Topic 5 Part 3 *[209 marks]*

1a. *[1 mark]*

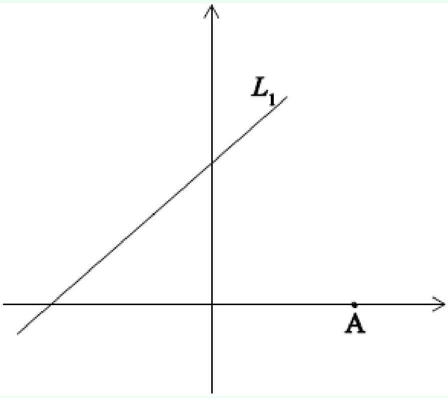
Markscheme

$2 \times 0 - 3 \times 6 \neq 11$ ***(R1)***

Note: Stating
$2 \times 0 - 3 \times 6 = -18$ without a conclusion is not sufficient.

OR

Clear sketch of L_1 and A.



(R1)

OR

Point **A** is (6, 0) and
$2y - 3x = 11$ has x-intercept at
$-\frac{11}{3}$ or the line has only one x-intercept which occurs when x is negative. ***(R1)*** ***(C1)***

Examiners report

There were multiple acceptable reasons why the line did not pass through a given point (including numerically substituting values in the equation; drawing a graph or algebraically finding the x-intercept of the line). This was one of two reasoning marks in the paper.

1b. *[2 marks]*

Markscheme

$2y = 3x + 11$ **or**
$y - \frac{3}{2}x = \frac{11}{2}$ ***(M1)***

Note: Award ***(M1)*** for a correct first step in making y the subject of the equation.

$(\text{gradient equals}) = \frac{3}{2}(1.5)$ ***(A1)*** ***(C2)***

Note: Do not accept $1.5x$.

Examiners report

There were multiple acceptable reasons why the line did not pass through a given point (including numerically substituting values in the equation; drawing a graph or algebraically finding the x-intercept of the line). This was one of two reasoning marks in the paper.

1c.

[1 mark]

Markscheme

$(m =) - \frac{2}{3}$ ***(A1)*(ft)** ***(C1)***

Notes: Follow through from their part (b).

Examiners report

There were multiple acceptable reasons why the line did not pass through a given point (including numerically substituting values in the equation; drawing a graph or algebraically finding the x-intercept of the line). This was one of two reasoning marks in the paper.

1d.

[2 marks]

Markscheme

$0 = -\frac{2}{3}(6) + c$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of their gradient and (6, 0) into any form of the equation.

$(c =)$ 4 ***(A1)*(ft)** ***(C2)***

Note: Follow through from part (c).

Examiners report

There were multiple acceptable reasons why the line did not pass through a given point (including numerically substituting values in the equation; drawing a graph or algebraically finding the x-intercept of the line). This was one of two reasoning marks in the paper.

2a.

[1 mark]

Markscheme

$2x(x-4)$ **or**
$2x^2 - 8x$ ***(A1)*** ***(C1)***

Note: Award ***(A0)*** for
$x - 4 \times 2x$.

[1 mark]

Examiners report

[N/A]

2b. *[3 marks]*

Markscheme

$2x(x-4)=10$ ***(M1)***

Note: Award ***(M1)*** for equating their answer in part (a) to
10.

$x^2-4x-5=0$ ***(M1)***
OR
Sketch of
$y=2x^2-8x$ and
$y=10$ ***(M1)***
OR
Using GDC solver
$x=5$ and
$x=-1$ ***(M1)***
OR
$2(x+1)(x-5)$ ***(M1)***
$x=5\ (\mathrm{m})$ ***(A1)*****(ft)** ***(C3)***

Notes: Follow through from their answer to part (a).
Award at most ***(M1)(M1)(A0)*** if both
5 and
-1 are given as final answer.
Final ***(A1)*****(ft)** is awarded for choosing only the positive solution(s).

[3 marks]

Examiners report

[N/A]

2c. *[2 marks]*

Markscheme

$2\times 5=10\ (\mathrm{m})$ ***(A1)*****(ft)**
$5-4=1\ (\mathrm{m})$ ***(A1)*****(ft)** ***(C2)***

Note: Follow through from their answer to part (b).
Do not accept negative answers.

[2 marks]

Examiners report

[N/A]

3a. *[1 mark]*

Markscheme

$-\frac{80}{940}\ \left(-0.0851, -0.085106\ldots, -\frac{4}{47}\right)$ ***(A1)*** ***(C1)***
[1 mark]

Examiners report

[N/A]

3b. *[1 mark]*

Markscheme

$-0.0851\ (-0.085106\ldots) < -\frac{1}{12}(-0.083333\ldots)$ ***(A1)*(ft)** ***(C1)***

Notes: Accept "less than" in place of inequality.
Award ***(A0)*** if incorrect inequality seen.
Follow through from part (a).

[1 mark]

Examiners report

[N/A]

3c. *[4 marks]*

Markscheme

(i) ramp

B is safe ***(A1)***

the gradient of ramp

B is

$-\frac{1}{12}$ ***(R1)***

Notes: Award ***(R1)*** for "the gradient of ramp

B is

$-\frac{1}{12}$" seen.
Do not award ***(A1)(R0)***.

(ii)

$2x = 1920$ ***(M1)***

Note: Accept alternative methods.

$960\ (\text{cm})$ ***(A1)*** ***(C4)***

[4 marks]

Examiners report

[N/A]

4a.

[3 marks]

Markscheme

$\frac{350}{\tan 20°}$ ***(M1)***

$= 961.617\ldots$ ***(A1)***

$= 962\ (\mathrm{m})$ ***(A1)*(ft)** ***(C3)***

Notes: Award ***(M1)*** for correct substitution into correct formula, ***(A1)*** for correct answer, ***(A1)*(ft)** for correct rounding to the nearest metre.

Award ***(M0)(A0)(A0)*** for 961 without working.

[3 marks]

Examiners report

[N/A]

4b.

[3 marks]

Markscheme

$961.617\ldots - 250 = 711.617\ldots$ ***(A1)*(ft)**

$\tan^{-1}\left(\frac{350}{711.617\ldots}\right)$ ***(M1)***

$= 26.2°\ (26.1896\ldots)$ ***(A1)*(ft)** ***(C3)***

Notes: Accept $26.1774\ldots$ from use of 3 sf answer 962 from part (a). Follow through from their answer to part (a).

Accept alternative methods.

[3 marks]

Examiners report

[N/A]

5a.

[2 marks]

Markscheme

3.8×320 ***(A1)***

Note: Award ***(A1)*** for 320 or equivalent seen.

$= 1216$ ***(A1)***

$= 1220\ (\mathrm{m})$ ***(AG)***

Note: Both unrounded and rounded answer must be seen for the final ***(A1)*** to be awarded.

[2 marks]

Examiners report

[N/A]

5b.

[1 mark]

Markscheme

$\frac{850}{303}$ $(\mathrm{ms^{-1}})$ $(2.81, 2.80528\ldots)$ ***(A1)(G1)***

[1 mark]

Examiners report

[N/A]

5c.

[3 marks]

Markscheme

$\mathrm{AC}^2 = 1220^2 + 850^2 - 2(1220)(850)\cos 110°$ ***(M1)(A1)***

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

$\mathrm{AC} = 1710\ (\mathrm{m})\ (1708.87\ldots)$ ***(A1)(G2)***

Notes: Accept
$1705\ (1705.33\ldots)$.

[3 marks]

Examiners report

[N/A]

5d.

[2 marks]

Markscheme

$1220 + 850 + 1708.87\ldots$ ***(M1)***
$= 3780\ (\mathrm{m})\ (3778.87\ldots)$ ***(A1)*****(ft)*****(G1)***

Notes: Award ***(M1)*** for adding the three sides. Follow through from their answer to part (c). Accept
$3771\ (3771.33\ldots)$.

[2 marks]

Examiners report

[N/A]

5e. *[3 marks]*

Markscheme

$\frac{\sin C}{1220} = \frac{\sin 110^\circ}{1708.87\ldots}$ ***(M1)(A1)*(ft)**

Notes: Award ***(M1)*** for substitution into sine rule formula, ***(A1)*(ft)** for correct substitutions. Follow through from their part (c).

$C = 42.1^\circ\ (42.1339\ldots)$ ***(A1)*(ft)*(G2)***

Notes: Accept
$41.9^\circ, 42.0^\circ, 42.2^\circ, 42.3^\circ$.

OR

$\cos C = \frac{1708.87\ldots^2 + 850^2 - 1220^2}{2 \times 1708.87\ldots \times 850}$ ***(M1)(A1)*(ft)**

Notes: Award ***(M1)*** for substitution into cosine rule formula, ***(A1)*(ft)** for correct substitutions. Follow through from their part (c).

$C = 42.1^\circ\ (42.1339\ldots)$ ***(A1)*(ft)*(G2)***

Notes: Accept
$41.2^\circ, 41.8^\circ, 42.4^\circ$.

[3 marks]

Examiners report

[N/A]

5f. *[3 marks]*

Markscheme

$\frac{1}{2} \times 1220 \times 850 \times \sin 110^\circ$ ***(M1)(A1)*(ft)**
OR
$\frac{1}{2} \times 1708.87\ldots \times 850 \times \sin 42.1339\ldots^\circ$ ***(M1)(A1)*(ft)**
OR
$\frac{1}{2} \times 1220 \times 1708.87\ldots \times \sin 27.8661\ldots^\circ$ ***(M1)(A1)*(ft)**

Note: Award ***(M1)*** for substitution into area formula, ***(A1)*(ft)** for correct substitution.

$= 487\,000\ \text{m}^2\ (487\,230\ldots\ \text{m}^2)$ ***(A1)*(ft)*(G2)***

Notes: The answer is
$487\,000\ \text{m}^2$, **units are required**.
Accept
$486\,000\ \text{m}^2\ (485\,633\ldots\ \text{m}^2)$.
If workings are not shown and units omitted, award ***(G1)*** for
$487\,000$ or $486\,000$.
Follow through from parts (c) and (e).

[3 marks]

Examiners report

[N/A]

6a. *[1 mark]*

Markscheme

$20lw$ **OR**

$V = 20lw$ ***(A1)***

[1 mark]

Examiners report

[N/A]

6b. *[2 marks]*

Markscheme

$3000 = 20lw$ ***(M1)***

Note: Award ***(M1)*** for equating their answer to part (a) to
3000.

$l = \frac{3000}{20w}$ ***(M1)***

Note: Award ***(M1)*** for rearranging equation to make
l subject of the formula. The above equation must be seen to award ***(M1)***.

OR

$150 = lw$ ***(M1)***

Note: Award ***(M1)*** for division by
20 on both sides. The above equation must be seen to award ***(M1)***.

$l = \frac{150}{w}$ ***(AG)***

[2 marks]

Examiners report

[N/A]

6c. *[2 marks]*

$S = 2l + 4w + 2(20)$

S

$2\left(\frac{150}{w}\right) + 4w + 2(20)$

S

$= 40 + 4w + \frac{300}{w}$

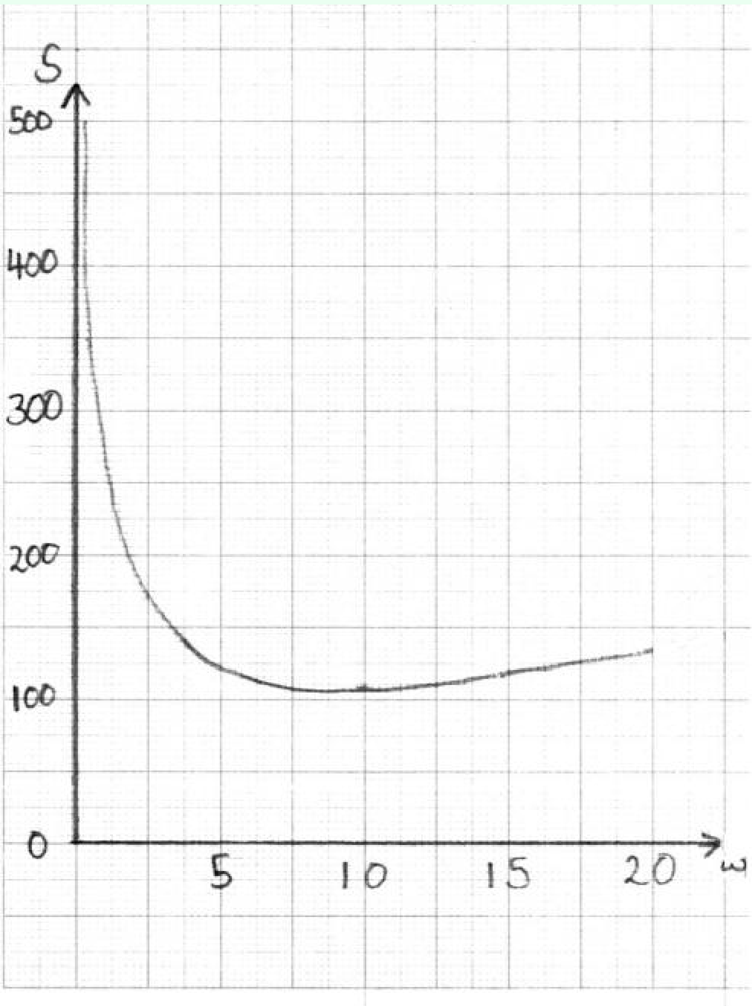
Examiners report

[N/A]

6d.

[2 marks]

Markscheme



(A1)(A1)(A1)(A1)

Note: Award ***(A1)*** for correct scales, window and labels on axes, ***(A1)*** for approximately correct shape, ***(A1)*** for minimum point in approximately correct position, ***(A1)*** for asymptotic behaviour at $w = 0$.

Axes must be drawn with a ruler and labeled w and S.

For a smooth curve (with approximately correct shape) there should be **one** continuous thin line, no part of which is straight and no (one-to-many) mappings of w.

The S-axis must be an asymptote. The curve must not touch the S-axis nor must the curve approach the asymptote then deviate away later.

[4 marks]

Examiners report

[N/A]

6e. *[3 marks]*

Markscheme

$4 - \frac{300}{w^2}$ ***(A1)(A1)(A1)***

Notes: Award ***(A1)*** for
4, ***(A1)*** for
-300, ***(A1)*** for
$\frac{1}{w^2}$ or
w^{-2}. If extra terms present, award at most ***(A1)(A1)(A0)***.

[3 marks]

Examiners report

[N/A]

6f. *[2 marks]*

Markscheme

$4 - \frac{300}{w^2} = 0$ **OR**
$\frac{300}{w^2} = 4$ **OR**
$\frac{\mathrm{d}S}{\mathrm{d}w} = 0$ ***(M1)***

Note: Award ***(M1)*** for equating their derivative to zero.

$w = 8.66 \ \left(\sqrt{75},\ 8.66025\ldots\right)$ ***(A1)*(ft)*(G2)***

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

[2 marks]

Examiners report

[N/A]

6g. *[1 mark]*

Markscheme

$17.3\left(\frac{150}{\sqrt{75}},\ 17.3205\ldots\right)$ ***(A1)*(ft)**

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

[1 mark]

Examiners report

[N/A]

6h.

[2 marks]

Markscheme

$40 + 4\sqrt{75} + \frac{300}{\sqrt{75}}$ ***(M1)***

Note: Award ***(M1)*** for substitution of their answer to part (f) into the expression for S.

$= 110 \text{ (cm)} \ (40 + 40\sqrt{3}, \ 109.282\ldots)$ ***(A1)*(ft)*(G2)***

Note: Do not accept 109.
Follow through from their answers to parts (f) and (g).

[2 marks]

Examiners report

[N/A]

7a.

[1 mark]

Markscheme

0 ***(A1)(G1)***

[1 mark]

Examiners report

[N/A]

7b.

[2 marks]

Markscheme

$1.8 = a(3)^2 + 0$ ***(M1)***

OR

$1.8 = a(-3)^2 + 0$ ***(M1)***

Note: Award ***(M1)*** for substitution of $y = 1.8$ or $x = 3$ and their value of c into equation.
0 may be implied.

$a = 0.2$ $\left(\frac{1}{5}\right)$ ***(A1)*(ft)*(G1)***

Note: Follow through from their answer to part (a).
Award ***(G1)*** for a correct answer only.

[2 marks]

Examiners report

[N/A]

7c.

[1 mark]

Markscheme

$y = 0.2x^2$ ***(A1)*(ft)**

Note: Follow through from their answers to parts (a) and (b).
Answer must be an equation.

[1 mark]

Examiners report

[N/A]

7d.

[2 marks]

Markscheme

$0.2 \times (2.4)^2$ ***(M1)***
$= 1.15 \text{ (m)}$
(1.152) ***(A1)*(ft)*(G1)***

Notes: Award ***(M1)*** for correctly substituted formula, ***(A1)*** for correct answer. Follow through from their answer to part (c).
Award ***(G1)*** for a correct answer only.

[2 marks]

Examiners report

[N/A]

7e.

[2 marks]

Markscheme

y is the height ***(A1)***
positive value of
x is half the width (*or equivalent*) ***(A1)***
[2 marks]

Examiners report

[N/A]

7f.

[2 marks]

Markscheme

$0.9 = 0.2x^2$ ***(M1)***

Note: Award ***(M1)*** for setting their equation equal to 0.9.

$x = \pm 2.12\ (\mathrm{m})$
$\left(\pm\frac{3}{2}\sqrt{2},\ \pm\sqrt{4.5},\ \pm 2.12132\ldots\right)$ ***(A1)*****(ft)*****(G1)***

Note: Accept 2.12. Award ***(G1)*** for a correct answer only.

[2 marks]

Examiners report

[N/A]

7g.

[2 marks]

Markscheme

(i)
2.55×5 ***(M1)***

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

$= 12.8\ (\mathrm{m}^3)$
$\left(12.75\ (\mathrm{m}^3)\right)$ ***(A1)(G2)***
[2 marks]

(ii)
$\frac{12.75}{36} \times 100$ ***(M1)***

Note: Award ***(M1)*** for correct quotient multiplied by 100.

$= 35.4(\%)$
$(35.4166\ldots)$ ***(A1)*****(ft)*****(G2)***

Note: Award ***(G2)*** for $35.6(\%) (35.5555\ldots(\%))$.
Follow through from their answer to part (g)(i).

[2 marks]

Examiners report

[N/A]

8a. *[2 marks]*

Markscheme

$(\text{AB}^2) = 20^2 - 12^2$ ***(M1)***

Note: Award ***(M1)*** for correctly substituted Pythagoras formula.

$\text{AB} = 16 \text{ cm}$ ***(A1)*** ***(C2)***

[2 marks]

Examiners report

This question was not well answered. Many candidates could not use Pythagoras' theorem correctly and many failed to appreciate the significance of
$\tan(< \text{DCB}) = 0.6$ and calculated the size of the angle DCB, rounding it to $31°$. Unfortunately, this method led to an inaccurate value for DB. Finding the area of triangle ADC was also difficult for many who did not realize that they needed to do a subtraction of triangle areas. Candidates who tried to find side lengths and angles for triangle ADC were generally unsuccessful in calculating its area.

8b. *[2 marks]*

Markscheme

$\frac{\text{DB}}{12} = 0.6$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in tangent ratio or equivalent *ie* seeing
12×0.6.

$\text{DB} = 7.2 \text{ cm}$ ***(A1)*** ***(C2)***

Note: Award ***(M1)(A0)*** for using
$\tan 31$ to get an answer of
7.21.
Award ***(M1)(A0)*** for
$\frac{12}{\sin 59} = \frac{\text{DB}}{\sin 31}$ to get an answer of
$7.2103\ldots$ or any other incorrect answer.

[2 marks]

Examiners report

This question was not well answered. Many candidates could not use Pythagoras' theorem correctly and many failed to appreciate the significance of
$\tan(< \text{DCB}) = 0.6$ and calculated the size of the angle DCB, rounding it to $31°$. Unfortunately, this method led to an inaccurate value for DB. Finding the area of triangle ADC was also difficult for many who did not realize that they needed to do a subtraction of triangle areas. Candidates who tried to find side lengths and angles for triangle ADC were generally unsuccessful in calculating its area.

8c.

[2 marks]

Markscheme

$\frac{1}{2} \times 12 \times (16 - 7.2)$ ***(M1)***

Note: Award ***(M1)*** for their correct substitution in triangle area formula.

OR

$\frac{1}{2} \times 12 \times 16 - \frac{1}{2} \times 12 \times 7.2$ ***(M1)***

Note: Award ***(M1)*** for subtraction of their two correct area formulas.

$= 52.8 \text{ cm}^2$ ***(A1)*(ft)** ***(C2)***

Notes: Follow through from parts (a) and (b).
Accept alternative methods.

[2 marks]

Examiners report

This question was not well answered. Many candidates could not use Pythagoras' theorem correctly and many failed to appreciate the significance of
$\tan(< \text{DCB}) = 0.6$ and calculated the size of the angle DCB, rounding it to $31°$. Unfortunately, this method led to an inaccurate value for DB. Finding the area of triangle ADC was also difficult for many who did not realize that they needed to do a subtraction of triangle areas. Candidates who tried to find side lengths and angles for triangle ADC were generally unsuccessful in calculating its area.

9a.

[3 marks]

Markscheme

$\text{AC}^2 = 30^2 + 24^2 - 2 \times 30 \times 24 \times \cos 35°$ ***(M1)(A1)***

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

$\text{AC} = 17.2 \text{ cm}$
$(17.2168\ldots)$ ***(A1)(G2)***

Notes: Use of radians gives
$52.7002\ldots$ Award ***(M1)(A1)(A0)***.
No marks awarded in this part of the question where candidates assume that angle
$\text{ACB} = 90°$.

[3 marks]

Examiners report

Some candidates assumed that triangle ACB was a right angled triangle with angle $\text{ACB} = 90^\circ$. Such candidates earned no marks for part (a) but were able to recover most of the marks in the remainder of the question. For those candidates who correctly used the cosine rule for part (a), most achieved all 3 marks for this part and used a correct formula for the area of the triangle in part (b) to obtain at least 2 marks for this part. The final mark was not awarded, however, if no units or the incorrect units were given. Parts (c) and (e) were generally well done with many candidates showing the unrounded answer before the required answer. Part (f) proved to be quite problematic for many candidates. Whilst many were able to earn a method mark for $\frac{2190 \times 2600}{22}$, a significant number of these candidates were unable to convert the units correctly and very few correct answers were seen. Indeed, the most popular answer seemed to be 2590 litres.

9b. *[3 marks]*

Markscheme

Units are required in part (b).

Area of triangle $\text{ABC} = \frac{1}{2} \times 24 \times 30 \times \sin 35^\circ$ ***(M1)(A1)***

Notes: Award ***(M1)*** for substitution into area formula, ***(A1)*** for correct substitutions.

Special Case: Where a candidate has assumed that angle $\text{ACB} = 90^\circ$ in part (a), award ***(M1)(A1)*** for a correct alternative substituted formula for the area of the triangle $\left(ie\ \frac{1}{2} \times \text{base} \times \text{height}\right)$.

$= 206\ \text{cm}^2$
$(206.487\ldots \text{cm}^2)$ ***(A1)(G2)***

Notes: Use of radians gives negative answer, $-154.145\ldots$ Award ***(M1)(A1)(A0)***.

Special Case: Award ***(A1)*****(ft)** where the candidate has arrived at an area which is correct to the standard rounding rules from their lengths (units required).

[3 marks]

Examiners report

Some candidates assumed that triangle ACB was a right angled triangle with angle $\text{ACB} = 90^\circ$. Such candidates earned no marks for part (a) but were able to recover most of the marks in the remainder of the question. For those candidates who correctly used the cosine rule for part (a), most achieved all 3 marks for this part and used a correct formula for the area of the triangle in part (b) to obtain at least 2 marks for this part. The final mark was not awarded, however, if no units or the incorrect units were given. Parts (c) and (e) were generally well done with many candidates showing the unrounded answer before the required answer. Part (f) proved to be quite problematic for many candidates. Whilst many were able to earn a method mark for $\frac{2190 \times 2600}{22}$, a significant number of these candidates were unable to convert the units correctly and very few correct answers were seen. Indeed, the most popular answer seemed to be 2590 litres.

9c. *[2 marks]*

Markscheme

$206.487\ldots \times 25 \times 2600$ ***(M1)***

Note: Award ***(M1)*** for multiplication of their answer to part (b) by
25 and
2600.

$13\,421\,688.61$ ***(A1)***

Note: Accept unrounded answer of
$13\,390\,000$ for use of
206.

$13\,400\,000$ ***(AG)***

Note: The final ***(A1)*** cannot be awarded unless both the unrounded and rounded answers are seen.

[2 marks]

Examiners report

Some candidates assumed that triangle ACB was a right angled triangle with angle
$\mathrm{ACB} = 90^\circ$. Such candidates earned no marks for part (a) but were able to recover most of the marks in the remainder of the question. For those candidates who correctly used the cosine rule for part (a), most achieved all 3 marks for this part and used a correct formula for the area of the triangle in part (b) to obtain at least 2 marks for this part. The final mark was not awarded, however, if no units or the incorrect units were given. Parts (c) and (e) were generally well done with many candidates showing the unrounded answer before the required answer. Part (f) proved to be quite problematic for many candidates. Whilst many were able to earn a method mark for
$\frac{2190 \times 2600}{22}$, a significant number of these candidates were unable to convert the units correctly and very few correct answers were seen. Indeed, the most popular answer seemed to be 2590 litres.

9d. *[2 marks]*

Markscheme

1.34×10^7 ***(A2)***

Notes: Award ***(A2)*** for the correct answer.
Award ***(A1)(A0)*** for
1.34 and an incorrect index value.
Award ***(A0)(A0)*** for any other combination (including answers such as
13.4×10^6).

[2 marks]

Examiners report

Some candidates assumed that triangle ACB was a right angled triangle with angle $\mathrm{ACB} = 90^\circ$. Such candidates earned no marks for part (a) but were able to recover most of the marks in the remainder of the question. For those candidates who correctly used the cosine rule for part (a), most achieved all 3 marks for this part and used a correct formula for the area of the triangle in part (b) to obtain at least 2 marks for this part. The final mark was not awarded, however, if no units or the incorrect units were given. Parts (c) and (e) were generally well done with many candidates showing the unrounded answer before the required answer. Part (f) proved to be quite problematic for many candidates. Whilst many were able to earn a method mark for $\frac{2190 \times 2600}{22}$, a significant number of these candidates were unable to convert the units correctly and very few correct answers were seen. Indeed, the most popular answer seemed to be 2590 litres.

9e. *[3 marks]*

Markscheme

$2 \times 206.487\ldots + 24 \times 25 + 30 \times 25 + 17.2168\ldots \times 25$ ***(M1)(M1)***

Note: Award ***(M1)*** for multiplication of their answer to part (b) by 2 for area of two triangular ends, ***(M1)*** for three correct rectangle areas using 24, 30 and their 17.2.

$2193.26\ldots$ ***(A1)***

Note: Accept 2192 for use of 3 sf answers.

2190 ***(AG)***

Note: The final ***(A1)*** cannot be awarded unless both the unrounded and rounded answers are seen.

[3 marks]

Examiners report

Some candidates assumed that triangle ACB was a right angled triangle with angle $\mathrm{ACB} = 90^\circ$. Such candidates earned no marks for part (a) but were able to recover most of the marks in the remainder of the question. For those candidates who correctly used the cosine rule for part (a), most achieved all 3 marks for this part and used a correct formula for the area of the triangle in part (b) to obtain at least 2 marks for this part. The final mark was not awarded, however, if no units or the incorrect units were given. Parts (c) and (e) were generally well done with many candidates showing the unrounded answer before the required answer. Part (f) proved to be quite problematic for many candidates. Whilst many were able to earn a method mark for $\frac{2190 \times 2600}{22}$, a significant number of these candidates were unable to convert the units correctly and very few correct answers were seen. Indeed, the most popular answer seemed to be 2590 litres.

9f. *[3 marks]*

Markscheme

$\frac{2190 \times 2600}{22 \times 10\,000}$ ***(M1)(M1)***

Notes: Award ***(M1)*** for multiplication by 2600 and division by 22, ***(M1)*** for division by $10\,000$.

The use of 22 may be implied *ie* division by 2200 would be acceptable.

25.9 litres $(25.8818\ldots)$ ***(A1)(G2)***

Note: Accept 26.

[3 marks]

Examiners report

Some candidates assumed that triangle ACB was a right angled triangle with angle $\text{ACB} = 90^\circ$. Such candidates earned no marks for part (a) but were able to recover most of the marks in the remainder of the question. For those candidates who correctly used the cosine rule for part (a), most achieved all 3 marks for this part and used a correct formula for the area of the triangle in part (b) to obtain at least 2 marks for this part. The final mark was not awarded, however, if no units or the incorrect units were given. Parts (c) and (e) were generally well done with many candidates showing the unrounded answer before the required answer. Part (f) proved to be quite problematic for many candidates. Whilst many were able to earn a method mark for $\frac{2190 \times 2600}{22}$, a significant number of these candidates were unable to convert the units correctly and very few correct answers were seen. Indeed, the most popular answer seemed to be 2590 litres.

10a. *[2 marks]*

Markscheme

$\frac{3}{4}(-2)^4 - (-2)^3 - 9(-2)^2 + 20$ ***(M1)***

Note: Award ***(M1)*** for substituting $x = -2$ in the function.

$= 4$ ***(A1)(G2)***

Note: If the coordinates $(-2,\ 4)$ are given as the answer award, at most, ***(M1)(A0)***. If no working shown award ***(G1)***.

If $x = -2,\ y = 4$ seen then award full marks.

[2 marks]

Examiners report

Surprisingly, a correct method for substituting the value of –2 into the given function led many candidates to a variety of incorrect answers. This suggests a poor handling of negative signs and/or poor use of the graphic display calculator. Many correct answers were seen in part (b) as candidates seemed to be well-drilled in the process of differentiation. Part (c), however, proved to be quite a discriminator. There were 5 marks for this part of the question and simply showing that
$x - 3$ is a turning point was not sufficient for all of these marks. Many simply scored only two marks by substituting
$x - 3$ into their answer to part (b). Once they had shown that there was a turning point at
$x - 3$, candidates were not expected to use the second derivative but to show that the function decreases for
$x < 3$ and increases for
$x > 3$. Part (d) required a sketch which could have either been done on lined paper or on graph paper. The majority of candidates obtained at least two marks here with the most common errors seen being incomplete labelled axes and curves which were far from being smooth. In part (e), many candidates identified the correct coordinates for the two marks available. But for many candidates, this is where responses stopped as, in part (f), connecting the gradient function found in part (b) to the given coordinates proved problematic and only a significant minority of candidates were able to arrive at the required answer of –24. Indeed, there were many NR (no responses) to this part and the final part of the question. As many candidates found part (f) difficult, even more candidates found getting beyond the gradient of L very difficult indeed. A minority of candidates wrote down the gradient of their perpendicular but then did not seem to know where to proceed from there. Substituting their gradient for b and the coordinates (2, –12) into the equation
$x + by + c = 0$ was a popular, but erroneous, method. It was a rare event indeed to see a script with a correct answer for this part of the question.

10b. *[3 marks]*

Markscheme

$3x^3 - 3x^2 - 18x$ ***(A1)(A1)(A1)***

Note: Award ***(A1)*** for each correct term, award at most ***(A1)(A1)(A0)*** if extra terms seen.

[3 marks]

Examiners report

Surprisingly, a correct method for substituting the value of –2 into the given function led many candidates to a variety of incorrect answers. This suggests a poor handling of negative signs and/or poor use of the graphic display calculator. Many correct answers were seen in part (b) as candidates seemed to be well-drilled in the process of differentiation. Part (c), however, proved to be quite a discriminator. There were 5 marks for this part of the question and simply showing that
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$x > 3$. Part (d) required a sketch which could have either been done on lined paper or on graph paper. The majority of candidates obtained at least two marks here with the most common errors seen being incomplete labelled axes and curves which were far from being smooth. In part (e), many candidates identified the correct coordinates for the two marks available. But for many candidates, this is where responses stopped as, in part (f), connecting the gradient function found in part (b) to the given coordinates proved problematic and only a significant minority of candidates were able to arrive at the required answer of –24. Indeed, there were many NR (no responses) to this part and the final part of the question. As many candidates found part (f) difficult, even more candidates found getting beyond the gradient of L very difficult indeed. A minority of candidates wrote down the gradient of their perpendicular but then did not seem to know where to proceed from there. Substituting their gradient for b and the coordinates (2, –12) into the equation
$x + by + c = 0$ was a popular, but erroneous, method. It was a rare event indeed to see a script with a correct answer for this part of the question.

10c. [5 marks]

Markscheme

$f'(3) = 3 \times (3)^3 - 3 \times (3)^2 - 18 \times 3$ ***(M1)***

Note: Award ***(M1)*** for substitution in their
$f'(x)$ of
$x = 3$.

$= 0$ ***(A1)***

OR

$3x^3 - 3x^2 - 18x = 0$ ***(M1)***

Note: Award ***(M1)*** for equating their
$f'(x)$ to zero.

$x = 3$ ***(A1)***

$f'(x_1) = 3 \times (x_1)^3 - 3 \times (x_1)^2 - 18 \times x_1 < 0$ where
$0 < x_1 < 3$ ***(M1)***

Note: Award ***(M1)*** for substituting a value of
x_1 in the range
$0 < x_1 < 3$ into their
f' and showing it is negative (decreasing).

$f'(x_2) = 3 \times (x_2)^3 - 3 \times (x_2)^2 - 18 \times x_2 > 0$ where
$x_2 > 3$ ***(M1)***

Note: Award ***(M1)*** for substituting a value of
x_2 in the range
$x_2 > 3$ into their
f' and showing it is positive (increasing).

OR

With or without a sketch:

Showing
$f(x_1) > f(3)$ where
$x_1 < 3$ and
x_1 is close to 3. ***(M1)***

Showing
$f(x_2) > f(3)$ where
$x_2 > 3$ and
x_2 is close to 3. ***(M1)***

Note: If a sketch of
$f(x)$ is drawn **in this part of the question and**
$x = 3$ is identified as a stationary point on the curve, then

(i) award, at most, ***(M1)(A1)(M1)(M0)*** if the stationary point has been found;

(ii) award, at most, ***(M0)(A0)(M1)(M0)*** if the stationary point has not been previously found.

Since the gradients go from negative (decreasing) through zero to positive (increasing) it is a local minimum ***(R1)(AG)***

Note: Only award ***(R1)*** if the first two marks have been awarded *ie*
$f'(3)$ has been shown to be equal to
0.

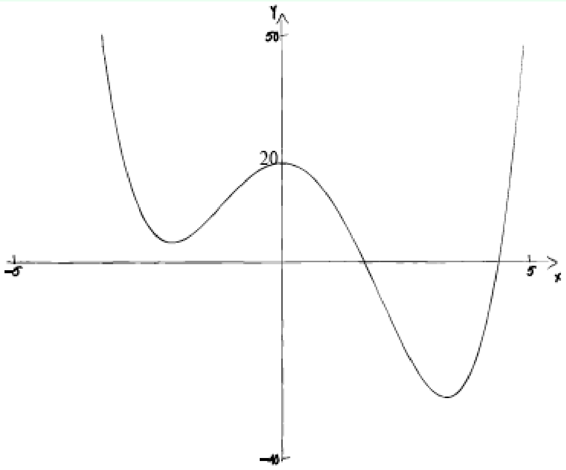
[5 marks]

Examiners report

Surprisingly, a correct method for substituting the value of –2 into the given function led many candidates to a variety of incorrect answers. This suggests a poor handling of negative signs and/or poor use of the graphic display calculator. Many correct answers were seen in part (b) as candidates seemed to be well-drilled in the process of differentiation. Part (c), however, proved to be quite a discriminator. There were 5 marks for this part of the question and simply showing that
$x-3$ is a turning point was not sufficient for all of these marks. Many simply scored only two marks by substituting
$x-3$ into their answer to part (b). Once they had shown that there was a turning point at
$x-3$, candidates were not expected to use the second derivative but to show that the function decreases for
$x<3$ and increases for
$x>3$. Part (d) required a sketch which could have either been done on lined paper or on graph paper. The majority of candidates obtained at least two marks here with the most common errors seen being incomplete labelled axes and curves which were far from being smooth. In part (e), many candidates identified the correct coordinates for the two marks available. But for many candidates, this is where responses stopped as, in part (f), connecting the gradient function found in part (b) to the given coordinates proved problematic and only a significant minority of candidates were able to arrive at the required answer of –24. Indeed, there were many NR (no responses) to this part and the final part of the question. As many candidates found part (f) difficult, even more candidates found getting beyond the gradient of L very difficult indeed. A minority of candidates wrote down the gradient of their perpendicular but then did not seem to know where to proceed from there. Substituting their gradient for b and the coordinates (2, –12) into the equation
$x+by+c=0$ was a popular, but erroneous, method. It was a rare event indeed to see a script with a correct answer for this part of the question.

10d. *[4 marks]*

Markscheme



(A1)(A1)(A1)(A1)

Notes: Award *(A1)* for labelled axes and indication of scale on both axes.

Award *(A1)* for smooth curve with correct shape.

Award *(A1)* for local minima in 2^{nd} and 4^{th} quadrants.

Award *(A1)* for *y* intercept $(0, 20)$ seen and labelled. Accept 20 on y-axis.

Do **not** award the third *(A1)* mark if there is a turning point on the x-axis.

If the derivative function is sketched then award, at most, ***(A1)(A0)(A0)(A0)***.

For a smooth curve (with correct shape) there should be **ONE** continuous thin line, no part of which is straight and no (one to many) mappings of x.

[4 marks]

Examiners report

Surprisingly, a correct method for substituting the value of –2 into the given function led many candidates to a variety of incorrect answers. This suggests a poor handling of negative signs and/or poor use of the graphic display calculator. Many correct answers were seen in part (b) as candidates seemed to be well-drilled in the process of differentiation. Part (c), however, proved to be quite a discriminator. There were 5 marks for this part of the question and simply showing that $x - 3$ is a turning point was not sufficient for all of these marks. Many simply scored only two marks by substituting $x - 3$ into their answer to part (b). Once they had shown that there was a turning point at $x - 3$, candidates were not expected to use the second derivative but to show that the function decreases for $x < 3$ and increases for $x > 3$. Part (d) required a sketch which could have either been done on lined paper or on graph paper. The majority of candidates obtained at least two marks here with the most common errors seen being incomplete labelled axes and curves which were far from being smooth. In part (e), many candidates identified the correct coordinates for the two marks available. But for many candidates, this is where responses stopped as, in part (f), connecting the gradient function found in part (b) to the given coordinates proved problematic and only a significant minority of candidates were able to arrive at the required answer of –24. Indeed, there were many NR (no responses) to this part and the final part of the question. As many candidates found part (f) difficult, even more candidates found getting beyond the gradient of *L* very difficult indeed. A minority of candidates wrote down the gradient of their perpendicular but then did not seem to know where to proceed from there. Substituting their gradient for *b* and the coordinates (2, –12) into the equation $x + by + c = 0$ was a popular, but erroneous, method. It was a rare event indeed to see a script with a correct answer for this part of the question.

10e. *[2 marks]*

Markscheme

$(0, 20)$ ***(G1)(G1)***

Note: If parentheses are omitted award ***(G0)(G1)***.

OR

$x = 0,\ y = 20$ ***(G1)(G1)***

Note: If the derivative function is sketched in part (d), award ***(G1)*(ft)*(G1)*(ft)** for $(-1.12, 12.2)$.

[2 marks]

Examiners report

Surprisingly, a correct method for substituting the value of –2 into the given function led many candidates to a variety of incorrect answers. This suggests a poor handling of negative signs and/or poor use of the graphic display calculator. Many correct answers were seen in part (b) as candidates seemed to be well-drilled in the process of differentiation. Part (c), however, proved to be quite a discriminator. There were 5 marks for this part of the question and simply showing that $x - 3$ is a turning point was not sufficient for all of these marks. Many simply scored only two marks by substituting $x - 3$ into their answer to part (b). Once they had shown that there was a turning point at $x - 3$, candidates were not expected to use the second derivative but to show that the function decreases for $x < 3$ and increases for $x > 3$. Part (d) required a sketch which could have either been done on lined paper or on graph paper. The majority of candidates obtained at least two marks here with the most common errors seen being incomplete labelled axes and curves which were far from being smooth. In part (e), many candidates identified the correct coordinates for the two marks available. But for many candidates, this is where responses stopped as, in part (f), connecting the gradient function found in part (b) to the given coordinates proved problematic and only a significant minority of candidates were able to arrive at the required answer of –24. Indeed, there were many NR (no responses) to this part and the final part of the question. As many candidates found part (f) difficult, even more candidates found getting beyond the gradient of L very difficult indeed. A minority of candidates wrote down the gradient of their perpendicular but then did not seem to know where to proceed from there. Substituting their gradient for b and the coordinates (2, –12) into the equation $x + by + c = 0$ was a popular, but erroneous, method. It was a rare event indeed to see a script with a correct answer for this part of the question.

10f. *[2 marks]*

$f'(2) = 3(2)^3 - 3(2)^2 - 18(2)$

$x = 2$

$f'(x)$

$= -24$

Examiners report

Surprisingly, a correct method for substituting the value of –2 into the given function led many candidates to a variety of incorrect answers. This suggests a poor handling of negative signs and/or poor use of the graphic display calculator. Many correct answers were seen in part (b) as candidates seemed to be well-drilled in the process of differentiation. Part (c), however, proved to be quite a discriminator. There were 5 marks for this part of the question and simply showing that
$x - 3$ is a turning point was not sufficient for all of these marks. Many simply scored only two marks by substituting
$x - 3$ into their answer to part (b). Once they had shown that there was a turning point at
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$x < 3$ and increases for
$x > 3$. Part (d) required a sketch which could have either been done on lined paper or on graph paper. The majority of candidates obtained at least two marks here with the most common errors seen being incomplete labelled axes and curves which were far from being smooth. In part (e), many candidates identified the correct coordinates for the two marks available. But for many candidates, this is where responses stopped as, in part (f), connecting the gradient function found in part (b) to the given coordinates proved problematic and only a significant minority of candidates were able to arrive at the required answer of –24. Indeed, there were many NR (no responses) to this part and the final part of the question. As many candidates found part (f) difficult, even more candidates found getting beyond the gradient of L very difficult indeed. A minority of candidates wrote down the gradient of their perpendicular but then did not seem to know where to proceed from there. Substituting their gradient for b and the coordinates (2, –12) into the equation
$x + by + c = 0$ was a popular, but erroneous, method. It was a rare event indeed to see a script with a correct answer for this part of the question.

10g. *[5 marks]*

Markscheme

(i) Gradient of perpendicular

$= \frac{1}{24}$

$(0.0417, 0.041666\ldots)$ ***(A1)*(ft)*(G1)***

Note: Follow through from part (f).

(ii)

$y + 12 = \frac{1}{24}(x - 2)$ ***(M1)(M1)***

Note: Award ***(M1)*** for correct substitution of

$(2, -12)$, ***(M1)*** for correct substitution of their perpendicular gradient into equation of line.

OR

$-12 = \frac{1}{24} \times 2 + d$ ***(M1)***

$d = -\frac{145}{12}$

$y = \frac{1}{24}x - \frac{145}{12}$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of

$(2, -12)$ and gradient into equation of a straight line, ***(M1)*** for correct substitution of the perpendicular gradient and correct substitution of

d into equation of line.

$b = -24,\ c = -290$ ***(A1)*(ft)*(A1)*(ft)*(G3)***

Note: Follow through from parts (f) and g(i).

To award **(ft)** marks,

b and

c must be integers.

Where candidate has used

0.042 from g(i), award ***(A1)*(ft)** for

-288.

[5 marks]

Examiners report

Surprisingly, a correct method for substituting the value of –2 into the given function led many candidates to a variety of incorrect answers. This suggests a poor handling of negative signs and/or poor use of the graphic display calculator. Many correct answers were seen in part (b) as candidates seemed to be well-drilled in the process of differentiation. Part (c), however, proved to be quite a discriminator. There were 5 marks for this part of the question and simply showing that

$x - 3$ is a turning point was not sufficient for all of these marks. Many simply scored only two marks by substituting

$x - 3$ into their answer to part (b). Once they had shown that there was a turning point at

$x - 3$, candidates were not expected to use the second derivative but to show that the function decreases for

$x < 3$ and increases for

$x > 3$. Part (d) required a sketch which could have either been done on lined paper or on graph paper. The majority of candidates obtained at least two marks here with the most common errors seen being incomplete labelled axes and curves which were far from being smooth. In part (e), many candidates identified the correct coordinates for the two marks available. But for many candidates, this is where responses stopped as, in part (f), connecting the gradient function found in part (b) to the given coordinates proved problematic and only a significant minority of candidates were able to arrive at the required answer of –24. Indeed, there were many NR (no responses) to this part and the final part of the question. As many candidates found part (f) difficult, even more candidates found getting beyond the gradient of L very difficult indeed. A minority of candidates wrote down the gradient of their perpendicular but then did not seem to know where to proceed from there. Substituting their gradient for b and the coordinates (2, –12) into the equation

$x + by + c = 0$ was a popular, but erroneous, method. It was a rare event indeed to see a script with a correct answer for this part of the question.

11a. *[3 marks]*

Markscheme

$\frac{70}{\sin 78} = \frac{50}{\sin \rm{A\hat{B}C}}$ ***(M1)(A1)***

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

$\rm{A\hat{B}C} = 44.3^\circ$ (
44.3209...) ***(A1)(G3)***

Note: If radians are used the answer is
0.375918..., award at most ***(M1)(A1)(A0)***.

[3 marks]

Examiners report

[N/A]

11b. *[4 marks]*

Markscheme

area $\Delta\mathrm{ABC} = \frac{1}{2} \times 70 \times 50 \times \sin(57.6790\ldots)$ ***(A1)(M1)(A1)*(ft)**

Notes: Award ***(A1)*(ft)** for their
$57.6790\ldots$ seen, ***(M1)*** for substituted area formula, ***(A1)*(ft)** for correct substitution.
Follow through from part (a).

$= 1480\ \mathrm{m}^2$
$(1478.86\ldots)$ ***(A1)*(ft)*(G3)***

Notes: The answer is
$1480\ \mathrm{m}^2$, units are required.
$1479.20\ldots$ if 3 sf used.
If radians are used the answer is
$1554.11\ldots\mathrm{m}^2$, award ***(A1)*(ft)*(M1)(A1)*(ft)*(A1)*(ft)*(G3)***.

[4 marks]

Examiners report

[N/A]

11c. *[3 marks]*

Markscheme

$\mathrm{BM}^2 = 70^2 + 25^2 - 2 \times 70 \times 25 \times \cos(57.6790\ldots)$ ***(M1)(A1)(ft)***

Notes: Award ***(M1)*** for substituted cosine rule, ***(A1)*(ft)** for correct substitution. Follow through from their angle in part (b).

$\mathrm{BM} = 60.4\ (\mathrm{m})$
$(60.4457\ldots)$ ***(A1)*(ft)*(G2)***

Notes: If the 3 sf answer is used the answer is
$60.5\ (\mathrm{m})$.
If radians are used the answer is
$62.5757\ldots\ (\mathrm{m})$, award ***(M1)(A1)*(ft)*(A1)*(ft)*(G2)***.

[3 marks]

Examiners report

[N/A]

11d. [5 marks]

Markscheme

$\tan 63.4^\circ = \frac{\text{TB}}{60.4457\ldots}$ ***(M1)***

Note: Award ***(M1)*** for their correctly substituted trig equation.

$\text{TB} = 120.707\ldots$ ***(A1)*(ft)**

Notes: Follow through from part (c). If 3 sf answers are used throughout,
$\text{TB} = 120.815\ldots$
If
$\text{TB} = 120.707\ldots$ is seen without working, award ***(A2)***.

$\tan \text{N}\hat{\text{M}}\text{B} = \frac{\left(\frac{120.707\ldots}{2}\right)}{60.4457\ldots}$ ***(A1)*(ft)*(M1)***

Notes: Award ***(A1)*(ft)** for their
TB divided by
2 seen, ***(M1)*** for their correctly substituted trig equation.
Follow through from part (c) and **within part (d)**.

$\text{N}\hat{\text{M}}\text{B} = 45.0^\circ$
$(44.9563\ldots)$ ***(A1)*(ft)*(G3)***

Notes: If 3 sf are used throughout, answer is
45°.
If radians are used the answer is
$0.308958\ldots$, and if full working is shown, award at most ***(M1)(A1)*(ft)*(A1)*(ft)*(M1)(A0)***.
If no working is shown for radians answer, award ***(G2)***.

OR

$\tan \text{N}\hat{\text{M}}\text{B} = \frac{\text{NB}}{\text{BM}}$ ***(M1)***
$\tan 63.4^\circ = \frac{2\times\text{NB}}{\text{BM}}$ ***(A1)(M1)***

Note: Award ***(A1)*** for
$2 \times \text{NB}$ seen.

$\tan \text{N}\hat{\text{M}}\text{B} = \frac{1}{2}\tan 63.4^\circ$ ***(M1)***
$\text{N}\hat{\text{M}}\text{B} = 45.0^\circ$
$(44.9563\ldots)$ ***(A1)(G3)***

Notes: If radians are used the answer is
$0.308958\ldots$, and if full working is shown, award at most ***(M1)(A1)(M1)(M1)(A0)***. If no working is shown for radians answer, award ***(G2)***.

[5 marks]

Examiners report

[N/A]

12a. *[3 marks]*

Markscheme

$2\pi r + 4r + 4l$ ***(A1)(A1)(A1)***

Notes: Award ***(A1)*** for
$2\pi r$ ("
π" must be seen), ***(A1)*** for
$4r$, ***(A1)*** for
$4l$. Accept equivalent forms. Accept
$T = 2\pi r + 4r + 4l$. Award a maximum of ***(A1)(A1)(A0)*** if extra terms are seen.

[3 marks]

Examiners report

[N/A]

12b. *[3 marks]*

Markscheme

$0.75 = \frac{\pi r^2 l}{2}$ ***(A1)(A1)(A1)***

Notes: Award ***(A1)*** for their formula equated to
0.75, ***(A1)*** for
l substituted into volume of cylinder formula, ***(A1)*** for volume of cylinder formula divided by
2.
If "
π" not seen in part (a) accept use of
3.14 or greater accuracy. Award a maximum of ***(A1)(A1)(A0)*** if extra terms are seen.

[3 marks]

Examiners report

[N/A]

12c. *[2 marks]*

Markscheme

$T = 2\pi r + 4r + 4\left(\frac{1.5}{\pi r^2}\right)$ ***(A1)*****(ft)*****(A1)***

$= (2\pi + 4)r + \frac{6}{\pi r^2}$ ***(AG)***

Notes: Award ***(A1)*****(ft)** for correct rearrangement of their volume formula in part (b) seen, award ***(A1)*** for the correct substituted formula for
T. The final line must be seen, with no incorrect working, for this second ***(A1)*** to be awarded.

[2 marks]

Examiners report

[N/A]

12d. *[3 marks]*

Markscheme

$\frac{\mathrm{d}T}{\mathrm{d}r} = 2\pi + 4 - \frac{12}{\pi r^3}$ ***(A1)(A1)(A1)***

Note: Award ***(A1)*** for
$2\pi + 4$, ***(A1)*** for
$\frac{-12}{\pi}$, ***(A1)*** for
r^{-3}.
Accept 10.3 (10.2832…) for
$2\pi + 4$, accept
-3.82
$-3.81971\ldots$ for
$\frac{-12}{\pi}$. Award a maximum of ***(A1)(A1)(A0)*** if extra terms are seen.

[3 marks]

Examiners report

[N/A]

12e. *[2 marks]*

Markscheme

$2\pi + 4 - \frac{12}{\pi r^3} = 0$ **OR**
$\frac{\mathrm{d}T}{\mathrm{d}r} = 0$ ***(M1)***

Note: Award ***(M1)*** for setting their derivative equal to zero.

$r = 0.718843\ldots$ **OR**
$\sqrt[3]{0.371452\ldots}$ **OR**
$\sqrt[3]{\frac{12}{\pi(2\pi+4)}}$ **OR**
$\sqrt[3]{\frac{3.81971}{10.2832\ldots}}$ ***(A1)***
$r = 0.719\ (\mathrm{m})$ ***(AG)***

Note: The rounded and unrounded or formulaic answers must be seen for the final ***(A1)*** to be awarded. The use of 3.14 gives an unrounded answer of
$r = 0.719039\ldots$.

[2 marks]

Examiners report

[N/A]

12f. *[2 marks]*

Markscheme

$0.75 = \frac{\pi \times (0.719)^2 l}{2}$ ***(M1)***

Note: Award ***(M1)*** for substituting
0.719 into their volume formula. Follow through from part (b).

$l = 0.924 \text{ (m)}$
$(0.923599\dots)$ ***(A1)*(ft)*(G2)***

[2 marks]

Examiners report

[N/A]

12g. *[2 marks]*

Markscheme

$T = (2\pi + 4) \times 0.719 + \frac{6}{\pi (0.719)^2}$ ***(M1)***

Notes: Award ***(M1)*** for substituting
0.719 in their expression for
T. Accept alternative methods, for example substitution of their
l and
0.719 into their part (a) (for which the answer is
11.08961024). Follow through from their answer to part (a).

$= 11.1 \text{ (m)}$
$(11.0880\dots)$ ***(A1)*(ft)*(G2)***

Examiners report

[N/A]

13a. *[3 marks]*

Markscheme

$V = 16 \times 1\frac{3}{4} \times 2\frac{2}{3}$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in volume formula. Accept decimal substitution of
2.66 or better.

$= 74.6666\ \dots$ ***(A1)***
$= 74\frac{2}{3} \text{ m}^3 \left(\frac{224}{3} \text{ m}^3\right)$ ***(A1)*** ***(C3)***

Note: Correct answer only.

[3 marks]

Examiners report

This question was well answered by the majority of candidates. Candidates encountered difficulty in part (a) with using fractions finding the exact volume. Nearly all candidates could use the formula for volume and most could achieve at least 2 marks in this first part. Most candidates could find the percentage error correctly using the formula once they found the estimate for the volume. Very few candidates substituted the formula incorrectly, or had an incorrect denominator.

13b.

[3 marks]

Markscheme

$\% \text{ error} = \frac{\left(90 - 74\frac{2}{3}\right) \times 100}{74\frac{2}{3}}$ ***(A1)(M1)***

Note: Award ***(A1)*** for
90 seen, or inferred in numerator, ***(M1)*** for correct substitution into percentage error formula.

$= 20.5$ ***(A1)*(ft)** ***(C3)***

Note: Accept
-20.5.

[3 marks]

Examiners report

This question was well answered by the majority of candidates. Candidates encountered difficulty in part (a) with using fractions finding the exact volume. Nearly all candidates could use the formula for volume and most could achieve at least 2 marks in this first part. Most candidates could find the percentage error correctly using the formula once they found the estimate for the volume. Very few candidates substituted the formula incorrectly, or had an incorrect denominator.

14a.

[3 marks]

Markscheme

$V = \sqrt{\frac{500^3}{36\pi}}$ ***(M1)***

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

$V = 1051.305 \ldots$ ***(A1)***
$V = 1051.31 \text{ cm}^3$ ***(A1)*(ft)** ***(C3)***

Note: Award last ***(A1)*(ft)** for correct rounding to 2 decimal places of their answer. Unrounded answer must be seen so that the follow through can be awarded.

[3 marks]

Examiners report

This question was well answered by many of the candidates. A significant number of candidates lost two marks in part (a) for not using the calculator correctly and omitting brackets in the denominator when entering the volume expression in their GDC. Also, those students who did not show the unrounded answer in the working box could not be awarded the last mark in part a). Follow through marks were awarded for parts (b) and (c) which most candidates gained.

14b.

[1 mark]

Markscheme

1051 ***(A1)*(ft)**

[1 mark]

Examiners report

This question was well answered by many of the candidates. A significant number of candidates lost two marks in part (a) for not using the calculator correctly and omitting brackets in the denominator when entering the volume expression in their GDC. Also, those students who did not show the unrounded answer in the working box could not be awarded the last mark in part (a). Follow through marks were awarded for parts (b) and (c) which most candidates gained.

14c.

[2 marks]

Markscheme

1.051×10^3 ***(A1)*(ft)*(A1)*(ft)** ***(C2)***

Note: Award ***(A1)*** for 1.051 (accept 1.05) ***(A1)*** for $\times 10^3$.

[2 marks]

Examiners report

This question was well answered by many of the candidates. A significant number of candidates lost two marks in part (a) for not using the calculator correctly and omitting brackets in the denominator when entering the volume expression in their GDC. Also, those students who did not show the unrounded answer in the working box could not be awarded the last mark in part a). Follow through marks were awarded for parts (b) and (c) which most candidates gained.

15a.

[1 mark]

Markscheme

30° ***(A1)*** ***(C3)***

[1 mark]

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.

15b.

[1 mark]

Markscheme

8.5 (cm) ***(A1)***

[1 mark]

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.

15c. *[1 mark]*

Markscheme

$120°$ ***(A1)***

[1 mark]

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.

15d. *[3 marks]*

Markscheme

$\frac{\text{BC}}{\sin 120} = \frac{8.5}{\sin 30}$ ***(M1)(A1)*(ft)**

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

$\text{BC} = 14.7\left(\frac{17\sqrt{3}}{2}\right)$ ***(A1)*(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.

16a. *[1 mark]*

Markscheme

1380 (m) ***(A1)*** ***(C1)***

[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.

16b. *[3 marks]*

Markscheme

$1380 \tan 28.3$ ***(M1)***

$= 743.05....$ ***(A1)*(ft)**

$= 743$ (m) ***(A1)*(ft)** ***(C3)***

Notes: Award ***(M1)*** for correct substitution in tan formula or equivalent, ***(A1)*(ft)** for their 743.05 seen, ***(A1)*(ft)** 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.

16c. *[2 marks]*

Markscheme

percentage error $= \frac{743.05...-718}{718} \times 100$ ***(M1)***

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

= 3.49 % (*% symbol not required*) ***(A1)*(ft)** ***(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.

17a. *[1 mark]*

Markscheme

–2 ***(A1)*** ***(C1)***

Note: Accept (0, –2).

[1 mark]

Examiners report

Although the first three parts of this question were well answered, with most candidates knowing how to find the y intercept, gradient of a given line and gradient of the perpendicular line, very few candidates could find the equation of the perpendicular line and correctly state it in the required form.

17b.

[1 mark]

Markscheme

$-\frac{1}{2}$ ***(A1)*** ***(C1)***

[1 mark]

Examiners report

Although the first three parts of this question were well answered, with most candidates knowing how to find the y intercept, gradient of a given line and gradient of the perpendicular line, very few candidates could find the equation of the perpendicular line and correctly state it in the required form.

17c.

[1 mark]

Markscheme

2 ***(A1)*****(ft)** ***(C1)***

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

[1 mark]

Examiners report

Although the first three parts of this question were well answered, with most candidates knowing how to find the y intercept, gradient of a given line and gradient of the perpendicular line, very few candidates could find the equation of the perpendicular line and correctly state it in the required form.

17d. *[3 marks]*

Markscheme

$y = 2x + c$ (*can be implied*)
$7 = 2 \times 3 + c$ ***(M1)***
$c = 1$ ***(A1)*(ft)**
$y = 2x + 1$

Notes: Award ***(M1)*** for substitution of (3, 7), ***(A1)*(ft)** for c.

Follow through from their answer to part (c).

OR

$y - 7 = 2(x - 3)$ ***(M1)(M1)***

Note: Award ***(M1)*** for substitution of their answer to part (c), ***(M1)*** for substitution of (3, 7).

$2x - y + 1 = 0$ **or** $-2x + y - 1 = 0$ ***(A1)*(ft)** ***(C3)***

Note: Award ***(A1)*(ft)** for their equation in the stated form.

[3 marks]

Examiners report

Although the first three parts of this question were well answered, with most candidates knowing how to find the y intercept, gradient of a given line and gradient of the perpendicular line, very few candidates could find the equation of the perpendicular line and correctly state it in the required form.

18a. *[2 marks]*

Markscheme

$\text{AG} = \sqrt{0.8^2 + 0.5^2}$ ***(M1)***

AG = 0.943 m ***(A1)*** ***(C2)***

[2 marks]

Examiners report

This question was well answered. Surprisingly few candidates used the basic trigonometric ratios (for right angle triangles), opting instead to use the sine or cosine laws.

18b. *[2 marks]*

Markscheme

$\text{AF} = \sqrt{\text{AG}^2 + 1.80^2}$ ***(M1)***

= 2.03 m ***(A1)*(ft)** ***(C2)***

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

[2 marks]

Examiners report

This question was well answered. Surprisingly few candidates used the basic trigonometric ratios (for right angle triangles), opting instead to use the sine or cosine laws.

18c. *[2 marks]*

Markscheme

$\cos \mathrm{G\hat{A}F} = \frac{0.943(39\ldots)}{2.03(22\ldots)}$ ***(M1)***

$\mathrm{G\hat{A}F} = 62.3°$ ***(A1)*(ft)** ***(C2)***

Notes: Award ***(M1)*** for substitution into correct trig ratio.

Accept alternative ratios which give 62.4° **or** 62.5°.

Follow through from their answers to parts (a) and (b).

[2 marks]

Examiners report

This question was well answered. Surprisingly few candidates used the basic trigonometric ratios (for right angle triangles), opting instead to use the sine or cosine laws.

19a. *[1 mark]*

Markscheme

A(0, 4) *Accept* $x = 0$, $y = 4$ ***(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.

19b. *[1 mark]*

Markscheme

B(8, 0) *Accept* $x = 8$, $y = 0$ ***(A1)*(ft)**

Note: Award ***(A0)*** if coordinates are reversed in (i) and ***(A1)*(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.

19c. *[2 marks]*

Markscheme

$\text{AB} = \sqrt{8^2 + 4^2} \ = \sqrt{80}$ ***(M1)***

AB = 8.944 ***(A1)***

= 8.94 ***(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.

19d. *[3 marks]*

Markscheme

$y = –0.5x + 4$ ***(M1)***
Gradient AB = –0.5 ***(A1)***

Note: Award ***(A2)*** if –0.5 seen.

OR

Gradient
$\text{AB} = \frac{(0-4)}{(8-0)}$ ***(M1)***
$= -\frac{1}{2}$ ***(A1)***

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

Gradient CN = 2 ***(A1)*(ft)*(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.

19e.

[2 marks]

Markscheme

CN: $y = 2x + c$

$7 = 2(4) + c$ ***(M1)***

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

$y = 2x - 1$ ***(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.

19f.

[3 marks]

Markscheme

$x + 2(2x - 1) = 8$ *or equivalent* ***(M1)***

N(2, 3) ($x = 2$, $y = 3$) ***(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.

19g.

[3 marks]

Markscheme

Cosine rule:

$\cos(\mathrm{A\hat{C}B}) = \frac{5^2+8.06^2-8.944^2}{2\times5\times8.06}$ ***(M1)(A1)***

Note: Award ***(M1)*** for use of cosine rule with numbers from the problem substituted, ***(A1)*** for correct substitution.

$\mathrm{A\hat{C}B} = 82.9°$ ***(A1)(G2)***

Note: If alternative right-angled trigonometry method used award ***(M1)*** for use of trig ratio in both triangles, ***(A1)*** for correct substitution of their values in each ratio, ***(A1)*** for answer.

Note: Accept 82.8° 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.

19h.

[3 marks]

Markscheme

Area

$\mathrm{ACB} = \frac{5\times8.06\sin(82.9)}{2}$ ***(M1)(A1)*(ft)**

Note: Award ***(M1)*** for substituted area formula, ***(A1)*** for correct substitution. Follow through from their angle in part (e).

OR

Area

$\mathrm{ACB} = \frac{\mathrm{AB}\times\mathrm{CN}}{2} = \frac{8.94\times\sqrt{(4-2)^2+(7-3)^2}}{2}$ ***(M1)(M1)*(ft)**

Note: Award ***(M1)*** substituted area formula with their values, ***(M1)*** for substituted distance formula. Follow through from coordinates of N.

Area ACB = 20.0 ***(A1)*(ft)*(G2)***

Note: Accept 20

[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.

20a. *[2 marks]*

Markscheme

$\frac{9-1}{0-(-4)}$ ***(M1)***

$= 2$ ***(A1)(G2)***

Notes: Award ***(M1)*** for correct substitution into the gradient formula.

[2 marks]

Examiners report

This question was in general well answered. In part (a) the gradient of the line AB was correctly found although some candidates did not substitute well in the gradient formula and found answers as
$\frac{1}{2}$ or –2. Also some students read B as (0, 8) instead of (0, 9). In part (b) many students again did not make good use of time as they found the equation of the line instead of just extending it to find the y - intercept. The equation of L_2 in (c) was correctly found in the form $y = mx + c$ but very few students were able to rearrange the equation in the form $ax + by + d = 0$ where a, b, d
$\in \mathbb{Z}$. In (d) many candidates found the coordinates of point D by solving simultaneous equations which led again to a waste of time. The last two parts of this question were well done by those students that attempted them.

20b. *[1 mark]*

Markscheme

–6 ***(A1)***

Note: Accept (0, –6) .

[1 mark]

Examiners report

This question was in general well answered. In part (a) the gradient of the line AB was correctly found although some candidates did not substitute well in the gradient formula and found answers as
$\frac{1}{2}$ or –2. Also some students read B as (0, 8) instead of (0, 9). In part (b) many students again did not make good use of time as they found the equation of the line instead of just extending it to find the y - intercept. The equation of L_2 in (c) was correctly found in the form $y = mx + c$ but very few students were able to rearrange the equation in the form $ax + by + d = 0$ where a, b, d
$\in \mathbb{Z}$. In (d) many candidates found the coordinates of point D by solving simultaneous equations which led again to a waste of time. The last two parts of this question were well done by those students that attempted them.

20c. *[3 marks]*

Markscheme

$y = -\frac{1}{2}x - 1$ (or equivalent) ***(A1)*(ft)*(A1)***

Notes: Award ***(A1)*(ft)** for gradient, ***(A1)*** for correct y-intercept. Follow through from their gradient in (a).

$x + 2y + 2 = 0$ ***(A1)*(ft)**

Notes: Award ***(A1)*(ft)** from their gradient and their y-intercept. Accept any multiple of this equation with integer coefficients.

OR

$y - 1 = -\frac{1}{2}(x + 4)$ (or equivalent) ***(A1)*(ft)*(A1)***

Note: Award ***(A1)*(ft)** for gradient, ***(A1)*** for any point on the line correctly substituted in equation.

$x + 2y + 2 = 0$ ***(A1)*(ft)**

Notes: Award ***(A1)*(ft)** from their equation. Accept any multiple of this equation with integer coefficients.

[3 marks]

Examiners report

This question was in general well answered. In part (a) the gradient of the line AB was correctly found although some candidates did not substitute well in the gradient formula and found answers as $\frac{1}{2}$ or –2. Also some students read B as (0, 8) instead of (0, 9). In part (b) many students again did not make good use of time as they found the equation of the line instead of just extending it to find the y - intercept. The equation of L_2 in (c) was correctly found in the form $y = mx + c$ but very few students were able to rearrange the equation in the form $ax + by + d = 0$ where $a, b, d \in \mathbb{Z}$. In (d) many candidates found the coordinates of point D by solving simultaneous equations which led again to a waste of time. The last two parts of this question were well done by those students that attempted them.

20d. *[1 mark]*

Markscheme

D(2, –2) or $x = 2$, $y = -2$ ***(A1)***

Note: Award ***(A0)*** if brackets not present.

[1 mark]

Examiners report

This question was in general well answered. In part (a) the gradient of the line AB was correctly found although some candidates did not substitute well in the gradient formula and found answers as $\frac{1}{2}$ or –2. Also some students read B as (0, 8) instead of (0, 9). In part (b) many students again did not make good use of time as they found the equation of the line instead of just extending it to find the y - intercept. The equation of L_2 in (c) was correctly found in the form $y = mx + c$ but very few students were able to rearrange the equation in the form $ax + by + d = 0$ where $a, b, d \in \mathbb{Z}$. In (d) many candidates found the coordinates of point D by solving simultaneous equations which led again to a waste of time. The last two parts of this question were well done by those students that attempted them.

20e.

[2 marks]

Markscheme

R(6, 6) **or** $x = 6$, $y = 6$ ***(A1)(A1)***

Note: Award at most ***(A0)(A1)*****(ft)** if brackets not present and absence of brackets has not already been penalised in part (d).

[2 marks]

Examiners report

This question was in general well answered. In part (a) the gradient of the line AB was correctly found although some candidates did not substitute well in the gradient formula and found answers as $\frac{1}{2}$ or –2. Also some students read B as (0, 8) instead of (0, 9). In part (b) many students again did not make good use of time as they found the equation of the line instead of just extending it to find the y - intercept. The equation of L_2 in (c) was correctly found in the form $y = mx + c$ but very few students were able to rearrange the equation in the form $ax + by + d = 0$ where $a, b, d \in \mathbb{Z}$. In (d) many candidates found the coordinates of point D by solving simultaneous equations which led again to a waste of time. The last two parts of this question were well done by those students that attempted them.

20f.

[4 marks]

Markscheme

(i)

$\mathrm{DR} = \sqrt{8^2 + 4^2}$ ***(M1)***

$\mathrm{DR} = \sqrt{80}$ (8.94) ***(A1)*****(ft)*****(G2)***

Note: Award ***(M1)*** for correct substitution into the distance formula. Follow through from their D and R.

(ii)

$\text{Area} = \frac{\sqrt{80} \times \sqrt{45}}{2}$ ***(M1)***

= 30 (30.0) ***(A1)*****(ft)*****(G2)***

Note: Award ***(M1)*** for correct substitution in the area of triangle formula. Follow through from their answer to part (f) (i).

[4 marks]

Examiners report

This question was in general well answered. In part (a) the gradient of the line AB was correctly found although some candidates did not substitute well in the gradient formula and found answers as $\frac{1}{2}$ or –2. Also some students read B as (0, 8) instead of (0, 9). In part (b) many students again did not make good use of time as they found the equation of the line instead of just extending it to find the y - intercept. The equation of L_2 in (c) was correctly found in the form $y = mx + c$ but very few students were able to rearrange the equation in the form $ax + by + d = 0$ where $a, b, d \in \mathbb{Z}$. In (d) many candidates found the coordinates of point D by solving simultaneous equations which led again to a waste of time. The last two parts of this question were well done by those students that attempted them.