Topic 1 Part 8 *[231 marks]*

1a. *[2 marks]*

Markscheme

$\frac{(\tan(2\times30)+1)(2\cos(30)-1)}{41^2-9^2}$ ***(M1)***

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

$= 0.00125 \quad \left(\frac{1}{800}\right)$ ***(A1)*** ***(C2)***

Note: Using radians the answer is -0.000570502, award at most ***(M1)(A0)***.

Examiners report

Despite a significant number of candidates scoring well on this question, many candidates failed to use their calculator correctly. Common errors identified were: the use of radians; incorrect use of the double parentheses, calculating tan(61) instead of tan(60) + 1 ; or premature rounding. Such candidates earned, at most, method in part (a).

1b. *[2 marks]*

Markscheme

(i)

0.0013 ***(A1)*****(ft)**

Note: Follow through from part (a).

(ii)

0.001 ***(A1)*****(ft)** ***(C2)***

Note: Follow through from part (a).

Examiners report

Despite errors in part (a), part (b)(i) tended to be often a correct follow through answer but some candidates struggled to give a 2 sf answer correctly, using truncation instead of rounding or dropping the leading zeros. Part (b)(ii) was more often answered correctly.

1c. *[2 marks]*

Markscheme

$\left|\frac{0.002-0.00125}{0.00125}\right| \times 100$ ***(M1)***

Notes: Award ***(M1)*** for their correct substitution into the percentage error formula. Absolute value signs are not required.

Their **unrounded** answer from part (a) must be used.

Do **not** accept use of answers from part (b).

$= 60 \ (\%)$ ***(A1)*****(ft)** ***(C2)***

Notes: The $\%$ sign is not required.

The answer from radians is 450.568%, award ***(M1)(A1)*****(ft)**.

Follow through from part (a).

Examiners report

In part (c) many candidates used the percentage error formula incorrectly, reversing the estimated and the exact value, or using one of the rounded answers from part (b) as the exact value.

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. *[2 marks]*

Markscheme

800×1.55 ***(M1)***

Note: Award ***(M1)*** for multiplication by 1.55.

$= 1240$ ***(A1)*** ***(C2)***

Examiners report

Many candidates lost at least two marks on this question for using an incorrect rate. The difference between “Bank buys” and “Bank sells” was not understood by many candidates. Their use of the table was often not consistent, leading to the candidates losing 4 marks, 2 in part (a) and 2 in part (b). Only very few candidates were confused on when to multiply and when to divide by a conversion rate. It was disappointing to see that so many candidates were not able to apply their knowledge of currency conversion in the real world context where both rates are given and the candidate had to decide which one to use. Methods marks were given out frequently, showing candidates were confident to calculate currency conversion with given rates.

3b. *[4 marks]*

Markscheme

$\frac{100 \times 1.92}{1.28}$ ***(A1)(M1)(M1)***

Notes: Award ***(M1)*** for multiplication by a GBP rate (1.92 or 2.05), ***(M1)*** for division by a USD rate (1.28 or 1.15), ***(A1)*** for two correct rates used.

$= 150$ ***(A1)*** ***(C4)***

Note: Award a maximum of ***(A1)*(ft)*(M1)(M1)(A1)*(ft)** for $\frac{100 \times 2.05}{1.15}$, if in part (a) a rate of 1.75 is used.

Award a maximum of ***(A1)*(ft)*(M1)(M1)(A1)*(ft)** if division by an EUR rate is seen in part (a) and multiplication by 1.28 and division by 1.92 is seen in (b).

Examiners report

Many candidates lost at least two marks on this question for using an incorrect rate. The difference between “Bank buys” and “Bank sells” was not understood by many candidates. Their use of the table was often not consistent, leading to the candidates losing 4 marks, 2 in part (a) and 2 in part (b). Only very few candidates were confused on when to multiply and when to divide by a conversion rate. It was disappointing to see that so many candidates were not able to apply their knowledge of currency conversion in the real world context where both rates are given and the candidate had to decide which one to use. Methods marks were given out frequently, showing candidates were confident to calculate currency conversion with given rates.

4a. *[3 marks]*

Markscheme

(i) $u_1 + d = 30,\ u_1 + 4d = 90,\ 3d = 90 - 30$ (or equivalent) ***(M1)***

Note: Award ***(M1)*** for **one** correct equation. Accept a list of at least 5 correct terms.

$(d =)\ 20$ ***(A1)***

(ii) $(u_1 =)\ 10$ ***(A1)*(ft)** ***(C3)***

Note: Follow through from (a)(i), irrespective of working shown if $u_1 = 30 - (\text{their } d)$ **OR** $u_1 = 90 - 4 \times (\text{their } d)$

Examiners report

Part (a) was answered correctly by many candidates, but working using equations was rarely seen. A “trial and error” method, based upon a list of terms was the most seen method.

4b. *[3 marks]*

Markscheme

$(u_7 =) 10(3^{(7-1)}$ **OR** $(u_7 =) 10 \times 3^6$ ***(M1)(A1)*****(ft)**

Note: Award ***(M1)*** for substituted geometric sequence formula, ***(A1)*****(ft)** for their correct substitutions.

OR

$10;\ 30;\ 90;\ 270;\ 810;\ 2430;\ 7290$ ***(M1)(A1)*****(ft)**

Note: Award ***(M1)*** for a list of at least 5 consecutive terms of a geometric sequence, ***(A1)*****(ft)** for terms corresponding to their answers in part (a).

$= 7290$ ***(A1)*****(ft)** ***(C3)***

Note: Follow through from part (a).

Examiners report

In part (b) many found the correct answer, but many others did not. Some gave the seventh term of the arithmetic sequence, some gave a term of an incorrect order and some a completely incorrect answer. Finding the correct ratio was the most common problem. Often repeated multiplication was used to find the answer, but also the formula for the nth term of a geometric sequence was used. Several did not use the correct three terms from the question.

5a. *[3 marks]*

Markscheme

$5000\left(1+\frac{4.5}{12\times100}\right)^{12\times7}$ ***(M1)(A1)***

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

OR

$N=7$

$I\%=4.5$

$PV=(\pm)5000$

$P/Y=1$

$C/Y=12$ ***(A1)(M1)***

Note: Award ***(A1)*** for $C/Y=12$ seen, ***(M1)*** for all other correct entries.

OR

$N=84$

$I\%=4.5$

$PV=(\pm)5000$

$P/Y=12$

$C/Y=12$ ***(A1)(M1)***

Note: Award ***(A1)*** for $C/Y=12$ seen, ***(M1)*** for all other correct entries.

$=6847.26\ (\text{euros})$ ***(A1)*** ***(C3)***

Note: Answer must be correct to 2 decimal places for the final ***(A1)*** to be awarded.

Examiners report

Many correct answers were given for part (a). Incorrect answers were in most cases the result of incorrect substitution into the compound interest formula, or incorrect use of the calculator, both in using the formula or when using the finance application. A common mistake was the use of 0.045 instead of 4.5 for r in the formula.

5b. *[3 marks]*

Markscheme

$14000 = 7000\left(1 + \frac{r}{100}\right)^{10}$ ***(M1)(A1)***

Notes: Award ***(M1)*** for substitution into compound interest formula equated to 14000 or equivalent.

Award ***(A1)*** for correct substitutions.

OR

$N = 10$

$PV = \pm 7000$

$FV \mp 14000$

$P/Y = 1$

$C/Y = 1$ ***(A1)(M1)***

Note: Award ***(A1)*** for $C/Y = 1$ seen, ***(M1)*** for other correct entries. PV and FV must have opposite signs.

$r = 7.18\%$ $(7.17734\ldots\%,\ 0.0718)$ ***(A1)*** ***(C3)***

Note: Do not penalize if $\%$ sign is missing. Do not accept 0.0718%.

Examiners report

In part (b) a correct equation was often given, but an analytical or graphical solution was rarely found. When the finance application of the GDC was used candidates often found the correct answer.

6a. *[1 mark]*

Markscheme

$180 = 150m + c$ (or equivalent) ***(A1)*** ***(C1)***

Examiners report

The equations in part (a) and (b) were given correctly by the vast majority of the candidates.

6b. *[1 mark]*

Markscheme

$181.5 = 210m + c$ (or equivalent) ***(A1)*** ***(C1)***

Examiners report

The equations in part (a) and (b) were given correctly by the vast majority of the candidates.

6c. *[4 marks]*

Markscheme

$m = 0.25,\ c = 176.25$ ***(A1)(A1)*****(ft)**

Note: Follow through from part (a) and part (b), irrespective of working shown.

$L = 0.025(4) + 176.25$ ***(M1)***

Note: Award ***(M1)*** for substitution of their m, their c and 40 into equation.

$L = 177 \quad (177.25)\ (\text{mm})$ ***(A1)*****(ft)** ***(C4)***

Note: Follow through, within **part (c)**, from their m and c only if working shown.

Examiners report

Part (c) was in most cases either completely correct or awarded no marks at all. Only few were able to find the values of *m* and *c*, and therefore the length at 40°C. Part (c) was often left open or answered incorrectly. A common answer was $L = 40m + c$. Very few partial correct responses were given. Some candidates managed a correct 3 sf answer by intelligent guessing. As the question was not structured asking for the m and c values explicitly, not many candidates made an attempt to find those values. Very few seemed to realize they could find those values using their GDC. An attempt to use simultaneous equations was the most common approach.

7a. *[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]

7b. *[1 mark]*

Markscheme

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

Note: Follow through from their part (a).

Examiners report

[N/A]

7c. *[2 marks]*

Markscheme

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

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

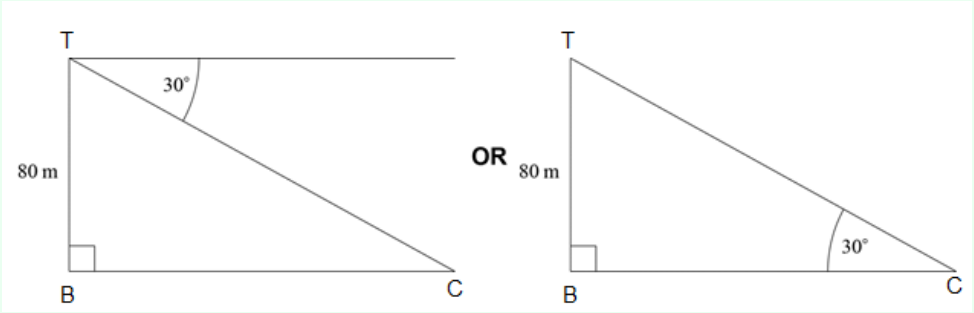
Award ***(A0)(A0)*** for answers such as 22.5×10^1.

Examiners report

[N/A]

8a. *[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]

8b. *[2 marks]*

Markscheme

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

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

$(BC =) 139\ (m)$ $(138.564\ldots\ (m))$ ***(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]

8c. *[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]

9a. *[2 marks]*

Markscheme

(i) d_n **OR** $1,\ 0.95,\ 0.90,\ 0.85,\ \ldots$ ***(A1)*** ***(C1)***

(ii) b_n **OR** $1,\ \frac{3}{2},\ \frac{9}{4},\ \frac{27}{8},\ \ldots$ ***(A1)*** ***(C1)***

Examiners report

[N/A]

9b. *[1 mark]*

Markscheme

$\frac{1}{2}$ **OR** 0.5 ***(A1)*** ***(C1)***

Note: Accept 'divide by 2' for ***(A1)***.

Examiners report

[N/A]

9c. *[3 marks]*

Markscheme

$-6\left(\frac{1}{2}\right)^{10-1}$ ***(M1)(A1)*****(ft)**

Notes: Award ***(M1)*** for substitution in the GP n^{th} term formula, ***(A1)*****(ft)** for their correct substitution.

Follow through from their common ratio in part (b)(i).

OR

$\left(-6,\ -3,\ -\frac{3}{2},\ -\frac{3}{4},\right) -\frac{3}{8},\ -\frac{3}{16},\ -\frac{3}{32},\ -\frac{3}{64},\ -\frac{3}{128}$ ***(M1)(A1)*****(ft)**

Notes: Award ***(M1)*** for terms 5 and 6 correct (using their ratio).

Award ***(A1)*****(ft)** for terms 7, 8 and 9 correct (using their ratio).

$-\frac{3}{256}$ $\left(-\frac{6}{512}\right)$ ***(A1)*****(ft)** ***(C3)***

Examiners report

[N/A]

10a. *[3 marks]*

Markscheme

$1000\left(1+\frac{5}{4\times100}\right)^{4\times3}$ ***(M1)(A1)***

Note: Award ***(M1)*** for substitution into compound interest formula, ***(A1)*** for correct substitution.

OR

$\mathrm{N}=3$

$\mathrm{I}\%=5$

$\mathrm{PV}=-1000$

$\mathrm{P/Y}=1$

$\mathrm{C/Y}=4$ ***(A1)(M1)***

Note: Award ***(A1)*** for $\mathrm{C/Y}=4$ seen, ***(M1)*** for other correct entries.

OR

$\mathrm{N}=12$

$\mathrm{I}\%=5$

$\mathrm{PV}=-1000$

$\mathrm{P/Y}=4$

$\mathrm{C/Y}=4$ ***(A1)(M1)***

Note: Award ***(A1)*** for $\mathrm{C/Y}=4$ seen, ***(M1)*** for other correct entries.

$=1160.75$ (€) ***(A1)*** ***(C3)***

Examiners report

[N/A]

10b. *[3 marks]*

Markscheme

$1000\left(1+\frac{5}{4\times100}\right)^{4\times t}=1300$ ***(M1)(A1)***

Note: Award ***(M1)*** for using the compound interest formula with a variable for time, ***(A1)*** for substituting correct values and equating to 1300.

OR

$\mathrm{I}\%=5$

$\mathrm{PV}=\pm1000$

$\mathrm{FV}=\mp1300$

$\mathrm{P/Y}=1$

$\mathrm{C/Y}=4$ ***(A1)(M1)***

Note: Award ***(A1)*** for 1300 seen, ***(M1)*** for the other correct entries.

OR

$\mathrm{I}\%=5$

$\mathrm{PV}=\pm1000$

$\mathrm{FV}=\mp1300$

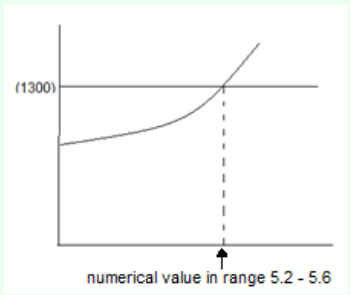
$\mathrm{P/Y}=4$

$\mathrm{C/Y}=4$ ***(A1)(M1)***

Note: Award ***(A1)*** for 1300 seen, ***(M1)*** for the other correct entries.

OR

Sketch drawn of two appropriate lines which intersect at a point



Note: Award ***(M1)*** for a sketch with a straight line intercepted by appropriate curve, ***(A1)*** for a numerical answer in the range $5.2-5.6$.

$t=5.28\ (\text{years})\quad(5.28001\ldots)$ ***(A1) (C3)***

Examiners report

[N/A]

11a. *[1 mark]*

Markscheme

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

Examiners report

[N/A]

11b. *[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]

11c. *[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]

11d. *[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]

12a. *[1 mark]*

Markscheme

$10\ (\text{km h}^{-1})$ ***(A1)***

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12b. *[2 marks]*

Markscheme

36 ***(G2)***

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12c. *[1 mark]*

Markscheme

41.5 ***(G1)***

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12d. *[2 marks]*

Markscheme

$41.5 - 32.5$ ***(M1)***

$= 9\ (\pm 1)$ ***(A1)*****(ft)*****(G2)***

Notes: Award ***(M1)*** for quartiles seen. Follow through from part (c).

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12e. *[2 marks]*

Markscheme

$120 - 110$ ***(M1)***

$= 10$ ***(A1)(G2)***

Note: Award ***(M1)*** for 110 seen.

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12f. *[2 marks]*

Markscheme

$p = 4 \quad q = 10$ ***(A1)*****(ft)*****(A1)*****(ft)**

Note: Follow through from part (e).

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12g. *[2 marks]*

Markscheme

(i) $30 < s \leqslant 40$ ***(A1)***

(ii)

35 ***(A1)*****(ft)**

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

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12h. *[3 marks]*

Markscheme

(i) $36.8\ (\text{km h}^{-1})$ (36.8333) ***(G2)*****(ft)**

Notes: Follow through from part (f).

(ii) 8.85 $(8.84904\ldots)$ ***(G1)*****(ft)**

Note: Follow through from part (f), irrespective of working seen.

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

12i. *[2 marks]*

Markscheme

$\frac{26}{120} \times 100$ ***(M1)***

Note: Award ***(M1)*** for $\frac{26}{120} \times 100$ seen.

$= 21.7\ (\%)$ $\left(21.6666\ldots,\ 21\frac{2}{3},\ \frac{65}{3}\right)$ ***(A1)(G2)***

Examiners report

For the great majority, this was a straightforward and accessible question. There were many, however, who had no appreciation of medians, percentiles and quartiles – all straightforward concepts. Most were able to read from the graph, using correctly the scales; only the weakest misinterpreting these. Calculation of the mean and standard deviation are expected to be completed using the graphic display calculator (GDC) – formulae are no longer required and the covariance will **not** be given in questions. Many candidates, however, were unable to calculate the mean and standard deviation of a (grouped) frequency distribution, instead treating the data as raw; comments on the G2 forms from schools indicated that some teachers were also unable to do this and advice must be sought.

13a. *[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.

13b. *[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).

$= 1943.76\ldots\ (\text{seconds})$ ***(A1)*****(ft)**

$= 32\ (\text{minutes})$ ***(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.

13c. *[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)**

$\text{ACB} = 30.0^\circ\ \ (29.9979\ldots^\circ)$ ***(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.

13d. *[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.

13e. *[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.

13f. *[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

13g. *[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

14a. *[3 marks]*

Markscheme

$\frac{-192}{x^3} + k$ ***(A1)(A1)(A1)***

Note: Award ***(A1)*** for -192, ***(A1)*** for x^{-3}, ***(A1)*** for k (only).

Examiners report

Differentiation of terms including negative indices remains a testing process; it will continue to be tested. There was, however, a noticeable improvement in responses compared to previous years. The parameter k was problematic for a number of candidates.

14b. *[2 marks]*

Markscheme

at local minimum $f'(x) = 0$ ***(M1)***

Note: Award ***(M1)*** for seeing $f'(x) = 0$ (may be implicit in their working).

$\frac{-192}{4^3} + k = 0$ ***(A1)***

$k = 3$ ***(AG)***

Note: Award ***(A1)*** for substituting $x = 4$ in their $f'(x) = 0$, provided it leads to $k = 3$. The conclusion $k = 3$ must be seen for the ***(A1)*** to be awarded.

Examiners report

In part (b), the manipulation of the derivative to find the local minimum point caused difficulties for all but the most able; note that a GDC approach is not accepted in such questions and that candidates are expected to be able to apply the theory of the calculus as appropriate. Further, once a parameter is given, candidates are expected to use this value in subsequent parts.

14c. *[2 marks]*

Markscheme

$\frac{96}{2^2} + 3(2)$ ***(M1)***

Note: Award ***(M1)*** for substituting $x = 2$ and $k = 3$ in $f(x)$.

$= 30$ ***(A1)(G2)***

Examiners report

Parts (c) and (d) were accessible and all but the weakest candidates scored well.

14d. *[2 marks]*

Markscheme

$\frac{-192}{2^3} + 3$ ***(M1)***

Note: Award ***(M1)*** for substituting $x = 2$ and $k = 3$ in their $f'(x)$.

$= -21$ ***(A1)(ft)(G2)***

Note: Follow through from part (a).

Examiners report

Parts (c) and (d) were accessible and all but the weakest candidates scored well.

14e. *[3 marks]*

Markscheme

$y - 30 = \frac{1}{21}(x - 2)$ ***(A1)*****(ft)*****(M1)***

Notes: Award ***(A1)*****(ft)** for their $\frac{1}{21}$ seen, ***(M1)*** for the correct substitution of their point and their normal gradient in equation of a line.

Follow through from part (c) and part (d).

OR

gradient of normal $= \frac{1}{21}$ ***(A1)*****(ft)**

$30 = \frac{1}{21} \times 2 + c$ ***(M1)***

$c = 29\frac{19}{21}$

$y = \frac{1}{21}x + 29\frac{19}{21} \quad (y = 0.0476x + 29.904)$

$x - 21y + 628 = 0$ ***(A1)*****(ft)*****(G2)***

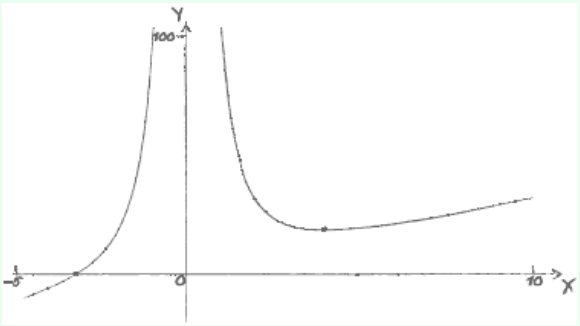
Notes: Accept equivalent answers.

Examiners report

Part (e) discriminated at the highest level; the gradient of the normal often was not used, the form of the answer not given correctly.

14f. *[4 marks]*

Markscheme



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

Notes: Award ***(A1)*** for correct window (at least one value, other than zero, labelled on each axis), the axes must also be labelled; ***(A1)*** for a smooth curve with the correct shape (graph should not touch y-axis and should not curve away from the y-axis), on the given domain; ***(A1)*** for axis intercept in approximately the correct position (nearer -5 than zero); ***(A1)*** for local minimum in approximately the correct position (first quadrant, nearer the y-axis than $x = 10$).

If there is no scale, award a maximum of ***(A0)(A1)(A0)(A1)*** – the final ***(A1)*** being awarded for the zero and local minimum in approximately correct positions relative to each other.

Examiners report

Curve sketching is a skill that most candidates find very difficult; axes must be labelled and some indication of the window must be present; care must be taken with the domain and the range; any asymptotic behaviour must be indicated. It was very rare to see sketches that attained full marks, yet this should be a skill that all can attain. There were many no attempts seen, yet some of these had correct answers to part (g).

14g. *[2 marks]*

Markscheme

$(-3.17,\ 0)\quad((-3.17480\ldots,\ 0))$ ***(G1)(G1)***

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

Accept $x = -3.17,\ y = 0$. Award ***(G1)*** for -3.17 seen.

Examiners report

Curve sketching is a skill that most candidates find very difficult; axes must be labelled and some indication of the window must be present; care must be taken with the domain and the range; any asymptotic behaviour must be indicated. It was very rare to see sketches that attained full marks, yet this should be a skill that all can attain. There were many no attempts seen, yet some of these had correct answers to part (g).

14h. *[2 marks]*

Markscheme

$0 < x \leqslant 4$ or $0 < x < 4$ ***(A1)(A1)***

Notes: Award ***(A1)*** for correct end points of interval, ***(A1)*** for correct notation (note: lower inequality must be strict).

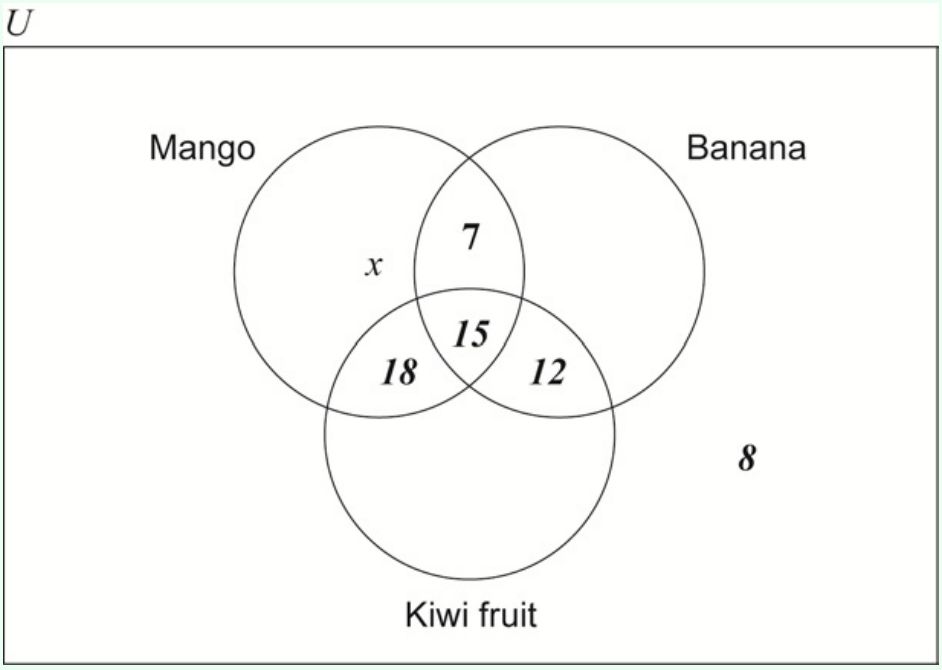
Award a maximum of ***(A1)(A0)*** if y or $f(x)$ used in place of x.

Examiners report

Part (h) was not well attempted in the main; decreasing (and increasing) functions is a testing concept for the majority.

15a. *[3 marks]*

Markscheme



(A1)(A1)(A1)

Notes: Award ***(A1)*** for 15 in the correct place.

Award ***(A1)*** for 7, 18 and 12 seen in the correct places.

Award ***(A1)*** for 8 in the correct place.

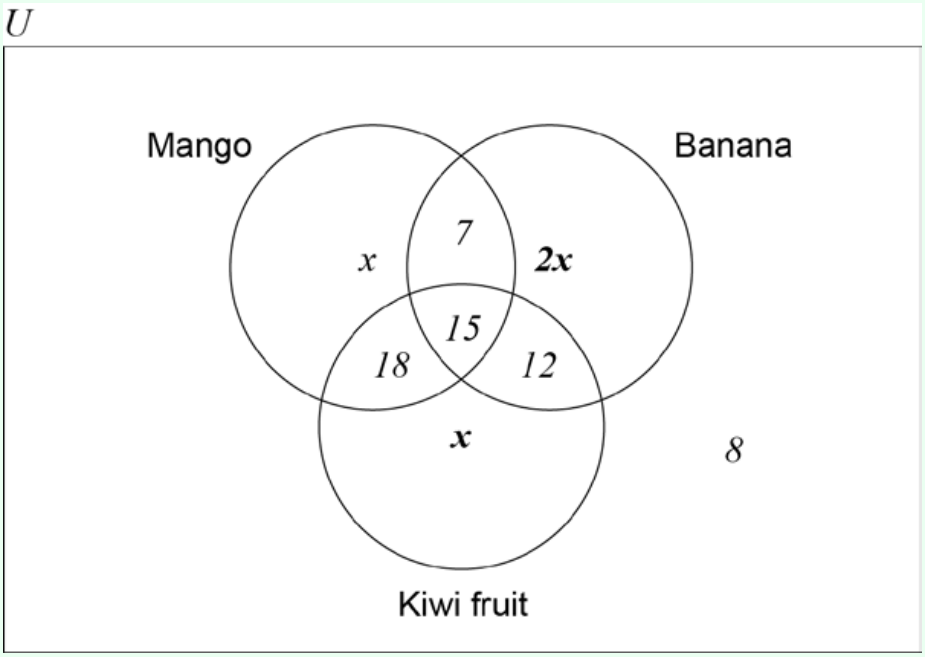
Award at most ***(A0)(A1)(A1)*** if diagram is missing the rectangle.

Examiners report

[N/A]

15b. *[2 marks]*

Markscheme



(A1)(A1)

Notes: Award ***(A1)*** for x seen in the correct places.

Award ***(A1)*** for $2x$ seen in the correct place.

Award ***(A0)(A1)*(ft)** if x and $2x$ are replaced by 10 and 20 respectively.

Examiners report

[N/A]

15c. *[2 marks]*

Markscheme

$2x + x + x + 15 + 8 + 7 + 18 + 12 = 100 \quad (4x + 60 = 100 \text{ or equivalent})$ ***(M1)***

Note: Award ***(M1)*** for equating the sum of the elements of their Venn diagram to 100. Equating to 100 may be implied.

$(x =) \, 10$ ***(A1)*(ft)*(G2)***

Note: Follow through from their Venn diagram. The answer must be a positive integer.

Examiners report

[N/A]

15d. *[2 marks]*

Markscheme

(i)

50 ***(A1)*****(ft)**

(ii)

82 ***(A1)*****(ft)**

Note: Follow through from their answer to part (c) and their Venn diagram.

Award ***(A0)*****(ft)*****(A1)*****(ft)** if answer is $\frac{50}{100}$ and $\frac{82}{100}$.

Examiners report

[N/A]

15e. *[4 marks]*

Markscheme

(i) $\frac{8}{100}$ $\left(\frac{2}{25};\ 0.08;\ 8\%\right)$ ***(A1)***

Note: Correct answer only. There is no follow through.

(ii) $\frac{37}{100}$ $(0.37,\ 37\%)$ ***(A1)*****(ft)**

Note: Follow through from their Venn diagram.

(iii) $\frac{15}{22}$ $(0.681;\ 0.682;\ 68.2\%)$ $(0.681818\ldots)$ ***(A1)(A1)*****(ft)*****(G2)***

Notes: Award ***(A1)*** for numerator, ***(A1)*****(ft)** for denominator, follow through from their Venn diagram. Award ***(A0)(A0)*** if answer is given as incorrect reduced fraction without working.

Examiners report

[N/A]

15f. *[3 marks]*

Markscheme

$\frac{8}{100} \times \frac{7}{99}$ ***(A1)*****(ft)*****(M1)***

Note: Award ***(A1)*****(ft)** for correct fractions, follow through from their answer to part (e)(i), ***(M1)*** for multiplying their fractions.

$= \frac{56}{9900}$ $\left(\frac{14}{2477},\ 0.00565656\ldots,\ 0.00566,\ 0.0056,\ 0.566\%\right)$ ***(A1)*****(ft)*****(G2)***

Examiners report

[N/A]

16a. *[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]

16b. *[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]

16c. *[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]

16d. *[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]

16e. *[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]

17a. *[2 marks]*

Markscheme

(i) $S_1 = 7$ ***(A1)***

(ii) $S_2 = 16$ ***(A1)***

Examiners report

[N/A]

17b. *[1 mark]*

Markscheme

$(u_2 =)\ 16 - 7 = 9$ ***(M1)(AG)***

Note: Award ***(M1)*** for subtracting 7 from 16. The 9 must be seen.

OR

$16 - 7 - 7 = 2$

$(u_2 =)\ 7 + (2-1)(2) = 9$ ***(M1)(AG)***

Note: Award ***(M1)*** for subtracting twice 7 from 16 and for correct substitution in correct arithmetic sequence formula.

The 9 must be seen.

Do not accept: $9 - 7 = 2,\ u_2 = 7 + (2-1)(2) = 9$.

Examiners report

[N/A]

17c. *[2 marks]*

Markscheme

$u_1 = 7$ ***(A1)*****(ft)**

$d = 2\ (= 9 - 7)$ ***(A1)*****(ft)*****(G2)***

Notes: Follow through from their S_1 in part (a)(i).

Examiners report

[N/A]

17d. *[2 marks]*

Markscheme

$7 + 2 \times (10 - 1)$ ***(M1)***

Note: Award ***(M1)*** for correct substitution in the correct arithmetic sequence formula. Follow through from **their** parts (a)(i) and (c).

$= 25$ ***(A1)*****(ft)*****(G2)***

Note: Award ***(A1)*****(ft)** for their correct tenth term.

Examiners report

[N/A]

17e. *[3 marks]*

Markscheme

$7 + 2 \times (n - 1) > 1000$ ***(A1)*****(ft)*****(M1)***

Note: Award ***(A1)*****(ft)** for their correct expression for the n^{th} term, ***(M1)*** for comparing their expression to 1000. Accept an equation. Follow through from their parts (a)(i) and (c).

$n = 498$ ***(A1)*****(ft)*****(G2)***

Notes: Answer must be a natural number.

Examiners report

[N/A]

17f. *[2 marks]*

Markscheme

$6n + n^2 = 1512$ **OR** $\frac{n}{2}(14 + 2(n-1)) = 1512$ **OR**

$S_n = 1512$ **OR** $7 + 9 + \ldots + u_n = 1512$ ***(M1)***

Notes: Award ***(M1)*** for equating the sum of the first n terms to 1512. Accept a sum of at least the first 7 correct terms.

$n = 36$ ***(A1)(G2)***

Note: If $n = 36$ is seen without working, award ***(G2)***. Award a maximum of ***(M1)(A0)*** if -42 is also given as a solution.

Examiners report

[N/A]

18a. *[3 marks]*

Markscheme

$\pi \times 3.25^2 \times 39$ ***(M1)(A1)***

(= 1294.1398)

Answer 1294.14 (cm^3)(2dp) ***(A1)*****(ft)*****(G2)***

(UP) *not applicable in this part due to wording of question.* ***(M1)*** *is for substituting appropriate numbers from the problem into the correct formula, even if the units are mixed up.* ***(A1)*** *is for correct substitutions or correct answer with more than 2dp in cubic centimetres seen. Award* ***(G1)*** *for answer to > 2dp with no working and no attempt to correct to 2dp. Award* ***(M1)(A0)(A1)(ft)*** *for* $\pi \times 32.5^2 \times 39$ cm^3 (= 129413.9824) = 129413.98

Use of $\pi = \frac{22}{7}$ **or** 3.142 *etc is premature rounding and is awarded at most* ***(M1)(A1)(A0)*** *or* ***(M1)(A0)(A1)(ft)*** *depending on whether the intermediate value is seen or not. For all other incorrect substitutions, award* ***(M1)(A0)*** *and only follow through the 2 dp correction if the intermediate answer to more decimal places is seen. Answer given as a multiple of* π *is awarded at most* ***(M1)(A1)(A0).*** *As usual, an* ***unsubstituted*** *formula followed by correct answer only receives the G marks.*

[3 marks]

Examiners report

(i) Many candidates incurred the new one-off unit penalty here. Too many ignored the call for two decimal places and some extrapolated that instruction to later parts (which was clearly not intended). There was the predictable confusion of using radius instead of diameter. Another common error was to divide the cylinder volume by that of the ball, to decide how many would fit. Some follow-through was allowed later from this error, however, this led to zero or negligible air volume, which was clearly ridiculous.

Choice and use of the formulae for volumes was often competent but the conversion to cubic metres was very badly done. Almost no correct answers were seen at all.

18b. *[1 mark]*

Markscheme

39/6.5 = 6 ***(A1)***

[1 mark]

Examiners report

(i) Many candidates incurred the new one-off unit penalty here. Too many ignored the call for two decimal places and some extrapolated that instruction to later parts (which was clearly not intended). There was the predictable confusion of using radius instead of diameter. Another common error was to divide the cylinder volume by that of the ball, to decide how many would fit. Some follow-through was allowed later from this error, however, this led to zero or negligible air volume, which was clearly ridiculous.

Choice and use of the formulae for volumes was often competent but the conversion to cubic metres was very badly done. Almost no correct answers were seen at all.

18c. *[4 marks]*

Markscheme

*Unit penalty **(UP)** is applicable where indicated in the left hand column.*

(UP) (i) Volume of one ball is
$\frac{4}{3}\pi \times 3.25^3$ cm^3 ***(M1)***

Volume of air $= \pi \times 3.25^2 \times 39 - 6 \times \frac{4}{3}\pi \times 3.25^3 = 431$ cm^3 ***(M1)(A1)*****(ft)*****(G2)***

*Award first **(M1)** for substituted volume of sphere formula or for numerical value of sphere volume seen (143.79… or 45.77… $\times\pi$). Award second **(M1)** for subtracting candidate's sphere volume multiplied by their answer to (b). Follow through from parts (a) and (b) only, but negative or zero answer is always awarded **(A0)*****(ft)***

(UP) (ii) 0.000431m^3 or 4.31×10^{-4} m^3 ***(A1)*****(ft)**

[4 marks]

Examiners report

(i) Many candidates incurred the new one-off unit penalty here. Too many ignored the call for two decimal places and some extrapolated that instruction to later parts (which was clearly not intended). There was the predictable confusion of using radius instead of diameter. Another common error was to divide the cylinder volume by that of the ball, to decide how many would fit. Some follow-through was allowed later from this error, however, this led to zero or negligible air volume, which was clearly ridiculous.

Choice and use of the formulae for volumes was often competent but the conversion to cubic metres was very badly done. Almost no correct answers were seen at all.

18d. *[5 marks]*

Markscheme

*Unit penalty **(UP)** is applicable where indicated in the left hand column.*

(i)

Angle $\widehat{BTL} = 180 - 80 - 26.5$ or

$180 - 90 - 26.5 - 10$ ***(M1)***

$= 73.5°$ ***(A1)(G2)***

(ii)

$\frac{BT}{\sin(26.5°)} = \frac{120}{\sin(73.5°)}$ ***(M1)(A1)*****(ft)**

(UP) BT = 55.8 m (3sf) ***(A1)*****(ft)**

[5 marks]

*If radian mode has been used throughout the question, award **(A0)** to the first incorrect answer then follow through, but negative lengths are always awarded **(A0)(ft)**.*

The answers are (all 3sf)

*(ii)(a) – 124 m **(A0)*****(ft)***

*(ii)(b) 123 m **(A0)***

*(ii)(c) 313 m **(A0)***

*If radian mode has been used throughout the question, award **(A0)** to the first incorrect answer then follow through, but negative lengths are always awarded **(A0)*****(ft)***

Examiners report

(ii) Candidates were often sloppy in reading the information. In particular, despite the statement BL = 120 clearly written, many took GL as 120. Triangle TBL was often taken as right-angled. Angle BTL presented few problems, though sometimes the method was very long-winded. Candidates often managed part (a) then went awry in later parts. Many unit penalties were applied, if not already used in questions 1 or 2.

18e. *[2 marks]*

Markscheme

*Unit penalty **(UP)** is applicable where indicated in the left hand column.*

TG = 55.8sin(80°) or 55.8cos(10°) ***(M1)***

(UP) = 55.0 m (3sf) ***(A1)*****(ft)*****(G2)***

*Apply **(AP)** if 0 missing*

[2 marks]

*If radian mode has been used throughout the question, award **(A0)** to the first incorrect answer then follow through, but negative lengths are always awarded **(A0)(ft)**.*

The answers are (all 3sf)

*(ii)(a) – 124 m **(A0)*****(ft)***

*(ii)(b) 123 m **(A0)***

*(ii)(c) 313 m **(A0)***

*If radian mode has been used throughout the question, award **(A0)** to the first incorrect answer then follow through, but negative lengths are always awarded **(A0)*****(ft)***

Examiners report

(ii) Candidates were often sloppy in reading the information. In particular, despite the statement BL = 120 clearly written, many took GL as 120. Triangle TBL was often taken as right-angled. Angle BTL presented few problems, though sometimes the method was very long-winded. Candidates often managed part (a) then went awry in later parts. Many unit penalties were applied, if not already used in questions 1 or 2.

18f. *[3 marks]*

Markscheme

*Unit penalty **(UP)** is applicable where indicated in the left hand column.*

$\text{MT}^2 = 200^2 + 55.8^2 - 2 \times 200 \times 55.8 \times \cos(100^\circ)$ ***(M1)(A1)*****(ft)**

(UP) MT = 217 m (3sf) ***(A1)*****(ft)**

Follow through only from part (ii)(a)(ii). Award marks at discretion for any valid alternative method.

[3 marks]

*If radian mode has been used throughout the question, award **(A0)** to the first incorrect answer then follow through, but negative lengths are always awarded **(A0)(ft)**.*

The answers are (all 3sf)

*(ii)(a) – 124 m **(A0)*****(ft)**

*(ii)(b) 123 m **(A0)***

*(ii)(c) 313 m **(A0)***

*If radian mode has been used throughout the question, award **(A0)** to the first incorrect answer then follow through, but negative lengths are always awarded **(A0)*****(ft)***

Examiners report

(ii) Candidates were often sloppy in reading the information. In particular, despite the statement BL = 120 clearly written, many took GL as 120. Triangle TBL was often taken as right-angled. Angle BTL presented few problems, though sometimes the method was very long-winded. Candidates often managed part (a) then went awry in later parts. Many unit penalties were applied, if not already used in questions 1 or 2.

19a. *[2 marks]*

Markscheme

$u_1 = d = 1$. ***(A1)(A1)***

[2 marks]

Examiners report

(i) Identification of u_1 and d was fine. In (b) many candidates failed to recognise the need for a general proof and simply gave an example substitution. Part (c) was well done.

19b. *[2 marks]*

Markscheme

Sum is
$\frac{1}{2}n(2u_1 + d(n-1))$ or
$\frac{1}{2}n(u_1 + u_n)$ ***(M1)***

*Award **(M1)** for either sum formula seen, even without substitution.*

So sum is
$\frac{1}{2}n(2 + (n-1)) = \frac{1}{2}n(n+1)$ ***(A1)(AG)***

*Award **(A1)** for substitution of*
$u_1 = 1 = d$ *or*
$u_1 = 1$ *and*
$u_n = n$ *with simplification where appropriate.*
$\frac{1}{2}n(n+1)$ *must be seen to award this **(A1)**.*

[2 marks]

Examiners report

(i) Identification of u_1 and d was fine. In (b) many candidates failed to recognise the need for a general proof and simply gave an example substitution. Part (c) was well done.

19c. *[2 marks]*

Markscheme

$\frac{1}{2}(200)(201) = 20100$ ***(M1)(A1)(G2)***

***(M1)** is for correct formula with correct numerical input. Original sum formula with u, d and n can be used.*

[2 marks]

Examiners report

(i) Identification of u_1 and d was fine. In (b) many candidates failed to recognise the need for a general proof and simply gave an example substitution. Part (c) was well done.

19d. *[3 marks]*

Markscheme

$\frac{1-3^n}{1-3} = 29524$ ***(M1)(A1)***

***(M1)** for correctly substituted formula on one side, **(A1)** for = 29524 on the other side.*

n = 10. ***(A1)(G2)***

*Trial and error is a valid method. Award **(M1)** for at least*
$\frac{1-3^{10}}{1-3}$ *seen and then **(A1)** for = 29524, **(A1)** for*
$n = 10$. *For only unproductive trials with*
$n \neq 10$, *award **(M1)** and then **(A1)** if the evaluation is correct.*

[3 marks]

Examiners report

(ii) Too many candidates here failed to swap to the GP formulae. Those who did know what was happening here often performed the calculations well and got decent marks. The explanations in (d) were often unsatisfactory but some allowance was made for the language difficulties encountered by candidates writing in a 2nd or higher language. The last part (e) of the question, intended as a high-grade discriminator performed that task very well.

19e. *[1 mark]*

Markscheme

Common ratio is
$\frac{1}{3}$, (0.333 (3sf) or 0.3) ***(A1)***

Accept 'divide by 3'.

[1 mark]

Examiners report

(ii) Too many candidates here failed to swap to the GP formulae. Those who did know what was happening here often performed the calculations well and got decent marks. The explanations in (d) were often unsatisfactory but some allowance was made for the language difficulties encountered by candidates writing in a 2nd or higher language. The last part (e) of the question, intended as a high-grade discriminator performed that task very well.

19f. *[2 marks]*

Markscheme

$\frac{1-\left(\frac{1}{3}\right)^{10}}{1-\frac{1}{3}}$ ***(M1)***

= 1.50 (3sf) ***(A1)*****(ft)*****(G1)***

1.5 and
$\frac{3}{2}$ *receive* ***(A0)(AP)*** *if* ***AP*** *not yet used Incorrect formula seen in (a) or incorrect value in (b) can follow through to (c). Can award* ***(M1)*** *for*
$1+\left(\frac{1}{3}\right)+\left(\frac{1}{9}\right)+\ldots\ldots$

[2 marks]

Examiners report

(ii) Too many candidates here failed to swap to the GP formulae. Those who did know what was happening here often performed the calculations well and got decent marks. The explanations in (d) were often unsatisfactory but some allowance was made for the language difficulties encountered by candidates writing in a 2nd or higher language. The last part (e) of the question, intended as a high-grade discriminator performed that task very well.

19g. *[1 mark]*

Markscheme

Both
$\left(\frac{1}{3}\right)^{10}$ and
$\left(\frac{1}{3}\right)^{1000}$ (or those numbers divided by 2/3) are 0 when corrected to 3sf, so they make no difference to the final answer. ***(R1)***

Accept any valid explanation but please note: statements which only convey the idea of convergence are not enough for ***(R1)****. The reason must show recognition that the convergence is adequately fast (though this might be expressed in a much less technical manner).*

[1 mark]

Examiners report

(ii) Too many candidates here failed to swap to the GP formulae. Those who did know what was happening here often performed the calculations well and got decent marks. The explanations in (d) were often unsatisfactory but some allowance was made for the language difficulties encountered by candidates writing in a 2nd or higher language. The last part (e) of the question, intended as a high-grade discriminator performed that task very well.

19h. *[3 marks]*

Markscheme

The sequence given is
$G_1 + G_2$ ***(M1)***

The sum is 29 524 + 1.50 ***(A1)*****(ft)**

= 29 525.5 ***(A1)*****(ft)*****(G2)***

*The **(M1)** is implied if the sum of the two numbers is seen. Award **(G1)** for 29 500 with no working. **(M1)** can be awarded for* $2 + 3\frac{1}{3} + \ldots$ *Award final **(A1)** only for answer given correct to 1dp.*

[3 marks]

Examiners report

(ii) Too many candidates here failed to swap to the GP formulae. Those who did know what was happening here often performed the calculations well and got decent marks. The explanations in (d) were often unsatisfactory but some allowance was made for the language difficulties encountered by candidates writing in a 2nd or higher language. The last part (e) of the question, intended as a high-grade discriminator performed that task very well.

20a. *[1 mark]*

Markscheme

47.5 (cm) ***(A1)***

Examiners report

[N/A]

20b. *[4 marks]*

Markscheme

(i)
45.85 (cm) ***(G2)***

Note: Accept
45.9 .

(ii)
17.1 (17.0888...) ***(G1)***
(iii)
47.5 (cm) ***(G1)***

Examiners report

[N/A]

20c. *[2 marks]*

Markscheme

$62.5 - 32.5 = 30$ ***(M1)(A1)(G2)***

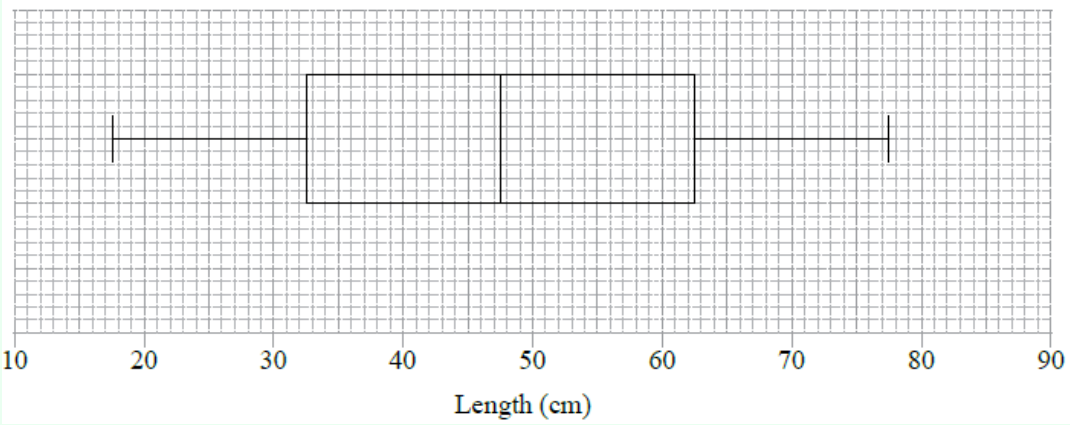
Note: Award ***(M1)*** for correct quartiles seen.

Examiners report

[N/A]

20d. *[4 marks]*

Markscheme



(A1) for correct label and scale
***(A1)*(ft)** for correct median
***(A1)*(ft)** for correct quartiles and box
(A1) for endpoints at
17.5 and
77.5 joined to box by straight lines ***(A1)(A1)*(ft)(A1)*(ft)(A1)***

Notes: The final ***(A1)*** is lost if the lines go through the box. Follow through from their parts (b) and (c).

Examiners report

[N/A]

20e. *[2 marks]*

Markscheme

$\varepsilon = \left|\frac{43-45.85}{45.85}\right| \times 100\%$ **(M1)**

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

$= 6.22\%$ (
$6.21592\ldots$) ***(A1)*(ft)(G2)***

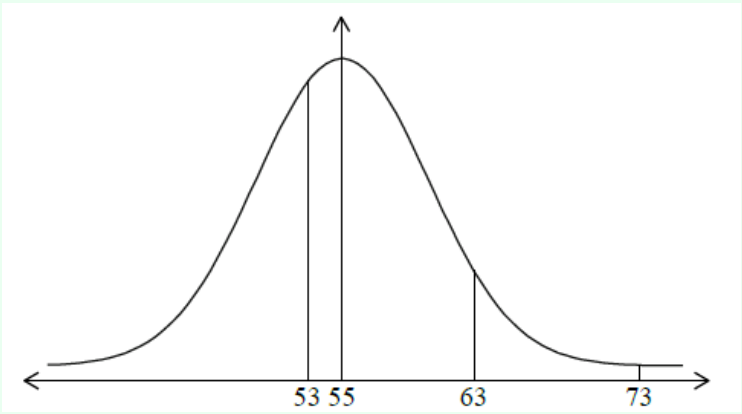
Notes: Follow through from their answer to part (b)(i). Accept
6.32% with use of
45.9 .

Examiners report

[N/A]

21a. *[3 marks]*

Markscheme



(A1) for normal curve with mean of
55 indicated
(A1) for three lines in approximately the correct position
(A1) for labels on the three lines ***(A1)(A1)(A1)***

Examiners report

[N/A]

21b. *[4 marks]*

Markscheme

(i)
$\mathrm{P}(53 \leqslant \text{Weight} < 63) = 0.486$ (
$0.485902\ldots$) ***(M1)(A1)(G2)***

Note: Award ***(M1)*** for correct region indicated on labelled diagram.

(ii)
$\mathrm{P}(\text{Weight} > 73) = 0.00506$ (
0.00506402) ***(M1)(A1)(G2)***

Note: Award ***(M1)*** for correct region indicated on labelled diagram.

Examiners report

[N/A]

21c. *[2 marks]*

Markscheme

$\mathrm{P}(\text{Weight} > w) = 0.3$ ***(M1)***
$w = 58.7$ (
$58.6708\ldots$) ***(A1)(G2)***

Note: Award ***(M1)*** for correct region indicated on labelled diagram.

Examiners report

[N/A]

21d. *[2 marks]*

Markscheme

Expected number of large size eggs

$= 2000(0.121)$ ***(M1)***
$= 242$ ***(A1)(G2)***

Examiners report

[N/A]

21e. *[3 marks]*

Markscheme

Expected income
$= 2000 \times 0.30 \times 0.388 + 2000 \times 0.50 \times 0.486 + 2000 \times 0.65 \times 0.121 + 2000 \times 0.80 \times 0.00506$ ***(M1)(M1)***

Note: Award ***(M1)*** for their correct products, ***(M1)*** for addition of 4 terms.

$= 884.20$ USD ***(A1)*****(ft)*****(G3)***

Note: Follow through from part (b).

Examiners report

[N/A]