Topic 5 Part 6 *[213 marks]*

1a. *[2 marks]*

Markscheme

$(3,\ 1)$ ***(A1)(A1)*** ***(C2)***

Note: Accept $x = 3, y = 1$. Award ***(A0)(A1)*** if parentheses are missing.

Examiners report

Parts (a), finding the midpoint, and (b) finding the gradient, of this question were done well by the majority of candidates.

1b. *[2 marks]*

Markscheme

$\frac{2-0}{0-6}$ ***(M1)***

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

$= -\frac{1}{3}(-0.333333\ldots)$ ***(A1)*** ***(C2)***

Note: Accept $-\frac{2}{6}$.

Examiners report

Parts (a), finding the midpoint, and (b) finding the gradient, of this question were done well by the majority of candidates. Some candidates substituted incorrectly into the gradient formula or reversed the numerator and denominator.

1c. *[2 marks]*

Markscheme

$(y-2) = -\frac{1}{3}(x-3)$ ***(M1)***

OR

$2 = -\frac{1}{3}(3) + c$ ***(M1)***

Note: Award ***(M1)*** for substitution of their gradient from part (b).

$y = -\frac{1}{3}x + 3$ ***(A1)(ft)*** ***(C2)***

Note: Follow through from part (b).

The answer must be an equation in the form $y = mx + c$ for the ***(A1)(ft)*** to be awarded.

Examiners report

There was a significant number of candidates who calculated the equation of the normal to the given line and not the equation of a parallel line. It seemed those candidates answered the question they expected and not the question asked.

2a. *[3 marks]*

Markscheme

$\frac{4}{3}\pi(6371)^3$ ***(M1)***

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

$= 1.08 \times 10^{12}$ $(1.08320\ldots \times 10^{12})$ ***(A2)*** ***(C3)***

Notes: Award ***(A1)(A0)*** for correct mantissa between 1 and 10, with incorrect index.

Award ***(A1)(A0)*** for $1.08\text{E}12$

Award ***(A0)(A0)*** for answers of the type: 108×10^{10}.

Examiners report

In part (a) many candidates correctly substituted the volume formula and wrote correctly their answer using scientific notation. The calculator notation E12 was very rarely used. A minority converted to metres, resulting in an incorrect exponent. Some candidates used an incorrect equation or used their calculator incorrectly.

2b. *[3 marks]*

Markscheme

$\frac{1.08320\ldots\times10^{12}}{2.1958\times10^{10}}$ ***(M1)***

Note: Award ***(M1)*** for dividing their answer to part (a) by 2.1958×10^{10}.

$= 49.3308\ldots$ ***(A1)*****(ft)**

Note: Accept $49.1848\ldots$ from use of 3 sf answer to part (a).

$= 49$ ***(A1)*** ***(C3)***

Notes: Follow through from part (a).

The final ***(A1)*** is awarded for their unrounded non-integer answer seen and given correct to the nearest integer.

Do not award the final ***(A1)*** for a rounded answer of 0 or if it is incorrect by a large order of magnitude.

Examiners report

In part (b) many candidates subtracted the values, where they should be divided, resulting in an answer of an unrealistic magnitude. Some reversed the numerator and denominator, leading to an answer of 0.02, which would have rounded to the unrealistic answer of 0. When a reasonable answer was found, the final mark for rounding was lost by some candidates when there was no rounding or when rounding was incorrect. There seemed to be little understanding of whether or not an answer was reasonable.

3a. *[4 marks]*

Markscheme

$\mathrm{AC}^2 = 8^2 + 6^2$ ***(M1)***

Note: Award ***(M1)*** for correct substitution into Pythagoras, or recognition of Pythagorean triple.

$\mathrm{AC} = 10$ ***(A1)***

Note: Award ***(A2)*** for $\mathrm{AC} = 10$ **OR** $\mathrm{AM} = 5$ with no working seen.

$\mathrm{VM}^2 = 13^2 - 5^2$ ***(M1)***

Note: Award ***(M1)*** for correct second use of Pythagoras, using the result from the first use of Pythagoras.

$\mathrm{VM} = 12\ (\mathrm{cm})$ ***(A1)*** ***(C4)***

Notes: Accept alternative methods and apply the markscheme as follows: Award ***(M1)(A1)*** for first correct use of Pythagoras with lengths from the question, ***(M1)*** for a correct second use of Pythagoras, consistent with the method chosen, ***(A1)*** for correct height.

Examiners report

In part (a) many candidates struggled to identify right angled triangles correctly. A regular mistake was to calculate the slant height and not the vertical height. Often values were used which did not correspond to a right angled triangle in the diagram, such as 13 and 8. Another common mistake was incorrect use of Pythagoras, where the hypotenuse was not correctly identified or was incorrectly substituted into the formula.

3b. *[2 marks]*

Markscheme

$\frac{1}{3} \times 8 \times 6 \times 12$ ***(M1)***

Note: Award ***(M1)*** for their correct substitutions into volume formula.

$= 192\ \mathrm{cm}^3$ ***(A1)(ft)*** ***(C2)***

Notes: Follow through from part (a), only if working seen.

Examiners report

Despite the problems to obtain a correct answer for part (a), in part (b) many candidates wrote down a correctly substituted formula for the volume of a pyramid (with their height substituted) and received follow through marks. Very few, having calculated their volume correctly, failed to give the correct units. Some candidates used the perimeter (28) of the base and not the area.

4a. *[3 marks]*

Markscheme

$72 = 12x + 4h$ (or equivalent) ***(M1)***

Note: Award ***(M1)*** for a correct equation obtained from the total length of the edges.

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

$(a =)\ 36$ ***(A1)*** ***(C3)***

Examiners report

The model in this question seemed to be too difficult for the vast majority of the candidates, and therefore was a strong discriminator between grade 6 and grade 7 candidates. An attempt to find an equation for the volume of the cube often started with $V = x \times 2x \times h$. Many struggled to translate the total length of the edges into a correct equation, and consequently were unable to substitute h. Some tried to write x in terms of h and got lost, others tried to work backwards from the expression given in the question.

4b. *[3 marks]*

Markscheme

$\frac{\mathrm{d}V}{\mathrm{d}x} = 72x - 18x^2$ ***(A1)***

$72x - 18x^2 = 0$ **OR** $\frac{\mathrm{d}V}{\mathrm{d}x} = 0$ ***(M1)***

Notes: Award ***(A1)*** for $-18x^2$ seen. Award ***(M1)*** for equating derivative to zero.

$(x =) \ 4$ ***(A1)*(ft)** ***(C3)***

Note: Follow through from part (a).

OR

Sketch of V with visible maximum ***(M1)***

Sketch with $x \geqslant 0, \ V \geqslant 0$ and indication of maximum (e.g. coordinates) ***(A1)*(ft)**

$(x =) \ 4$ ***(A1)*(ft)** ***(C3)***

Notes: Follow through from part (a).

Award ***(M1)(A1)(A0)*** for $(4, \ 192)$.

Award ***(C3)*** for $x = 4, \ y = 192$.

Examiners report

As very few found a value for a, often part (b) was not attempted. When a derivative was calculated this was usually done correctly.

5a. *[3 marks]*

Markscheme

$\sqrt{(100-1)^2 + (200+2)^2}$ ***(M1)***

$\sqrt{50605} \quad (= 224.955\ldots)$ ***(A1)***

Note: Award ***(M1)(A1)*** if $\sqrt{50605}$ seen.

224.96 ***(A1)*** ***(C3)***

Note: Award ***(A1)*** for their answer given correct to 2 decimal places.

Examiners report

[N/A]

5b. *[1 mark]*

Markscheme

225 ***(A1)*(ft)** ***(C1)***

Note: Follow through from their part (a).

Examiners report

[N/A]

5c. *[2 marks]*

Markscheme

2.25×10^2 ***(A1)*(ft)*(A1)*(ft)** ***(C2)***

Notes: Award ***(A1)(A0)*** for 2.25 and an incorrect index value.

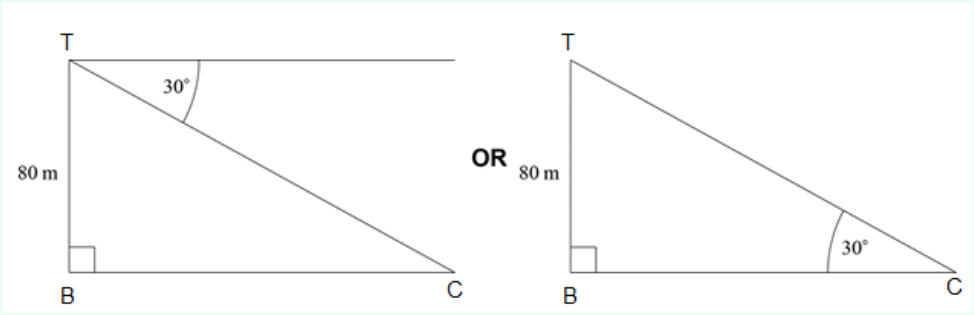
Award ***(A0)(A0)*** for answers such as 22.5×10^1.

Examiners report

[N/A]

6a. *[2 marks]*

Markscheme



(A1)(A1) ***(C2)***

Notes: Award ***(A1)*** for 80 m in the correct position on diagram.

Award ***(A1)*** for 30° in a correct position on diagram.

Examiners report

[N/A]

6b. *[2 marks]*

Markscheme

$\tan 30^\circ = \frac{80}{\text{BC}}$ **OR** $\tan 60^\circ = \frac{\text{BC}}{80}$ **OR** $\frac{80}{\sin 30^\circ} = \frac{\text{BC}}{\sin 60^\circ}$ ***(M1)***

Note: Award ***(M1)*** for a correct trigonometric or Pythagorean equation for BC with correctly substituted values.

$(\text{BC} =) \ 139 \ (\text{m}) \quad (138.564\ldots \ (\text{m}))$ ***(A1)*(ft)** ***(C2)***

Notes: Accept an answer of $80\sqrt{3}$ which is the exact answer.

Follow through from part (a).

Do not penalize use of radians unless it leads to a negative answer.

Examiners report

[N/A]

6c. *[2 marks]*

Markscheme

$\left|\frac{150-138.564\ldots}{138.564\ldots}\right| \times 100$ ***(M1)***

Notes: Award ***(M1)*** for their correct substitution into the percentage error formula.

$= 8.25(\%)$ $(8.25317\ldots\%)$ ***(A1)*****(ft)** ***(C2)***

Notes: Accept $7.91(\%)$ ($7.91366\ldots$ if 139 is used.

Accept $8.23(\%)$ ($8.22510\ldots$ if 138.6 is used.

Follow through from their answer to part (b).

If answer to part (b) is 46.2, answer to part (c) is 225%, award ***(M1)(A1)*****(ft)** with or without working seen. If answer to part (b) is negative, award at most ***(M1)(A0)***.

Examiners report

[N/A]

7a. *[2 marks]*

Markscheme

(i) -2 ***(A1)*** ***(C1)***

(ii) 10 ***(A1)*** ***(C1)***

Examiners report

[N/A]

7b. *[2 marks]*

Markscheme

$2x + y - 3 = 0$ ***(A1)*****(ft)*****(A1)*** ***(C2)***

Notes: Award ***(A1)*****(ft)** for gradient, ***(A1)*** for correct y-intercept.

The answer must be an equation.

Examiners report

[N/A]

7c. *[2 marks]*

Markscheme

$-2x + 3 = 0$ or equivalent ***(M1)***

$(x =) \ 1.5$ ***(A1)*(ft)** ***(C2)***

Notes: Follow through from their equation in part (b). If answer given as coordinates $(1.5, \ 0)$ award at most ***(M1)(A0)*** if working seen or ***(A1)(A0)*** if no working seen.

Examiners report

[N/A]

8a. *[1 mark]*

Markscheme

10 m ***(A1)(C1)***

Examiners report

[N/A]

8b. *[2 marks]*

Markscheme

$\text{A}\hat{\text{M}}\text{C} = 70^\circ$ **OR** $\text{A}\hat{\text{C}}\text{M} = 55^\circ$ ***(A1)***

$\text{C}\hat{\text{M}}\text{B} = 110^\circ$ ***(A1)*** ***(C2)***

Examiners report

[N/A]

8c. *[3 marks]*

Markscheme

$\mathrm{CB}^2 = 10^2 + 10^2 - 2 \times 10 \times 10 \times \cos 110^\circ$ ***(M1)(A1)*****(ft)**

Notes: Award ***(M1)*** for substitution into the cosine rule formula, ***(A1)*****(ft)** for correct substitution. Follow through from their answer to part (b).

OR

$\frac{\mathrm{CB}}{\sin 110^\circ} = \frac{10}{\sin 35^\circ}$ ***(M1)(A1)*****(ft)**

Notes: Award ***(M1)*** for substitution into the sine rule formula, ***(A1)*****(ft)** for correct substitution. Follow through from their answer to part (b).

OR

$\hat{\mathrm{ACB}} = 90^\circ$ ***(A1)***

$\sin 55^\circ = \frac{\mathrm{CB}}{55}$ **OR** $\cos 35^\circ = \frac{\mathrm{CB}}{20}$ ***(M1)***

Note: Award ***(A1)*** for some indication that $\hat{\mathrm{ACB}} = 90^\circ$, ***(M1)*** for correct trigonometric equation.

OR

Perpendicular MN is drawn from M to CB. ***(A1)***

$\frac{\frac{1}{2}\mathrm{CB}}{10} = \cos 35^\circ$ ***(M1)***

Note: Award ***(A1)*** for some indication of the perpendicular bisector of BC, ***(M1)*** for correct trigonometric equation.

$\mathrm{CB} = 16.4\ (\mathrm{m})$ $(16.3830\ldots\ (\mathrm{m}))$ ***(A1)*****(ft)*****(C3)***

Notes: Where a candidate uses $\hat{\mathrm{CMB}} = 90^\circ$ and finds $\mathrm{CB} = 14.1\ (\mathrm{m})$ award, at most, ***(M1)(A1)(A0)***.

Where a candidate uses $\hat{\mathrm{CMB}} = 60^\circ$ and finds $\mathrm{CB} = 10\ (\mathrm{m})$ award, at most, ***(M1)(A1)(A0)***.

Examiners report

[N/A]

9a. *[1 mark]*

Markscheme

$\mathrm{AO} = 4\ (\mathrm{cm})$ ***(A1)*** ***(C1)***

Examiners report

[N/A]

9b. *[2 marks]*

Markscheme

$\cos \hat{OAV} = \frac{4}{10}$ ***(M1)***

Note: Award ***(M1)*** for their correct trigonometric ratio.

OR

$\cos \hat{OAV} = \frac{10^2+8^2-10^2}{2\times10\times8}$ **OR** $\frac{10^2+4^2-(9.16515\ldots)^2}{2\times10\times4}$ ***(M1)***

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

$\hat{OAV} = 66.4°$ $(66.4218\ldots)$ ***(A1)*(ft)** ***(C2)***

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

Examiners report

[N/A]

9c. *[3 marks]*

Markscheme

$\text{area} = \frac{8\times10\times\sin(66.4218\ldots°)}{2}$ **OR** $\frac{1}{2}\times8\times\sqrt{10^2-4^2}$

OR $\frac{1}{2}\times10\times10\times\sin(47.1563\ldots°)$ ***(M1)(A1)*(ft)**

Notes: Award ***(M1)*** for substitution into the area formula, ***(A1)*(ft)** for correct substitutions. Follow through from their answer to part (b) and/or part (a).

$\text{area} = 36.7\ \text{cm}^2$ $(36.6606\ldots\ \text{cm}^2)$ ***(A1)*(ft)** ***(C3)***

Notes: Accept an answer of $8\sqrt{21}\ \text{cm}^2$ which is the exact answer.

Examiners report

[N/A]

10a. *[1 mark]*

Markscheme

$3600\ (\text{m}^2)$ ***(A1)(C1)***

Examiners report

[N/A]

10b. *[2 marks]*

Markscheme

$x(200-x) = 3600$ ***(M1)***

Note: Award ***(M1)*** for setting up an equation, equating to their 3600.

$180\ (\text{m})$ ***(A1)*(ft)** ***(C2)***

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

Examiners report

[N/A]

10c. *[2 marks]*

Markscheme

(i) $100\ (\text{m})$ ***(A1)*** ***(C1)***

(ii) $10\,000\ (\text{m}^2)$ ***(A1)*(ft)*(C1)***

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

Examiners report

[N/A]

10d. *[1 mark]*

Markscheme

$m = 3600$ **and** $n = 10\,000$ ***(A1)*(ft)** ***(C1)***

Notes: Follow through from part (a) and part (c)(ii), but only if their m is less than their n. Accept the answer $3600 \leqslant A \leqslant 10\,000$.

Examiners report

[N/A]

11a. *[4 marks]*

Markscheme

$\text{AC}^2 = 700^2 + 900^2 - 2 \times 700 \times 900 \times \cos 110°$ ***(M1)(A1)***

$\text{AC} = 1315.65\ldots$ ***(A1)(G2)***

length of course $= 2920\ (\text{m})$ $(2915.65\ldots\ \text{m})$ ***(A1)***

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

Award ***(G3)*** for 2920 $(2915.65\ldots)$ seen without working.

The final ***(A1)*** is awarded for adding 900 and 700 to their AC irrespective of working seen.

Examiners report

Most candidates were able to recognize and use the cosine rule correctly in part (a) and then to complete part (b) – though perhaps not giving the answer to the correct level of accuracy. It is expected that candidates can use “distance = speed x time” without the formula being given. The work involving sine rule was less successful, though correct responses were given by the great majority and the area of the course was again successfully completed by most candidates. A common error throughout these parts was the use of the total length of the course. A more fundamental error was the halving of the angle and/or the base in calculations – this error has been seen in a number of sessions and perhaps needs more emphasis.

11b. *[3 marks]*

Markscheme

$\frac{2915.65}{1.5}$ ***(M1)***

Note: Award ***(M1)*** for their length of course divided by 1.5.

Follow through from part (a).

$= 1943.76\ldots$ (seconds) ***(A1)*****(ft)**

$= 32$ (minutes) ***(A1)*****(ft)*****(G2)***

Notes: Award the final ***(A1)*** for correct conversion of **their** answer in seconds to minutes, correct to the nearest minute.

Follow through from part (a).

Examiners report

Most candidates were able to recognize and use the cosine rule correctly in part (a) and then to complete part (b) – though perhaps not giving the answer to the correct level of accuracy. It is expected that candidates can use "distance = speed x time" without the formula being given. The work involving sine rule was less successful, though correct responses were given by the great majority and the area of the course was again successfully completed by most candidates. A common error throughout these parts was the use of the total length of the course. A more fundamental error was the halving of the angle and/or the base in calculations – this error has been seen in a number of sessions and perhaps needs more emphasis.

11c. *[3 marks]*

Markscheme

$\frac{700}{\sin \text{ACB}} = \frac{1315.65\ldots}{\sin 110^\circ}$ ***(M1)******(A1)*****(ft)**

OR

$\cos \text{ACB} = \frac{900^2+1315.65\ldots^2-700^2}{2\times 900\times 1315.65\ldots}$ ***(M1)******(A1)*****(ft)**

$\text{ACB} = 30.0^\circ \quad (29.9979\ldots^\circ)$ ***(A1)*****(ft)*****(G2)***

Notes: Award ***(M1)*** for substitution into sine rule or cosine rule formula, ***(A1)*** for their correct substitution, ***(A1)*** for correct answer.

Accept 29.9° for sine rule and 29.8° for cosine rule from use of correct three significant figure values. Follow through from their answer to (a).

Examiners report

Most candidates were able to recognize and use the cosine rule correctly in part (a) and then to complete part (b) – though perhaps not giving the answer to the correct level of accuracy. It is expected that candidates can use "distance = speed x time" without the formula being given. The work involving sine rule was less successful, though correct responses were given by the great majority and the area of the course was again successfully completed by most candidates. A common error throughout these parts was the use of the total length of the course. A more fundamental error was the halving of the angle and/or the base in calculations – this error has been seen in a number of sessions and perhaps needs more emphasis.

11d. *[3 marks]*

Markscheme

$\frac{1}{2} \times 700 \times 900 \times \sin 110^\circ$ ***(M1)(A1)***

Note: Accept $\frac{1}{2} \times \text{their AC} \times 900 \times \sin(\text{their ACB})$. Follow through from parts (a) and (c).

$= 296000\ \text{m}^2 \quad (296003\ \text{m}^2)$ ***(A1)(G2)***

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

Award ***(G1)*** if 296000 is seen without units or working.

Examiners report

Most candidates were able to recognize and use the cosine rule correctly in part (a) and then to complete part (b) – though perhaps not giving the answer to the correct level of accuracy. It is expected that candidates can use “distance = speed x time” without the formula being given. The work involving sine rule was less successful, though correct responses were given by the great majority and the area of the course was again successfully completed by most candidates. A common error throughout these parts was the use of the total length of the course. A more fundamental error was the halving of the angle and/or the base in calculations – this error has been seen in a number of sessions and perhaps needs more emphasis.

11e. *[3 marks]*

Markscheme

$\sin 29.9979\ldots = \frac{\text{distance}}{900}$ ***(M1)***

$(\text{distance} =)\ 450\ (\text{m}) \quad (449.971\ldots)$ ***(A1)(ft)(G2)***

Note: Follow through from part (c).

OR

$\frac{1}{2} \times \text{distance} \times 1315.65\ldots = 296003$ ***(M1)***

$(\text{distance} =)\ 450\ (\text{m}) \quad (449.971\ldots)$ ***(A1)(ft)(G2)***

Note: Follow through from part (a) and part (d).

450 is greater than 375, thus the course complies with the safety regulations ***(R1)***

Notes: A comparison of their area from (d) and the area resulting from the use of 375 as the perpendicular distance is a valid approach and should be given full credit. Similarly a comparison of angle ACB and $\sin^{-1}\left(\frac{375}{900}\right)$ should be given full credit.

Award ***(R0)*** for correct answer without any working seen. Award ***(R1)(ft)*** for a justified reason consistent with their working.

Do not award ***(M0)(A0)(R1)***.

Examiners report

In part (e), unless evidence was presented, reasoning marks did not accrue; the interpretative nature of this part was a significant discriminator in determining the quality of a response.

11f. *[2 marks]*

Markscheme

$\tan 15^\circ = \frac{\text{AH}}{700}$ ***(M1)***

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

$\text{AH} = 188\ (\text{m})\quad (187.564\ldots)$ ***(A1)*****(ft)*****(G2)***

Examiners report

There were many instances of parts (f) and (g) being left blank and angle of elevation is still not well understood. Again, the interpretative nature of part (g) – even when part (f) was correct – caused difficulties

11g. *[3 marks]*

Markscheme

$\text{HC}^2 = 187.564\ldots^2 + 1315.65\ldots^2$ ***(M1)(A1)***

Note: Award ***(M1)*** for substitution into Pythagoras, ***(A1)*** for their $1315.65\ldots$ and their $187.564\ldots$ correctly substituted in formula.

$\text{HC} = 1330\ldots\ (\text{m})\quad (1328.95\ldots)$ ***(A1)*****(ft)*****(G2)***

Note: Follow through from their answer to parts (a) and (f).

Examiners report

There were many instances of parts (f) and (g) being left blank and angle of elevation is still not well understood. Again, the interpretative nature of part (g) – even when part (f) was correct – caused difficulties

12a. *[6 marks]*

Markscheme

(i) $x^2 + 3^2 = 4^2$ ***(M1)***

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

Accept correct alternative method using trigonometric ratios.

$x = 2.64575\ldots$ ***(A1)***

$x = 2.65\ (\text{cm})$ ***(AG)***

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

OR

$\sqrt{4^2 - 3^2}$ ***(M1)***

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

$= \sqrt{7}$ ***(A1)***

$= 2.65\ (\text{cm})$ ***(AG)***

Note: The exact answer must be seen for the final ***(A1)*** to be awarded.

(ii) $\pi \times 3^2 \times 4.5 + \frac{1}{3}\pi \times 3^2 \times 2.65$ ***(M1)(M1)(M1)***

Note: Award ***(M1)*** for correct substitution into the volume of a cylinder formula, ***(M1)*** for correct substitution into the volume of a cone formula, ***(M1)*** for adding both of their volumes.

$= 152\ \text{cm}^3$ $(152.210\ldots\ \text{cm}^3,\ 48.45\pi\ \text{cm}^3)$ ***(A1)(G3)***

Examiners report

[N/A]

12b. *[2 marks]*

Markscheme

$\pi 3^2 h = 125$ ***(M1)***

Note: Award ***(M1)*** for correct substitution into the volume of a cylinder formula.

Accept alternative methods. Accept 4.43 $(4.42913\ldots)$ from using rounded answers in $h = \frac{125 \times 4.5}{127}$.

$h = 4.42\ (\text{cm})$ $(4.42097\ldots\ (\text{cm}))$ ***(A1)(G2)***

Examiners report

[N/A]

12c. *[4 marks]*

Markscheme

$2\pi \times 3 \times 4.5 + \pi \times 3 \times 4 + \pi \times 3^2$ ***(M1)(M1)(M1)***

Note: Award ***(M1)*** for correct substitution into curved surface area of a cylinder formula, ***(M1)*** for correct substitution into the curved surface area of a cone formula, ***(M1)*** for adding the area of the base of the cylinder to the other two areas.

$= 151 \text{ cm}^2 \quad (150.796\ldots \text{ cm}^2,\ 48\pi \text{ cm}^2)$ ***(A1)(G3)***

Examiners report

[N/A]

12d. *[4 marks]*

Markscheme

$\frac{150.796\ldots}{7} \times 3$ ***(M1)(M1)***

Notes: Award ***(M1)*** for dividing their answer to (c) by 7, ***(M1)*** for multiplying by 3. Accept equivalent methods.

$= 64.63 \text{ (ZAR)}$ ***(A1)(ft)(G2)***

Notes: The ***(A1)*** is awarded for their correct answer, correctly rounded to 2 decimal places. Follow through from their answer to part (c). If rounded answer to part (c) is used the answer is 64.71 (ZAR).

Examiners report

[N/A]

12e. *[2 marks]*

Markscheme

$\frac{325}{13.03}$ ***(M1)***

Note: Award ***(M1)*** for dividing 325 by 13.03.

$= 24.94 \text{ (EUR)}$ ***(A1)(G2)***

Note: The ***(A1)*** is awarded for the correct answer rounded to 2 decimal places, unless already penalized in part (d).

Examiners report

[N/A]

13a. *[2 marks]*

Markscheme

$1.5 \times 10^8 \text{ (km)}$ ***(A2)*** ***(C2)***

Notes: Award ***(A2)*** for the correct answer.

Award ***(A1)(A0)*** for 1.5 and an incorrect index.

Award ***(A0)(A0)*** for answers of the form 15×10^7.

[2 marks]

Examiners report

[N/A]

13b. *[2 marks]*

Markscheme

$2\pi 1.5 \times 10^8$ ***(M1)***

$= 942\,000\,000$ (km) $(942\,477\,796.1\ldots, 3 \times 10^8 \pi, 9.42 \times 10^8)$ ***(A1)*****(ft)** ***(C2)***

Notes: Award ***(M1)*** for correct substitution into correct formula. Follow through from part (a).

Do not accept calculator notation

9.42E8.

Do not accept use of

$\frac{22}{7}$ or

3.14 for

π.

[2 marks]

Examiners report

[N/A]

13c. *[2 marks]*

Markscheme

$17 \times 942\,000\,000$ ***(M1)***

$= 1.60 \times 10^{10}$ (km) $\left(1.60221\ldots \times 10^{10}, 1.6014 \times 10^{10}, 16\,022\,122\,530, (5.1 \times 10^9)\pi\right)$ ***(A1)*****(ft)** ***(C2)***

Note: Follow through from part (b).

[2 marks]

Examiners report

[N/A]

14a. *[2 marks]*

Markscheme

The first time a correct answer has incorrect or missing units, the final (A1) is not awarded.

$\frac{4}{3}\pi(1)^3$ ***(M1)***

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

$= 4.19$ $\left(4.18879\ldots, \frac{4}{3}\pi\right)$ cm^3 ***(A1)*** ***(C2)***

[2 marks]

Examiners report

[N/A]

14b. *[1 mark]*

Markscheme

The first time a correct answer has incorrect or missing units, the final (A1) is not awarded.

$83.8\ \left(83.7758\ldots, \frac{80}{3}\pi\right)\ \text{cm}^3$ ***(A1)*****(ft)** ***(C1)***

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

[1 mark]

Examiners report

[N/A]

14c. *[2 marks]*

Markscheme

The first time a correct answer has incorrect or missing units, the final (A1) is not awarded.

$10 \times 8 \times 2$ ***(M1)***

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

$= 160\ \text{cm}^3$ ***(A1)*** ***(C2)***

[2 marks]

Examiners report

[N/A]

14d. *[1 mark]*

Markscheme

The first time a correct answer has incorrect or missing units, the final (A1) is not awarded.

$76.2\ \left(76.2241\ldots, \left(160 - \frac{80}{3}\pi\right)\right)\ \text{cm}^3$ ***(A1)*****(ft)** ***(C1)***

Note: Follow through from their part (b) and their part (c).

[1 mark]

Examiners report

[N/A]

15a. *[2 marks]*

Markscheme

$\tan 27.9° = \frac{9}{\text{OV}}$ ***(M1)***

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

$\text{OV} = 17.0\,(\text{cm})\,(16.9980\ldots)$ ***(A1)*** ***(C2)***

[2 marks]

Examiners report

[N/A]

15b. *[4 marks]*

Markscheme

$\frac{\pi(9)^2(16.9980\ldots)}{3} + \frac{1}{2} \times \frac{4\pi(9)^3}{3}$ ***(M1)(M1)(M1)***

Note: Award ***(M1)*** for correctly substituted volume of the cone, ***(M1)*** for correctly substituted volume of a sphere divided by two (hemisphere), ***(M1)*** for adding the correctly substituted volume of the cone to *either* a correctly substituted sphere *or* hemisphere.

$= 2970\ \text{cm}^3\ (2968.63\ldots)$ ***(A1)*****(ft)** ***(C4)***

Note: The answer is
$2970\ \text{cm}^3$, the units are required.

[4 marks]

Examiners report

[N/A]

16a. *[1 mark]*

Markscheme

12 ***(A1)*** ***(C1)***

Note: Award ***(A1)*** for
$(12, 18)$.

[1 mark]

Examiners report

[N/A]

16b. *[2 marks]*

Markscheme

$\frac{26-10}{0-24}$ ***(M1)***

Note: Accept
$\frac{26-18}{0-12}$ or
$\frac{18-10}{12-24}$ (or equivalent).

$= -\frac{2}{3}\ \left(-\frac{16}{24},\ -0.666666\ldots\right)$ ***(A1)*** ***(C2)***

Note: If either of the alternative fractions is used, follow through from their answer to part (a).
The answer is now ***(A1)*****(ft)**.

[2 marks]

Examiners report

[N/A]

16c. *[3 marks]*

Markscheme

gradient of

OM $= \frac{3}{2}$ ***(A1)*****(ft)**

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

$-\frac{2}{3} \times \frac{3}{2}$ ***(M1)***

Note: Award ***(M1)*** for multiplying their gradients.

Since the product is

-1, OAM is a right-angled triangle ***(R1)*****(ft)**

Notes: Award the final ***(R1)*** only if their conclusion is consistent with their answer for the product of the gradients.

The statement that OAM is a right-angled triangle without justification is awarded no marks.

OR

$(26-18)^2 + 12^2$ and

$12^2 + 18^2$ ***(A1)*****(ft)**

$\left((26-18)^2 + 12^2\right) + (12^2 + 18^2) = 26^2$ ***(M1)***

Note: This method can also be applied to triangle OMB.

Follow through from (a).

Hence a right angled triangle ***(R1)*****(ft)**

Note: Award the final ***(R1)*** only if their conclusion is consistent with their ***(M1)*** mark.

OR

$OA = OB = 26$ (cm) an isosceles triangle ***(A1)***

Note: Award ***(A1)*** for

$OA = 26$ (cm) and

$OB = 26$ (cm).

Line drawn from vertex to midpoint of base is perpendicular to the base ***(M1)***

Conclusion ***(R1)*** ***(C3)***

Note: Award, at most ***(A1)(M0)(R0)*** for stating that OAB is an isosceles triangle without any calculations.

[3 marks]

Examiners report

[N/A]

17a. *[1 mark]*

Markscheme

$(f'(x) =)$

$4x^3$ ***(A1)*** ***(C1)***

[1 mark]

Examiners report

[N/A]

17b. *[2 marks]*

Markscheme

4×2^3 ***(M1)***

Note: Award ***(M1)*** for substituting 2 into their derivative.

$= 32$ ***(A1)*****(ft)** ***(C2)***

Note: Follow through from their part (a).

[2 marks]

Examiners report

[N/A]

17c. *[3 marks]*

Markscheme

$y - 16 = -\frac{1}{32}(x - 2)$ **or**

$y = -\frac{1}{32}x + \frac{257}{16}$ ***(M1)(M1)***

Note: Award ***(M1)*** for their gradient of the normal seen, ***(M1)*** for point substituted into equation of a straight line in only x and y (with any constant 'c' eliminated).

$x + 32y - 514 = 0$ **or** any integer multiple ***(A1)*****(ft)** ***(C3)***

Note: Follow through from their part (b).

[3 marks]

Examiners report

[N/A]

18a. *[2 marks]*

Markscheme

$\text{BD} = \sqrt{\left(4^2 + 8^2\right)}$ ***(M1)***

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

$= 8.94 \left(8.94427\ldots, \sqrt{80}, 4\sqrt{5}\right)$ ***(A1)*** ***(C2)***

Examiners report

[N/A]

18b. *[4 marks]*

Markscheme

Area $\text{ABCD} = 2 \times \left(0.5 \times \frac{\text{their BD}}{2} \times \sqrt{500}\right)$ ***(M1)(M1)(M1)***

Note: Award ***(M1)*** for dividing their BD by 2, ***(M1)*** for **correct** substitution into the area of triangle formula, ***(M1)*** for adding two triangles (or multiplied by 2).

Accept alternative methods:

Area of kite $= 0.5 \times \sqrt{500} \times$ their part (a).

Award ***(M1)*** for stating kite formula.

Award ***(M1)*** for correctly substituting in $\sqrt{500}$.

Award ***(M1)*** for correctly substituting in their part (a).

$= 100$ ***(A1)*** ***(C4)***

Note: Accept 99.9522 if 3 sf answer is used from part (a).

Examiners report

[N/A]

19a. *[2 marks]*

Markscheme

$\frac{600-150}{6-1}$ ***(M1)***

OR

$600 = 150 + (6-1)m$ ***(M1)***

Note: Award ***(M1)*** for correct substitution into gradient formula or arithmetic sequence formula.

$= 90$ ***(A1)*** ***(C2)***

Examiners report

[N/A]

19b. *[1 mark]*

Markscheme

the annual rate of growth of the number of apartments ***(A1)*** ***(C1)***

Note: Do not accept common difference.

Examiners report

[N/A]

19c. *[2 marks]*

Markscheme

$150 = 90 \times (1) + n$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of their gradient and one of the given points into the equation of a straight line.

$n = 60$ ***(A1)(ft)*** ***(C2)***

Note: Follow through from part (a).

Examiners report

[N/A]

19d. *[1 mark]*

Markscheme

the initial number of apartments ***(A1)*** ***(C1)***

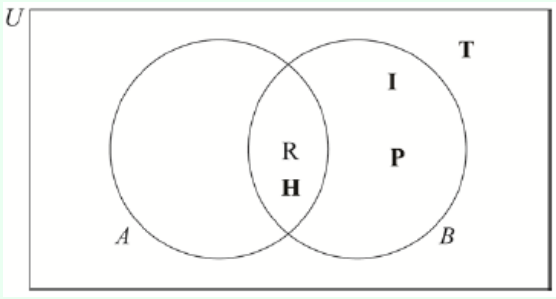
Note: Do not accept "first number in the sequence".

Examiners report

[N/A]

20a. *[3 marks]*

Markscheme



(A3) ***(C3)***

Note: Award ***(A3)*** if all four letters placed correctly,

(A2) if three letters are placed correctly,

(A1) if two letters are placed correctly.

Examiners report

[N/A]

20b. *[3 marks]*

Markscheme

(i) Rhombus and rectangle **OR** H and R ***(A1)*****(ft)**

(ii) Scalene triangle **OR** T ***(A2)*****(ft)** ***(C3)***

Notes: Award ***(A1)*** for a list R, H, I, P seen (identifying the union).

Follow through from their part (a).

Examiners report

[N/A]

21a. *[1 mark]*

Markscheme

$2x + 2y = 44$ ***(A1)*** ***(C1)***

Note: Accept equivalent forms.

Examiners report

[N/A]

21b. *[1 mark]*

Markscheme

$xy = 112$ ***(A1)*** ***(C1)***

Examiners report

[N/A]

21c. *[2 marks]*

Markscheme

$8, 14$ ***(A1)*****(ft)*****(A1)*****(ft)** ***(C2)***

Notes: Accept $x = 8, y = 14$ **OR** $x = 14, y = 8$

Follow through from their answers to parts (a) and (b) only if both values are positive.

Examiners report

[N/A]

21d. *[2 marks]*

Markscheme

$\frac{112}{1250} \times 100$ ***(M1)***

Note: Award ***(M1)*** for 112 divided by 1250.

$= 8.96$ ***(A1)*** ***(C2)***

Note: Do not penalize if percentage sign seen.

Examiners report

[N/A]

22a. *[2 marks]*

Markscheme

$\frac{\pi l^2}{2} = 39.27$ ***(M1)(A1)***

Note: Award ***(M1)*** for equating the formula for area of a semicircle to 39.27, award ***(A1)*** for correct substitution of l into the formula for area of a semicircle.

$l = 5\ (\text{m})$ ***(AG)***

Examiners report

[N/A]

22b. *[6 marks]*

Markscheme

(i) $5 \times \pi$ ***(M1)***

$= 15.7 \quad (15.7079..., 5\pi)\ (\text{m})$ ***(A1)(G2)***

(ii) $2\pi r = 15.7079\ldots$ **OR** $5\pi r = 39.27$ ***(M1)***

$(r =)\ 2.5\ (\text{m})$ ***(A1)*****(ft)*****(G2)***

Note: Follow through from part (b)(i).

(iii) $(h^2 =)\ 5^2 - 2.5^2$ ***(M1)***

Notes: Award ***(M1)*** for correct substitution into Pythagoras' theorem. Follow through from part (b)(ii).

$(h =)\ 4.33\ (4.33012\ldots)\ (\text{m})$ ***(A1)*****(ft)*****(G2)***

Examiners report

[N/A]

22c. *[1 mark]*

Markscheme

$9.33 - 2 \times r$ ***(A1)***

Examiners report

[N/A]

22d. *[1 mark]*

Markscheme

$V = \frac{\pi r^2}{3} \times (9.33 - 2r)$ ***(M1)***

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

$V = 3.11\pi r^2 - \frac{2}{3}\pi^3$ ***(AG)***

Examiners report

[N/A]

22e. *[2 marks]*

Markscheme

$6.22\pi r - 2\pi r^2$ ***(A1)(A1)***

Notes: Award ***(A1)*** for $6.22\pi r$, ***(A1)*** for $-2\pi r^2$.

If extra terms present, award at most ***(A1)(A0)***.

Examiners report

[N/A]

22f. *[4 marks]*

Markscheme

(i) $6.22\pi r - 2\pi r^2 = 0$ ***(M1)***

Note: Award ***(M1)*** for setting their derivative from part (e) to 0.

$r = 3.11\ (\text{m})$ ***(A1)*****(ft)*****(G2)***

Notes: Award ***(A1)*** for identifying 3.11 as the answer.

Follow through from their answer to part (e).

(ii) $\frac{1}{3}\pi(3.11)^3$ **OR** $3.11\pi(3.11)^2 - \frac{2}{3}\pi(3.11)^3$ ***(M1)***

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

$31.5\ (\text{m}^3)(31.4999\ldots)$ ***(A1)*****(ft)*****(G2)***

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

Examiners report

[N/A]

23a. *[4 marks]*

Markscheme

(i) $\cos \hat{\mathrm{ACB}} = \frac{10^2+12^2-15^2}{2\times10\times12}$ ***(M1)(A1)***

Note: Award ***(M1)*** for substituted cosine rule,

(A1) for correct substitution.

$\hat{\mathrm{ACB}} = 85.5^\circ \quad (85.4593\ldots)$ ***(A1)(G2)***

(ii) $\hat{\mathrm{DCE}} = \hat{\mathrm{ACB}} \quad \text{and} \quad \hat{\mathrm{ACB}} = 85.5^\circ \quad (85.4593\ldots^\circ)$ ***(A1)***

OR

$\hat{\mathrm{BCE}} = 180^\circ - 85.5^\circ = 94.5^\circ \quad \text{and} \quad \hat{\mathrm{DCE}} = 180^\circ - 94.5^\circ = 85.5^\circ$ ***(A1)***

Notes: Both reasons must be seen for the ***(A1)*** to be awarded.

$\hat{\mathrm{DCE}} = 85.5^\circ$ ***(AG)***

Examiners report

[N/A]

23b. *[5 marks]*

Markscheme

(i) $\hat{\mathrm{DEC}} = \frac{180^\circ - 85.5^\circ}{3}$ ***(M1)***

$\hat{\mathrm{DEC}} = 31.5^\circ$ ***(A1)(G2)***

(ii) $\frac{\sin(31.5^\circ)}{9} = \frac{\sin(85.5^\circ)}{\mathrm{DE}}$ ***(M1)(A1)*****(ft)**

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

$\mathrm{DE} = 17.2\ (\mathrm{km}) (17.1718\ldots).$ ***(A1)*****(ft)*****(G2)***

Examiners report

[N/A]

23c. *[4 marks]*

Markscheme

$0.5 \times 17.1718\ldots \times 9 \times \sin(63^\circ)$ ***(A1)*****(ft)*****(M1)*****(A1)*****(ft)**

Note: Award ***(A1)*****(ft)** for 63 seen, ***(M1)*** for substituted triangle area formula, ***(A1)*****(ft)** for $0.5 \times 17.1718\ldots \times 9 \times \sin(\text{their angle CDE})$.

OR

$(\text{triangle height} =)\ 9 \times \sin(63^\circ)$ ***(A1)*****(ft)*****(A1)*****(ft)**

$0.5 \times 17.1718\ldots \times 9 \times \sin(\text{their angle CDE})$ ***(M1)***

Note: Award ***(A1)*****(ft)** for 63 seen, ***(A1)*****(ft)** for correct triangle height with their angle CDE, ***(M1)*** for $0.5 \times 17.1718\ldots \times 9 \times \sin(\text{their angle CDE})$.

$= 68.9\ \text{km}^2 \quad (68.8509\ldots)$ ***(A1)*****(ft)*****(G3)***

Notes: Units are required for the last ***(A1)*****(ft)** mark to be awarded.

Follow through from parts (b)(i) and (b)(ii).

Follow through from their angle CDE **within this part of the question**.

Examiners report

[N/A]

24a. *[1 mark]*

Markscheme

$(0,\ 4)$ ***(A1)***

Notes: Accept $x = 0,\ y = 4$.

Examiners report

[N/A]

24b. *[2 marks]*

Markscheme

(i) $(a,\ 4)$ ***(A1)*****(ft)**

Notes: Follow through from part (a).

(ii) $\frac{4}{a}$ ***(A1)*****(ft)**

Note: Follow through from part (b)(i).

Examiners report

[N/A]

24c. *[4 marks]*

Markscheme

(i) $-\frac{a}{4}$ ***(A1)*****(ft)**

Note: Follow through from part (b)(ii).

(ii) $y = -\frac{a}{4}x + c$ ***(M1)***

Note: Award ***(M1)*** for substitution of their gradient from part (c)(i) in the equation.

$4 = -\frac{a}{4} \times a + c$

$c = \frac{1}{4} \times a^2 + 4$

$y = -\frac{a}{4}x + \frac{1}{4}a^2 + 4$ ***(A1)***

OR

$y - 4 = -\frac{a}{4}(x - a)$ ***(M1)***

Note: Award ***(M1)*** for substitution of their gradient from part (c)(i) in the equation.

$y = -\frac{ax}{4} + \frac{a^2}{4} + 4$ ***(A1)***

$4y = -ax + a^2 + 16$

$4y + ax - a^2 - 16 = 0$ ***(AG)***

Note: Both the simplified and the not simplified equations must be seen for the final ***(A1)*** to be awarded.

Examiners report

[N/A]

24d. *[3 marks]*

Markscheme

(i) $2a$ ***(A1)***

(ii) $\frac{4x}{2} = 3 \times 2a$ ***(M1)***

Note: Award ***(M1)*** for correct equation.

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

Note: Follow through from part (d)(i).

OR

$0 - 4 = -\frac{a}{4}(x - a)$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of their gradient and the coordinates of their point into the equation of a line.

$\frac{16}{a} = x - a$

$x = a + \frac{16}{a}$ ***(A1)*****(ft)**

Note: Follow through from parts (b)(i) and (c)(i).

OR

$4 \times 0 + ax - a^2 - 16 = 0$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of the coordinates of $\mathrm{A}(x,\ 0)$ into the equation of line AB.

$ax - a^2 - 16 = 0$

$x = a + \frac{16}{a}$ **OR** $x = \frac{(a^2+16)}{a}$ ***(A1)(G1)***

Examiners report

[N/A]

24e. *[2 marks]*

Markscheme

$4(0) + a(3a) - a^2 - 16 = 0$ ***(M1)***

Note: Award ***(M1)*** for correct substitution of their $3a$ from part (d)(ii) into the equation of line AB.

OR

$\frac{1}{2}\left(a + \frac{16}{a}\right) \times 4 = 3\left(\frac{4a}{2}\right)$ ***(M1)***

Note: Award ***(M1)*** for area of triangle AOB (with their substituted $a + \frac{16}{a}$ and 4) equated to three times their area of triangle AOB.

$a = 2.83$ $\left(2.82842..., 2\sqrt{2}, \sqrt{8}\right)$ ***(A1)*****(ft)*****(G1)***

Note: Follow through from parts (d)(i) and (d)(ii).

Examiners report

[N/A]

25a. *[3 marks]*

Markscheme

–1.10, 0.218, 3.13 ***(A1)(A1)(A1)***

[3 marks]

Examiners report

This question was either very well done – by the majority – or very poor and incomplete attempts were seen. This would perhaps indicate a lack of preparation in this area of the syllabus from some centres, though it is recognised that the differential calculus is one of the more problematic topics for the candidature.

It was however disappointing to note the number of candidates who do not use the GDC to good effect; in part (a) for example, the zeros were not found accurately due to "trace" being used; this is not a suitable approach – there is a built-in zero finder which should be used. Much of the question was accessible via a GDC approach, a sketch was given that could have been verified on the GDC; this was lost on many.

25b. *[3 marks]*

Markscheme

$f'(x) = 12x^2 - 18x - 12$ ***(A1)(A1)(A1)***

Note: Award ***(A1)*** for each correct term and award maximum of ***(A1)(A1)*** if other terms seen.

[3 marks]

Examiners report

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25c. *[4 marks]*

Examiners report

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25d. *[1 mark]*

Markscheme

(0, 3) ***(A1)***

Note: Accept $x = 0$, $y = 3$.

[1 mark]

Examiners report

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25e. *[2 marks]*

Markscheme

$f'(0) = -12$ ***(M1)(A1)*****(ft)*****(G2)***

Note: Award ***(M1)*** for substituting $x = 0$ into their derivative.

[2 marks]

Examiners report

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25f. *[2 marks]*

Markscheme

Tangent: $y = -12x + 3$ ***(A1)*****(ft)*****(A1)(G2)***

Note: Award ***(A1)*****(ft)** for their gradient, ***(A1)*** for intercept = 3.

Award ***(A1)(A0)*** if y = not seen.

[2 marks]

Examiners report

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25g. *[1 mark]*

Markscheme

-12 ***(A1)*****(ft)**

Note: Follow through from their part (e).

[1 mark]

Examiners report

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25h. *[3 marks]*

Markscheme

$12x^2 - 18x - 12 = -12$ ***(M1)***

$12x^2 - 18x = 0$ ***(M1)***

$x = 1.5, 0$

At Q $x = 1.5$ ***(A1)*****(ft)*****(G2)***

Note: Award ***(M1)(G2)*** for $12x^2 - 18x - 12 = -12$ followed by $x = 1.5$.

Follow through from their part (g).

[3 marks]

Examiners report

This question was either very well done – by the majority – or very poor and incomplete attempts were seen. This would perhaps indicate a lack of preparation in this area of the syllabus from some centres, though it is recognised that the differential calculus is one of the more problematic topics for the candidature.

It was however disappointing to note the number of candidates who do not use the GDC to good effect; in part (a) for example, the zeros were not found accurately due to “trace” being used; this is not a suitable approach – there is a built-in zero finder which should be used. Much of the question was accessible via a GDC approach, a sketch was given that could have been verified on the GDC; this was lost on many.