. A bus starts and ends its journey at A taking the route AD to DT to TA. Find the total distance for this journey. [3 marks]

Markscheme

\[ \sqrt{8.70^2 + 2.06^2 + 8.70 + 2.06} \quad (A1)(M1) \]
\[ = 19.7 \text{ km} \quad (A1)(ft)(G2) \]

Note: Award (A1) for AT, (M1) for adding the three sides of the triangle ADT, (A1)(ft) for answer. Follow through from their answer to part (c).

[3 marks]

Examiners report

The weak students answered parts (a) and (b) using right-angled trigonometry. Different types of mistakes were seen in (a) when applying the cosine rule: some forgot to square root their answer and others calculated each part separately and then missed the 2 minuses. Part (b) was better done than (a). Follow through was applied from (a) to (c). Part (d) was not well done. Most of the students lost one mark in this part question as they did not show the unrounded answer (2.0550...). Part (e) was fairly well done by those who attempted it. In (f) there were very few correct answers. Students found it difficult to find the time when the average speed and distance were given.

6f. The average speed of the bus while it is moving on the road is 70 km h\(^{-1}\). The bus stops for 5 minutes at each of D and T. [4 marks]

Estimate the time taken by the bus to complete its journey. Give your answer correct to the nearest minute.

Markscheme

\[ \frac{19.7}{70} \times 60 + 10 \quad (M1)(M1) \]
\[ = 26.9 \quad (A1)(ft) \]

Note: Award (M1) for time on road in minutes, (M1) for adding 10, (A1)(ft) for unrounded answer. Follow through from their answer to (e).

\[ = 27 \text{ (nearest minute)} \quad (A1)(ft)(G3) \]

Note: Award (A1)(ft) for their unrounded answer given to the nearest minute.

[4 marks]
A gardener has to pave a rectangular area 15.4 metres long and 5.5 metres wide using rectangular bricks. The bricks are 22 cm long and 11 cm wide.

7a. Calculate the total area to be paved. Give your answer in cm².

**Markscheme**

\[
15.4 \times 5.5 \quad (M1)
\]

\[
84.7 \text{ m}^2 \quad (A1)
\]

\[
= 847000 \text{ cm}^2 \quad (A1)(G3)
\]

**Note:** Award (G2) if 84.7 m² seen with no working.

**OR**

\[
1540 \times 550 \quad (A1)(M1)
\]

\[
= 847000 \text{ cm}^2 \quad (A1)(R)(G3)
\]

**Note:** Award (A1) for both dimensions converted correctly to cm, (M1) for multiplication of both dimensions. (A1)(R) for correct product of their sides in cm.

**Examiners report**

Part (a) was well done except for the fact that very few students were able to convert correctly from m² to cm² and this was very disappointing.

7b. Write down the area of each brick.

**Markscheme**

\[
242 \text{ cm}^2 \quad (A1)
\]

\[
(0.0242 \text{ m}^2) \quad (A1)
\]

**[1 marks]**

**Examiners report**

Part (a) was well done except for the fact that very few students were able to convert correctly from m² to cm² and this was very disappointing.

7c. Find how many bricks are required to pave the total area.

**Markscheme**

\[
\frac{847000}{242} \quad (A1)(M1)
\]

\[
= 3520 \quad (A1)
\]

**[2 marks]**
The gardener decides to have a triangular lawn ABC, instead of paving, in the middle of the rectangular area, as shown in the diagram below.

The distance AB is 4 metres, AC is 6 metres and angle BAC is 40°.

7d. Find the length of BC.  [3 marks]

**Markscheme**

\[
BC^2 = 4^2 + 6^2 - 2 \times 4 \times 6 \times \cos 40° \quad (M1)(A1)
\]

\[
BC = 3.90 \text{ m} \quad (A1)(G2)
\]

**Note:** Award (M1) for correct substituted formula, (A1) for correct substitutions, (A1) for correct answer.

[3 marks]

**Examiners report**

In part (b) the cosine rule and the area of a triangle were well done. In some cases units were missing and therefore a unit penalty was applied.

7e. Hence write down the perimeter of the triangular lawn.  [1 mark]

**Markscheme**

\[
\text{perimeter} = 13.9 \text{ m} \quad (A1)(ft)(G1)
\]

**Notes:** Follow through from part (b) (i).
In part (b) the cosine rule and the area of a triangle were well done. In some cases units were missing and therefore a unit penalty was applied.

7f. Calculate the area of the lawn. 

**Markscheme**

\[
\text{Area} = \frac{1}{2} \times 4 \times 6 \times \sin 40^\circ \quad (MI)
\]

= 7.71 m² \quad (A1)(ft)(G2)

**Notes:** Award (MI) for correct formula and correct substitution, (A1)(ft) for correct answer.

[2 marks]

Examiners report

In part (b) the cosine rule and the area of a triangle were well done. In some cases units were missing and therefore a unit penalty was applied.

7g. Find the percentage of the rectangular area which is to be lawn.

**Markscheme**

\[
\frac{7.71}{84.7} \times 100 \% = 9.11 \% \quad (A1)(MI)(A1)(ft)(G2)
\]

**Notes:** Accept 9.10 %.

Award (A1) for both measurements correctly written in the same unit, (MI) for correct method, (A1)(ft) for correct answer.

Follow through from (b) (iii) and from consistent error in conversion of units throughout the question.

[3 marks]

Examiners report

In part (b) the cosine rule and the area of a triangle were well done. In some cases units were missing and therefore a unit penalty was applied.
In another garden, twelve of the same rectangular bricks are to be used to make an edge around a small garden bed as shown in the diagrams below. FH is the length of a brick and C is the centre of the garden bed. M and N are the midpoints of the long edges of the bricks on opposite sides of the garden bed.

7h. Find the angle FCH. [2 marks]

Markscheme
\[
\frac{360}{12} \quad (MI) \\
= 30^\circ \quad (A1)(G2) \\
\]
[2 marks]

Examiners report
Part (c) was clearly the most difficult one for the students. The general impression was that they did not read the diagram in detail. A number of candidates could not distinguish the circle from the triangle and hence used an incorrect method to find the radius.

7i. Calculate the distance MN from one side of the garden bed to the other, passing through C. [3 marks]

Markscheme
\[
MN = 2 \times \frac{11}{\tan 15} \quad (A1)(ft)(MI) \\
OR \\
MN = 2 \times 11 \tan 75^\circ \\
MN = 82.1 \text{ cm} \quad (A1)(ft)(G2) \\
\]

Notes: Award (A1) for 11 and 2 seen (implied by 22 seen), (MI) for dividing by tan15 (or multiplying by tan 75).
Follow through from their angle in part (c) (i).

[3 marks]

Examiners report
Part (c) was clearly the most difficult one for the students. The general impression was that they did not read the diagram in detail. A number of candidates could not distinguish the circle from the triangle and hence used an incorrect method to find the radius.

The garden bed has an area of 5419 cm$^2$. It is covered with soil to a depth of 2.5 cm.

7j. Find the volume of soil used. [2 marks]
Markscheme
\[
\text{volume} = 5419 \times 2.5 \quad (M1)
\]
\[
= 13500 \text{ cm}^3 \quad (A1)(G2)
\]
[2 marks]

Examiners report
It was pleasing to see candidates recovering well to get full marks for the last two parts.

It is estimated that 1 kilogram of soil occupies 514 cm\(^3\).

7k.
Find the number of kilograms of soil required for this garden bed. [2 marks]

Markscheme
\[
\frac{13547.34 \ldots}{514} = 26.4 \quad (M1)(A1)(\text{ft})(G2)
\]

Note: Award (M1) for dividing their part (d) by 514.
Accept 26.3.

[2 marks]

Examiners report
It was pleasing to see candidates recovering well to get full marks for the last two parts.

The diagram shows triangle ABC in which \(AB = 28\) cm, \(BC = 13\) cm, \(BD = 12\) cm and \(AD = 20\) cm.

8a. Calculate the size of angle ADB. [3 marks]

\[
\cos ADB = \frac{12^2 + 20^2 - 28^2}{2(12)(20)}
\]
8b. Find the area of triangle ADB. [3 marks]

**Markscheme**

\[
\text{Area} = \frac{(12)(20) \sin 120^\circ}{2} \quad (M1)(A1)\]

Notes: Award (M1) for substituted area formula, (A1) for their correct substitutions.

\[= 104 \text{ cm}^2 \quad (A1)(G2)\]

Note: The final answer is 104 cm\(^2\), the units are required. Accept 100 cm\(^2\).

[3 marks]

8c. Calculate the size of angle BCD. [4 marks]

**Markscheme**

\[
\frac{\sin \text{BCD}}{12} = \frac{\sin 60^\circ}{13} \quad (A1)(R)(M1)(A1)\]

Note: Award (A1) for their 60 seen, (M1) for substituted sine rule formula, (A1) for correct substitutions.

\[
\text{BCD} = 53.1^\circ \quad (A1)(G3)\]

Note: Accept 53, do not accept 50 or 53.0.

[4 marks]

8d. Show that the triangle ABC is not right angled. [4 marks]
**Markscheme**

Using triangle ABC

\[ \frac{\sin \text{BAC}}{13} = \frac{\sin 53.1^\circ}{28} \quad (M1)(A1)(ft) \]

OR

Using triangle ABD

\[ \frac{\sin \text{BAD}}{12} = \frac{\sin 120^\circ}{28} \quad (M1)(A1)(ft) \]

Note: Award (M1) for substituted sine rule formula (one of the above), (A1)(ft) for their correct substitutions. Follow through from (a) or (c) as appropriate.

\[ \text{BAC} = \text{BAD} = 21.8^\circ (21.7867 \ldots) \quad (A1)(ft)(G2) \]

Notes: Accept 22, do not accept 20 or 21.7. Accept equivalent methods, for example cosine rule.

\[ 180^\circ - (53.1^\circ + 21.8^\circ) \neq 90^\circ, \text{ hence triangle ABC is not right angled} \quad (R1)(AG) \]

OR

\[ \frac{\text{CD}}{\sin 66.9^\circ} = \frac{15}{\sin 60^\circ} \quad (M1)(A1)(ft) \]

Note: Award (M1) for substituted sine rule formula, (A1)(ft) for their correct substitutions. Follow through from (a) and (c).

\[ \text{CD} = 13.8 (13.8075 \ldots) \quad (A1)(ft) \]

\[ 13^2 + 28^2 \neq 33.8^2, \text{ hence triangle ABC is not right angled} \quad (R1)(ft)(AG) \]

Note: The complete statement is required for the final (R1) to be awarded.

[4 marks]

**Examiners report**

The vast majority of candidates scored very well on this question. Those who did not attempted it using the trigonometry associated with right angled triangles. There were few problems with the use of radians and part (d), which was expected to prove challenging, was successfully overcome by more than half of the candidature. Problems arose mainly because of a lack of clarity in identifying the correct triangle.

Pauline owns a piece of land ABCD in the shape of a quadrilateral. The length of BC is 190 m, the length of CD is 120 m, the length of AD is 70 m, the size of angle BCD is 75° and the size of angle BAD is 115°.

Pauline decides to sell the triangular portion of land ABD. She first builds a straight fence from B to D.

9a. Calculate the length of the fence. [3 marks]
Markscheme

BD² = 190² + 120² − 2(190)(120) cos 75° (M1)(A1)

Note: Award (M1) for substituted cosine formula, (A1) for correct substitution.

= 197 m (A1)(G2)

Note: If radians are used award a maximum of (M1)(A1)(A0).

[3 marks]

Examiners report

Most candidates were able to recognise cosine rule, and substitute correctly. Where the final answer was not attained, this was mainly due to further unnecessary manipulation; the GDC should be used efficiently in such a case. Some students used the answer given and sine rule – this gained no credit.

9b. The fence costs 17 USD per metre to build.  [2 marks]

Calculate the cost of building the fence. Give your answer correct to the nearest USD.

Markscheme

\[ \text{cost} = 196.717 \ldots \times 17 \quad (M1) \]

= 3344 USD (A1)(ft)(G2)

Note: Accept 3349 from 197.

[2 marks]

Examiners report

Most candidates were able to recognise cosine rule, and substitute correctly. Where the final answer was not attained, this was mainly due to further unnecessary manipulation; the GDC should be used efficiently in such a case. Some students used the answer given and sine rule – this gained no credit.

9c. Show that the size of angle ABD is 18.8°, correct to three significant figures.  [3 marks]

Markscheme

\[ \frac{\sin(\text{ABD})}{70} = \frac{\sin(155^\circ)}{196.7} \quad (M1)(A1) \]

Note: Award (M1) for substituted sine formula, (A1) for correct substitution.

= 18.81\ldots \quad (A1)(ft)

= 18.8° \quad (AG)

Notes: Both the unrounded and rounded answers must be seen for the final (A1) to be awarded. Follow through from their (a). If 197 is used the unrounded answer is = 18.78\ldots
Examiners report

Most candidates were able to recognise cosine rule, and substitute correctly. Where the final answer was not attained, this was mainly due to further unnecessary manipulation; the GDC should be used efficiently in such a case. Some students used the answer given and sine rule – this gained no credit.

9d. Calculate the area of triangle ABD.

[4 marks]

Markscheme

angle BDA = 46.2° (AI)
Area = \( \frac{70 \times (196.717 \ldots) \times \sin(46.2°)}{2} \) (M1)(A1)

Note: Award (M1) for substituted area formula, (AI) for correct substitution.

Area ABD = 4970 m² (AI)(R)(G2)

Notes: If 197 used answer is 4980.

Notes: Follow through from (a) only. Award (G2) if there is no working shown and 46.2° not seen. If 46.2° seen without subsequent working, award (AI)(G2).

[4 marks]

Examiners report

Again, most candidates used the appropriate area formula – however, some did not appreciate the purpose of the given answer and were unable to complete the question accurately.

9e. She sells the land for 120 USD per square metre.

Calculate the value of the land that Pauline sells. Give your answer correct to the nearest USD.

[2 marks]

Markscheme

4969.38 \ldots \times 120 \quad (MI)
= 596327 USD \quad (AI)(R)(G2)

Notes: Follow through from their (d).

[2 marks]

Examiners report

Again, most candidates used the appropriate area formula – however, some did not appreciate the purpose of the given answer and were unable to complete the question accurately.

9f. Pauline invests 300000 USD from the sale of the land in a bank that pays compound interest compounded annually.

Find the interest rate that the bank pays so that the investment will double in value in 15 years.

[4 marks]
**Markscheme**

$$300000 \left(1 + \frac{r}{100}\right)^{15} = 600000$$ or equivalent \((A1)(M1)(A1)\)

**Notes:** Award \((A1)\) for 600000 seen or implied by alternative formula, \((M1)\) for substituted CI formula, \((A1)\) for correct substitutions.

\(r = 4.73\) \((A1)(ft)(G3)\)

**Notes:** Award \((G3)\) for 4.73 with no working. Award \((G2)\) for 4.7 with no working.

[4 marks]

**Examiners report**

The final part, in which compound interest was again asked for, tested most candidates but there were many successful attempts using either the GDC’s finance package or correct use of the formula. Care must be taken with the former to show some indication of the values to be used in the context of the question. With the latter approach marks were again lost due to a lack of appreciation of the difference between interest and value.

In the diagram, \(AD = 4\) m, \(AB = 9\) m, \(BC = 10\) m, \(BDA = 90^\circ\) and \(DBC = 100^\circ\).

[3 marks]

10a. Calculate the size of \(ABC\).

**Markscheme**

\[\sin ABD = \frac{4}{9} \quad (M1)\]

\[100 + \text{their (ABD)} \quad (M1)\]

\[126\% \quad (A1) \quad (C3)\]

**Notes:** Accept an equivalent trigonometrical equation involving angle ABD for the first \((M1)\). Radians used gives 100%. Award at most \((M1)(M1)(A0)\) if working shown.

\(BD = 8\) m leading to 127%. Award at most \((M1)(M1)(A0)\) (premature rounding).

[3 marks]
Examiners report

Although many candidates were able to calculate the size of angle ABD correctly, a significant number then simply stopped, failing to add on 100% and consequently losing the last two marks in part (a). Recovery was seen on many scripts in part (b) as candidates seemed to be well drilled in the use of the cosine rule and much correct working was seen. Indeed, despite many incorrect final answers of 26.4% seen in part (a), many used the correct angle of 126° in part (b).

10b. Calculate the length of AC.

Markscheme

\[ AC^2 = 10^2 + 9^2 - 2 \times 10 \times 9 \times \cos(126.38\ldots) \]  \( (M1)(A1) \)

Notes: Award \((M1)\) for substituted cosine formula. Award \((A1)\) for correct substitution using their answer to part (a).

\[ AC = 17.0 \text{ m} \]  \((A1)(\text{ft})\)  \( (C3) \)

Notes: Accept 16.9 m for using 126. Follow through from their answer to part (a). Radians used gives 5.08. Award at most \((M1)(A1)(A0)(\text{ft})\) if working shown.

Examiners report

Although many candidates were able to calculate the size of angle ABD correctly, a significant number then simply stopped, failing to add on 100% and consequently losing the last two marks in part (a). Recovery was seen on many scripts in part (b) as candidates seemed to be well drilled in the use of the cosine rule and much correct working was seen. Indeed, despite many incorrect final answers of 26.4% seen in part (a), many used the correct angle of 126° in part (b).

The diagram represents a small, triangular field, ABC, with BC = 25 m, angle BAC = 55° and angle ACB = 75°.

11a. Write down the size of angle ABC.

Markscheme

Angle ABC = 50°  \((A1)\)

[1 mark]
Examiners report
Many candidates assumed incorrectly that the triangle ABC is isosceles or/and that CN is an angle bisector, and those assumptions led them to use incorrect methods. Wherever those assumptions were made first, all or most of the marks were lost in that specific part of Question 4. There were provisions in the mark scheme to follow through in subsequent parts. Most candidates at least attempted parts a), b) and c). Some candidates incorrectly used an area formula for a right triangle in c) and lost all marks. Many candidates lost a mark for premature rounding in d). Part e) proved to be especially difficult for the candidates. Here many candidates offered guesses instead of sound mathematical reasoning.

11b. Calculate the length of AC. [3 marks]

Markscheme
\[
\frac{AC}{\sin 50^\circ} = \frac{25}{\sin 55^\circ} \quad (M1)(A1)(ft)
\]

Notes: Award (M1) for substitution into the correct formula, (A1)(ft) for correct substitution. Follow through from their angle ABC.

\[AC = 23.4 \text{ m} \quad (A1)(R)(G2)
\]

[3 marks]

Examiners report
Many candidates assumed incorrectly that the triangle ABC is isosceles or/and that CN is an angle bisector, and those assumptions led them to use incorrect methods. Wherever those assumptions were made first, all or most of the marks were lost in that specific part of Question 4. There were provisions in the mark scheme to follow through in subsequent parts. Most candidates at least attempted parts a), b) and c). Some candidates incorrectly used an area formula for a right triangle in c) and lost all marks. Many candidates lost a mark for premature rounding in d). Part e) proved to be especially difficult for the candidates. Here many candidates offered guesses instead of sound mathematical reasoning.

11c. Calculate the area of the field ABC. [3 marks]

Markscheme
Area of \(\Delta ABC = \frac{1}{2} \times 23.379\ldots \times 25 \times \sin 75^\circ \quad (M1)(A1)(ft)
\]

Notes: Award (M1) for substitution into the correct formula, (A1)(ft) for correct substitution. Follow through from their AC.

OR
Area of triangle ABC = \(\frac{29.479\ldots \times 19.151\ldots}{2} \quad (A1)(ft)(M1)
\]

Note: (A1)(ft) for correct values of AB (29.479\ldots) and CN (19.151\ldots). Follow through from their (a) and/or (b). Award (M1) for substitution of their values of AB and CN into the correct formula.

Area of \(\Delta ABC = 282 \text{ m}^2 \quad (A1)(ft)(G2)
\]

Note: Accept 283 \text{ m}^2 if 23.4 is used.

[3 marks]

Examiners report
Many candidates assumed incorrectly that the triangle ABC is isosceles or/and that CN is an angle bisector, and those assumptions led them to use incorrect methods. Wherever those assumptions were made first, all or most of the marks were lost in that specific part of Question 4. There were provisions in the mark scheme to follow through in subsequent parts. Most candidates at least attempted parts a), b) and c). Some candidates incorrectly used an area formula for a right triangle in c) and lost all marks. Many candidates lost a mark for premature rounding in d). Part e) proved to be especially difficult for the candidates. Here many candidates offered guesses instead of sound mathematical reasoning.
11d. N is the point on AB such that CN is perpendicular to AB. M is the midpoint of CN. Calculate the length of NM.

**Markscheme**

\[ NM = \frac{25 \times \sin 50^\circ}{2} \]  
(MI)(MI)

**Note:** Award (MI) for \( 25 \times \sin 50^\circ \) or equivalent for the length of CN. (MI) for dividing their CN by 2.

\[ NM = 9.58 \text{ m} \]  
(A1)(R)(G2)

**Note:** Follow through from their angle ABC.

**Notes:** Premature rounding of CN leads to the answers 9.60 or 9.6. Award at most (MI)(MI)(A0) if working seen. Do not penalize with (AP). CN may be found in (c).

**Note:** The working for this part of the question may be in part (b).

**Examiners report**

Many candidates assumed incorrectly that the triangle ABC is isosceles or/and that CN is an angle bisector, and those assumptions led them to use incorrect methods. Wherever those assumptions were made first, all or most of the marks were lost in that specific part of Question 4. There were provisions in the mark scheme to follow through in subsequent parts. Most candidates at least attempted parts a), b) and c). Some candidates incorrectly used an area formula for a right triangle in c) and lost all marks. Many candidates lost a mark for premature rounding in d). Part e) proved to be especially difficult for the candidates. Here many candidates offered guesses instead of sound mathematical reasoning.

11e. A goat is attached to one end of a rope of length 7 m. The other end of the rope is attached to the point M. Decide whether the goat can reach point P, the midpoint of CB. Justify your answer.
Markscheme

Angle NCB = 40° seen  (AI)(ft)

Note: Follow through from their (a).

From triangle MCP:

\[ MP^2 = (9.5756\ldots)^2 + 12.5^2 - 2 \times 9.5756\ldots \times 12.5 \times \cos(40°) \]  (M1)(AI)(ft)

\[ MP = 8.034\ldots \text{ m} \]  (AI)(ft)(G3)

Notes: Award (M1) for substitution into the correct formula, (AI)(ft) for their correct substitution. Follow through from their d). Award (G3) for correct value of MP seen without working.

OR

From right triangle MCP

\[ CP = 12.5 \text{ m seen} \]  (AI)

\[ MP^2 = (12.5)^2 - (9.575\ldots)^2 \]  (M1)(AI)(ft)

\[ MP = 8.034\ldots \text{ m} \]  (AI)(G3)(ft)

Notes: Award (M1) for substitution into the correct formula, (AI)(ft) for their correct substitution. Follow through from their (d). Award (G3) for correct value of MP seen without working.

OR

From right triangle MCP

Angle MCP = 40° seen  (AI)(ft)

\[ \frac{MP}{12.5} = \sin(40°) \text{ or equivalent} \]  (M1)(AI)(ft)

\[ MP = 8.034\ldots \text{ m} \]  (AI)(G3)(ft)

Notes: Award (M1) for substitution into the correct formula, (AI)(ft) for their correct substitution. Follow through from their (a). Award (G3) for correct value of MP seen without working.

The goat cannot reach point P as MP > 7 m .  (AI)(ft)

Note: Award (AI)(ft) only if their value of MP is compared to 7 m, and conclusion is stated.

[5 marks]

Examiners report

Many candidates assumed incorrectly that the triangle ABC is isosceles or/and that CN is an angle bisector, and those assumptions led them to use incorrect methods. Wherever those assumptions were made first, all or most of the marks were lost in that specific part of Question 4. There were provisions in the mark scheme to follow through in subsequent parts. Most candidates at least attempted parts a), b) and c). Some candidates incorrectly used an area formula for a right triangle in c) and lost all marks. Many candidates lost a mark for premature rounding in d). Part e) proved to be especially difficult for the candidates. Here many candidates offered guesses instead of sound mathematical reasoning.
The diagram below shows a square based right pyramid. ABCD is a square of side 10 cm. VX is the perpendicular height of 8 cm. M is the midpoint of BC.

12a. Write down the length of XM.

**Markscheme**

*UP applies in this question*

\[(UP)\quad XM = 5\text{ cm} \quad (AI)\]

*[1 mark]*

**Examiners report**

This part proved accessible to the great majority of candidates. The common errors were (1) the inversion of the tangent ratio (2) the omission of the units and (3) the incorrect rounding of the answer; with 58° being all too commonly seen.

---

In a mountain region there appears to be a relationship between the number of trees growing in the region and the depth of snow in winter. A set of 10 areas was chosen, and in each area the number of trees was counted and the depth of snow measured. The results are given in the table below.

<table>
<thead>
<tr>
<th>Number of trees ((x))</th>
<th>Depth of snow in cm ((y))</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td>75</td>
<td>50</td>
</tr>
<tr>
<td>66</td>
<td>40</td>
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<tr>
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<td>20</td>
</tr>
<tr>
<td>73</td>
<td>45</td>
</tr>
<tr>
<td>47</td>
<td>25</td>
</tr>
</tbody>
</table>

12b. Use your graphic display calculator to find the standard deviation of the number of trees.

**Markscheme**

16.8 \((G1)\)

*[1 mark]*
Examiners report
A straightforward question that saw many fine attempts. Given its nature – where much of the work was done on the GDC – it must be emphasised to candidates that incorrect entry of data into the calculator will result in considerable penalties; they must check their data entry most carefully.

The use of the inappropriate standard deviation was seen, but infrequently.

12c. Calculate the length of VM.

**Markscheme**

*UP applies in this question*

\[ VM^2 = 5^2 + 8^2 \quad (M1) \]

Note: Award (M1) for correct use of Pythagoras Theorem.

\[ (UP) \quad VM = \sqrt{89} = 9.43 \text{ cm} \quad (A1)(G1)(G2) \]

[2 marks]

Examiners report
This part proved accessible to the great majority of candidates. The common errors were (1) the inversion of the tangent ratio (2) the omission of the units and (3) the incorrect rounding of the answer; with 58° being all too commonly seen.

12d. Calculate the angle between VM and ABCD.

**Markscheme**

\[ \tan VMX = \frac{5}{8} \quad (M1) \]

Note: Other trigonometric ratios may be used.

\[ VMX = 58.0^\circ \quad (A1)(G1)(G2) \]

[2 marks]

Examiners report
This part proved accessible to the great majority of candidates. The common errors were (1) the inversion of the tangent ratio (2) the omission of the units and (3) the incorrect rounding of the answer; with 58° being all too commonly seen.
A path goes around a forest so that it forms the three sides of a triangle. The lengths of two sides are 550 m and 290 m. These two sides meet at an angle of 115°. A diagram is shown below.

**Markscheme**

*UP applies in this question*

\[ l^2 = 290^2 + 550^2 - 2 \times 290 \times 550 \times \cos 115° \quad (MI)(A1) \]

**Note:** Award (MI) for substituted cosine rule formula, (A1) for correct substitution.

\[ l = 722 \quad (A1)(G2) \]

\[ (UP) = 720 \text{ m} \quad (A1) \]

**Note:** If 720 m seen without working award (G3).

The final (A1) is awarded for the correct rounding of their answer.

**Examiners report**

Again, this part proved accessible to the majority with a large number of candidates attaining full marks. However, there were also a number of candidates who seemed not to have been prepared in the use of trigonometry in non-right-angled triangles. Also, failing to round the answer in (a) to the nearest 10 m was a common omission.

**Markscheme**

*UP applies in this question*

\[ \text{Area} = \frac{1}{2} \times 290 \times 550 \times \sin 115° \quad (MI)(A1) \]

**Note:** Award (MI) for substituted correct formula (A1) for correct substitution.

\[ (UP) = 72300 \text{ m}^2 \quad (A1)(G2) \]

[3 marks]
12g. Inside the forest a second path forms the three sides of another triangle named ABC. Angle BAC is 53°, AC is 180 m and BC [4 marks] is 230 m.

Calculate the size of angle ACB.

**Markscheme**

\[
\frac{180}{\sin B} = \frac{230}{\sin 53^\circ}
\]

(M1)(A1)

Note: Award (M1) for substituted sine rule formula, (A1) for correct substitution.

\[
B = 38.7^\circ \quad (A1)(G2)
\]

\[
A\hat{C}B = 180 - (53^\circ + 38.7^\circ)
\]

= 88.3° \quad (A1)(R)

[4 marks]

13a. Write down the y-intercept of the line AB. [1 mark]
13b. Calculate the gradient of the line AB.

Markscheme
\[
\frac{2 - 5}{6 - 2} \quad (M1)
\]

Note: Award (M1) for substitution in gradient formula.

\[
= -\frac{1}{2} \quad (A1) \quad (C2)
\]

Examiners report
This was generally well answered, the errors coming from incorrect substitution into the gradient formula rather than using the two intercepts.

13c. The acute angle between the line AB and the x-axis is \( \theta \).

Show \( \theta \) on the diagram.

Markscheme
Angle clearly identified. \((AI) \quad (CI)\)

Examiners report
There was often a lack of accuracy in the answers. Also, the use of the sine rule overly complicated matters for many.

13d. The acute angle between the line AB and the x-axis is \( \theta \).

Calculate the size of \( \theta \).
**Markscheme**

\[ \tan \theta = \frac{1}{2} \] (or equivalent fraction) \( (M1) \)

\[ \theta = 26.6^\circ \] \( (AI)(ft) \) \( (C2) \)

**Note:** \((ft)\) from (b).

Accept alternative correct trigonometrical methods.

[2 marks]

**Examiners report**

[N/A]

The diagram shows triangle ABC in which angle BAC = 30°, BC = 6.7 cm and AC = 13.4 cm.

14a. Calculate the size of angle ACB. [4 marks]

**Markscheme**

\[ \frac{\sin A\hat{B}C}{13.4} = \frac{\sin 30^\circ}{6.7} \] \( (M1)(A1) \)

**Note:** Award \((M1)\) for correct substituted formula, \((A1)\) for correct substitution.

\[ A\hat{B}C = 90^\circ \] \( (A1) \)

\[ A\hat{C}B = 60^\circ \] \( (AI)(ft) \) \( (C4) \)

**Note:** Radians give no solution, award maximum \((M1)(A1)(A0)\).

[4 marks]

**Examiners report**

Use of cosine rule was common. The assumption of a right angle in the given diagram was minimal.

14b. Nadia makes an accurate drawing of triangle ABC. She measures angle BAC and finds it to be 29°. Calculate the percentage error in Nadia’s measurement of angle BAC. [2 marks]
A chocolate bar has the shape of a triangular right prism ABCDEF as shown in the diagram. The ends are equilateral triangles of side 6 cm and the length of the chocolate bar is 23 cm.

15a. Write down the size of angle BAF.  

**Markscheme**  
60°  
(A1)  
[1 mark]  

**Examiners report**  
It was pleasing to show candidate working throughout this question. Follow through marks could be awarded when incorrect answers were given. Many candidates incorrectly calculated the weight of the chocolate bar by multiplying the surface area by 1.5g. Also a large number of students incorrectly used the formula for the volume of a pyramid rather than for a prism. Most candidates were successful in their use of the cosine rule but did not give the answer before it was rounded to 86.4, resulting in the loss of the final A mark. The last part acted as a clear discriminator, very few students were able to find the correct length of the new chocolate bar. Most students used units correctly.

15b. Hence or otherwise find the area of the triangular end of the chocolate bar.  

**Markscheme**  
$\frac{29 \cdot 30}{30} \times 100$  
(M1)  

**Note:** Award (M1) for correct substitution into correct formula.

% error $= -33.3\%$  
(A1)  
(C2)  

**Notes:** Percentage symbol not required. Accept positive answer.  

[2 marks]
Find the total surface area of the chocolate bar.  

15c.  

**Markscheme**  
*Unit penalty (UP) applies in this part*  

\[ \text{Area} = \frac{6 \times 6 \times \sin 60^\circ}{2} \]  
\[ (MI)(A1) \]  
\[ (UP) \quad = 15.6 \text{ cm}^2 \quad (9\sqrt{3}) \]  
\[ (A1)(G2) \]  

**Note:** Award (MI) for substitution into correct formula, (A1) for correct values. Accept alternative correct methods.  

[3 marks]

**Examiners report**  
It was pleasing to show candidate working throughout this question. Follow through marks could be awarded when incorrect answers were given. Many candidates incorrectly calculated the weight of the chocolate bar by multiplying the surface area by 1.5 g. Also a large number of students incorrectly used the formula for the volume of a pyramid rather than for a prism. Most candidates were successful in their use of the cosine rule but did not give the answer before it was rounded to 86.4, resulting in the loss of the final A mark. The last part acted as a clear discriminator, very few students were able to find the correct length of the new chocolate bar. Most students used units correctly.

---

15d.  

It is known that 1 cm$^3$ of this chocolate weighs 1.5 g. Calculate the weight of the chocolate bar.  

**Markscheme**  
*Unit penalty (UP) applies in this part*  

\[ \text{Surface Area} = 15.58 \times 2 + 23 \times 6 \times 3 \]  
\[ (MI)(MI) \]  

**Note:** Award (MI) for two terms with 2 and 3 respectively, (MI) for \(23 \times 6\) (138).  

\[ (UP) \quad \text{Surface Area} = 445 \text{ cm}^2 \quad (A1)(G2) \]  

[3 marks]

**Examiners report**  
It was pleasing to show candidate working throughout this question. Follow through marks could be awarded when incorrect answers were given. Many candidates incorrectly calculated the weight of the chocolate bar by multiplying the surface area by 1.5 g. Also a large number of students incorrectly used the formula for the volume of a pyramid rather than for a prism. Most candidates were successful in their use of the cosine rule but did not give the answer before it was rounded to 86.4, resulting in the loss of the final A mark. The last part acted as a clear discriminator, very few students were able to find the correct length of the new chocolate bar. Most students used units correctly.
**Markscheme**

*Unit penalty (UP) applies in this part*

weight $= 1.5 \times 15.59 \times 23 \quad (MI)(MI)$

**Note:** Award $(MI)$ for finding the volume, $(MI)$ for multiplying their volume by 1.5.

$(UP) \quad$ weight $= 538 \text{ g} \quad (AI)(B)(G3)$

[3 marks]

**Examiners report**

It was pleasing to show candidate working throughout this question. Follow through marks could be awarded when incorrect answers were given. Many candidates incorrectly calculated the weight of the chocolate bar by multiplying the surface area by 1.5 g. Also, a large number of students incorrectly used the formula for the volume of a pyramid rather than for a prism. Most candidates were successful in their use of the cosine rule but did not give the answer before it was rounded to 86.4, resulting in the loss of the final A mark. The last part acted as a clear discriminator, very few students were able to find the correct length of the new chocolate bar. Most students used units correctly.

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15e. A different chocolate bar made with the same mixture also has the shape of a triangular prism. The ends are triangles with sides of length 4 cm, 6 cm and 7 cm.

Show that the size of the angle between the sides of 6 cm and 4 cm is 86.4° correct to 3 significant figures.

**Markscheme**

\[ \cos \alpha = \frac{4^2 + 6^2 - 7^2}{2 \times 4 \times 6} \quad (MI)(A1) \]

**Note:** Award $(MI)$ for using cosine rule with values from the problem, $(A1)$ for correct substitution.

$\alpha = 86.41\ldots \quad (A1)$

$\alpha = 86.4^\circ \quad (AG)$

**Note:** 86.41… must be seen for final $(A1)$ to be awarded.

[3 marks]

**Examiners report**

It was pleasing to show candidate working throughout this question. Follow through marks could be awarded when incorrect answers were given. Many candidates incorrectly calculated the weight of the chocolate bar by multiplying the surface area by 1.5 g. Also, a large number of students incorrectly used the formula for the volume of a pyramid rather than for a prism. Most candidates were successful in their use of the cosine rule but did not give the answer before it was rounded to 86.4, resulting in the loss of the final A mark. The last part acted as a clear discriminator, very few students were able to find the correct length of the new chocolate bar. Most students used units correctly.

---

15f. The weight of this chocolate bar is 500 g. Find its length.  

[4 marks]
A farmer has a triangular field, ABC, as shown in the diagram.
AB = 35 m, BC = 80 m and BÂC = 105°, and D is the midpoint of BC.

A. Find the size of BĈA.

B. Calculate the length of AD.
16b. **Markscheme**

*Note: Unit penalty (UP) applies in parts (b)(c) and (e)*

Length BD = 40 m \( (AI) \)

Angle ABC = 180° − 105° − 25° = 50° \( (AI)(ft) \)

*Note: (ft) from their answer to (a).*

\[
AD^2 = 35^2 + 40^2 - (2 \times 35 \times 40 \times \cos 50°) \quad (M1)(AI)(ft)
\]

*Note: Award (MI) for correct substituted formula, (AI)(ft) for correct substitutions.*

\[
(UP) \quad AD = 32.0 \text{ m} \quad (AI)(ft)(G3)
\]

*Notes: If 80 is used for BD award at most (A0)(AI)(ft)(MI)(AI)(ft)(AI)(ft) for an answer of 63.4 m.*

If the angle ABC is incorrectly calculated in this part award at most (AI)(A0)(MI)(AI)(ft)(AI)(ft).

If angle BCA is used award at most (AI)(A0)(MI)(A0)(A0).

[5 marks]

**Examiners report**

This was a simple application of non-right angled trigonometry and most candidates answered it well. Some candidates lost marks in both parts due to the incorrect setting of the calculators. Those that did not score well overall primarily used Pythagoras.

---

16c. The farmer wants to build a fence around ABD.

Calculate the total length of the fence.

**Markscheme**

*Note: Unit penalty (UP) applies in parts (b)(c) and (e)*

\[
\text{length of fence} = 35 + 40 + 32 \quad (MI)
\]

\[
(UP) \quad = 107 \text{ m} \quad (AI)(ft)(G2)
\]

*Note: (MI) for adding 35 + 40 + their (b).*

[2 marks]

**Examiners report**

Most candidates scored full marks, many by follow through from an incorrect part (b). The main error was using the value for BC and not BD.

---

16d. The farmer wants to build a fence around ABD.

The farmer pays 802.50 USD for the fence. Find the cost per metre.

**Markscheme**

*Note: Unit penalty (UP) applies in parts (b)(c) and (e)*

**Examiners report**

---

The farmer pays 802.50 USD for the fence. Find the cost per metre.
**Markscheme**

cost per metre = \( \frac{802.50}{107} \) \((M1)\)

**Note:** Award \((M1)\) for dividing 802.50 by their \((c)\).

cost per metre = 7.50 USD (7.5 USD) (USD not required) \((A1)(ft)(G2)\)

[2 marks]

**Examiners report**

Most candidates scored full marks, many by follow through from an incorrect part \((b)\). The main error was using the value for \(BC\) and not \(BD\).

---

**16e.** Calculate the area of the triangle ABD.

**Markscheme**

*Note: Unit penalty (UP) applies in parts \((b)(c)\) and \((e)\)*

Area of ABD = \(\frac{1}{2} \times 35 \times 40 \times \sin 50^\circ\) \((M1)\)

= 536.2311102 \((A1)(ft)\)

\(UP\) = 536 m\(^2\) \((A1)(ft)(G2)\)

**Note:** Award \((M1)\) for correct substituted formula, \((A1)(ft)\) for correct substitution, \((ft)\) from their value of \(BD\) and their angle \(ABC\) in \((b)\).

[3 marks]

**Examiners report**

Done well; again some candidates used the right-angled formula.

---

**16f.** A layer of earth 3 cm thick is removed from ABD. Find the volume removed in cubic metres.

**Markscheme**

Volume = 0.03 \times 536 \((A1)(MI)\)

= 16.08

= 16.1 \((A1)(ft)(G2)\)

**Note:** Award \((A1)\) for 0.03, \((MI)\) for correct formula. \((ft)\) from their \((e)\).

If 3 is used award at most \((A0)(MI)/(A0)\).

[3 marks]
Examiners report
This part was poorly done; many candidates unable to convert 3 cm to 0.03 m. A significant number used the wrong formula, multiplying their answer by 1/3.

Tom stands at the top, T, of a vertical cliff 150 m high and sees a fishing boat, F, and a ship, S. B represents a point at the bottom of the cliff directly below T. The angle of depression of the ship is 40° and the angle of depression of the fishing boat is 55°.

17a. Calculate, SB, the distance between the ship and the bottom of the cliff. [2 marks]

Markscheme
\[ 150 \tan 50 \ (MI) \]

OR
\[ \frac{150}{\tan 45} \ (MI) \]
\[ = 179 \text{ (m) (178.763...)} \ (A1) \ (C2) \]

Examiners report
[N/A]

17b. Calculate, SF, the distance between the ship and the fishing boat. Give your answer correct to the nearest metre. [4 marks]

Markscheme
\[ 150 \tan 50 - 150 \tan 35 \ (MI)(MI) \]

Note: Award (MI) for 150 \tan 35, (MI) for subtraction from their part (a).

\[ = 73.7 \text{ (m) (73.7319...)} \ (AI)(ft) \]
\[ = 74 \text{ (m) (AI)(ft) (C4) } \]

Note: The final (AI) is awarded for the correct rounding of their answer to (b).
Note: There will always be one answer with a specified degree of accuracy on each paper.

Examiners report
[N/A]
The diagram shows a rectangular based right pyramid VABCD in which AD = 20 cm, DC = 15 cm and the height of the pyramid, VN = 30 cm.

**18a.** Calculate

(i) the length of AC;
(ii) the length of VC.

**Markscheme**

(i) \( \sqrt{15^2 + 20^2} \) (MI)

Note: Award (MI) for correct substitution in Pythagoras Formula.

AC = 25 cm (AI) (C2)

(ii) \( \sqrt{12.5^2 + 30^2} \) (MI)

Note: Award (MI) for correct substitution in Pythagoras Formula.

VC = 32.5 cm (AI)(B) (C2)

Note: Follow through from their AC found in part (a).

**Examiners report**

[N/A]

**18b.** Calculate the angle between VC and the base ABCD.

\[
\sin \text{VCN} = \frac{30}{32.5} \quad \tan \text{VCN} = \frac{30}{12.5} \quad \cos \text{VCN} = \frac{12.5}{32.5}
\]

\[
= 67.4^\circ \quad 67.3801\ldots
\]
19a. Calculate the size of angle ACB. [3 marks]

**Markscheme**

\[
\cos ACB = \frac{30^2 + 50^2 - 70^2}{2 \cdot 30 \cdot 50} \quad (M1)(A1)
\]

**Note:** Award (M1) for substituted cosine rule formula, (A1) for correct substitution.

ACB = 120° (AI)(G2)

19b. Calculate the area of the building’s footprint, ABC. [3 marks]

**Markscheme**

Area of triangle ABC = \(\frac{30(50) \sin 120°}{2}\) (MI)(AI)(ft)

**Note:** Award (MI) for substituted area formula, (AI)(ft) for correct substitution.

= 650 m\(^2\) (649.519 \ldots m^2) (AI)(ft)(G2)

**Notes:** The answer is 650 m\(^2\); the units are required. Follow through from their answer in part (a).
19c. Calculate the volume of the office block. [2 marks]

**Markscheme**

Volume = 649.519\ldots \times 120 \quad (MI)
= 77900 \text{ m}^3 (77942.2\ldots \text{ m}^3) \quad (A1)(G2)

**Note:** The answer is 77900 m$^3$; the units are required. Do not penalise lack of units if already penalized in part (b). Accept 78000 m$^3$ from use of 3sf answer 650 m$^2$ from part (b).

**Examiners report**

[N/A]

19d. To stabilize the structure, a steel beam must be made that runs from point C to point Q. Calculate the length of CQ. [2 marks]

**Markscheme**

CQ$^2 = 50^2 + 120^2$ \quad (MI)
CQ = 130 \text{ m} \quad (A1)(G2)

**Note:** The units are not required.

**Examiners report**

[N/A]

19e. Calculate the angle CQ makes with BC. [2 marks]

**Markscheme**

\[ \tan \angle QCB = \frac{120}{50} \quad (MI) \]

**Note:** Award (MI) for correct substituted trig formula.

\[ \angle QCB = 67.4^\circ (67.3801\ldots) \quad (A1)(G2) \]

**Note:** Accept equivalent methods.

**Examiners report**

[N/A]