

**GCSE
MATHEMATICS
8300/3H**

Higher Tier Paper 3 Calculator

Mark scheme

June 2021

Version: 1.0 Final



Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

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Glossary for Mark Schemes

GCSE examinations are marked in such a way as to award positive achievement wherever possible. Thus, for GCSE Mathematics papers, marks are awarded under various categories.

If a student uses a method which is not explicitly covered by the mark scheme the same principles of marking should be applied. Credit should be given to any valid methods. Examiners should seek advice from their senior examiner if in any doubt.

| | |
|------------------------|--|
| M | Method marks are awarded for a correct method which could lead to a correct answer. |
| A | Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied. |
| B | Marks awarded independent of method. |
| ft | Follow through marks. Marks awarded for correct working following a mistake in an earlier step. |
| SC | Special case. Marks awarded for a common misinterpretation which has some mathematical worth. |
| M dep | A method mark dependent on a previous method mark being awarded. |
| B dep | A mark that can only be awarded if a previous independent mark has been awarded. |
| oe | Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$ |
| [a, b] | Accept values between a and b inclusive. |
| [a, b) | Accept values $a \leq \text{value} < b$ |
| 3.14 ... | Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416 |
| Use of brackets | It is not necessary to see the bracketed work to award the marks. |

Examiners should consistently apply the following principles

Diagrams

Diagrams that have working on them should be treated like normal responses. If a diagram has been written on but the correct response is within the answer space, the work within the answer space should be marked. Working on diagrams that contradicts work within the answer space is not to be considered as choice but as working, and is not, therefore, penalised.

Responses which appear to come from incorrect methods

Whenever there is doubt as to whether a student has used an incorrect method to obtain an answer, as a general principle, the benefit of doubt must be given to the student. In cases where there is no doubt that the answer has come from incorrect working then the student should be penalised.

Questions which ask students to show working

Instructions on marking will be given but usually marks are not awarded to students who show no working.

Questions which do not ask students to show working

As a general principle, a correct response is awarded full marks.

Misread or miscopy

Students often copy values from a question incorrectly. If the examiner thinks that the student has made a genuine misread, then only the accuracy marks (A or B marks), up to a maximum of 2 marks are penalised. The method marks can still be awarded.

Further work

Once the correct answer has been seen, further working may be ignored unless it goes on to contradict the correct answer.

Choice

When a choice of answers and/or methods is given, mark each attempt. If both methods are valid then M marks can be awarded but any incorrect answer or method would result in marks being lost.

Work not replaced

Erased or crossed out work that is still legible should be marked.

Work replaced

Erased or crossed out work that has been replaced is not awarded marks.

Premature approximation

Rounding off too early can lead to inaccuracy in the final answer. This should be penalised by 1 mark unless instructed otherwise.

Continental notation

Accept a comma used instead of a decimal point (for example, in measurements or currency), provided that it is clear to the examiner that the student intended it to be a decimal point.

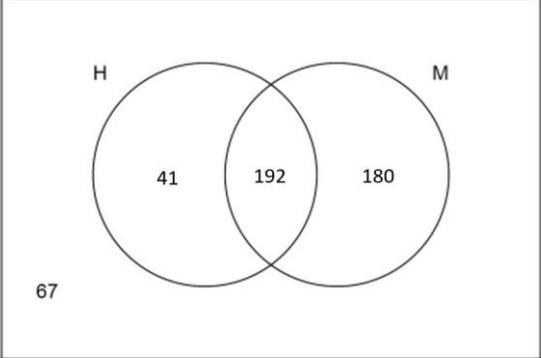
| Q | Answer | Mark | Comments |
|---|--------------------|------|----------|
| 1 | $b = \sqrt{a} + 3$ | B1 | |

| Q | Answer | Mark | Comments |
|---|-------------|------|----------|
| 2 | $0.\dot{5}$ | B1 | |

| Q | Answer | Mark | Comments |
|---|--------------------------------|------|----------|
| 3 | $\left(0, -\frac{2}{3}\right)$ | B1 | |

| Q | Answer | Mark | Comments |
|---|------------------|------|----------|
| 4 | $(x + 8)(x - 8)$ | B1 | |

| Q | Answer | Mark | Comments |
|----------|--|--------|--|
| 5 | $6 \times 10 - (12 + 7 + 15 + 3)$ or $60 - 37$ or 23 | M1 | implied by two numbers with a total of 23 eg -11 and 34 |
| | Two positive numbers with a total of 23 | A1 | |
| | Two positive numbers which make the range of the list 19 | B1 | eg a and 22, where $3 \leq a \leq 22$ |
| | Additional Guidance | | |
| | 2 and 21 is the only fully correct answer | | M1A1B1 |
| | 11.5 and 11.5 | | M1A1B0 |
| | 1 and 22 | | M1A1B0 |
| 0 and 23 | | M1A0B0 | |

| Q | Answer | Mark | Comments |
|----------------------------|---|------|-----------------------|
| | 480 × 0.4 or 192 | M1 | oe implied by 2400 |
| | $480 \times \frac{3}{8}$ or 180 | M1 | oe implied by 1440 |
| | 480 – their 192 – their 180 – 67 or 41 | M1 | oe implied by 287 |
| | their 192 × 12.5 + their 180 × 8 + their 41 × 7 or 2400 + 1440 + 287 | M1 | |
| | 4127 | A1 | |
| Additional Guidance | | | |
| | Method marks may be awarded for correct work seen on Venn diagram or in working, with no or incorrect answer, even if this is seen amongst multiple attempts | | |
| 6 | <p>For the 4th method mark, incorrectly placed values from their Venn diagram may be used or values connected to the correct category eg if house only and museum only values transposed on the Venn diagram accept their 192 × 12.5 + their 41 × 8 + their 180 × 7</p> <div style="text-align: center;">  </div> | | |
| | $40\% \text{ of } 413 = 165, \frac{3}{8} \text{ of } 165 = 62, 413 - 62 - 165 = 186$ $165 \times 12.50 + 62 \times 8 + 186 \times 7 = 3860.50$ | | MOM0M1M1A0 |
| | $H = 154.875, H\&M = 165.2$ $480 - 67 - 154.875 - 165.2$ | | MOM0M1 |

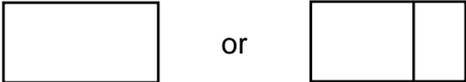
| Q | Answer | Mark | Comments |
|----------|---|-------|----------|
| 7 | $270 \div (2.6 + 1)$ or $270 \div 3.6$ or 75 or $\frac{2.6}{(2.6+1)}$ or $\frac{2.6}{3.6}$ or 0.72(...) or $2.6 - 1$ or 1.6 | M1 | oe |
| | their 75×2.6 or $270 - \text{their } 75$ or 195 or $270 \times \text{their } 0.72(\dots)$ or their $75 \times (2.6 - 1)$ or their $75 \times \text{their } 1.6$ or $\frac{\text{their } 1.6}{(2.6+1)}$ or 0.44(...) | M1dep | oe |
| | 120 | A1 | |
| | Additional Guidance | | |
| | 195 and 75 | | M1M1 |
| | $270 \div 2.6$ | | M0 |

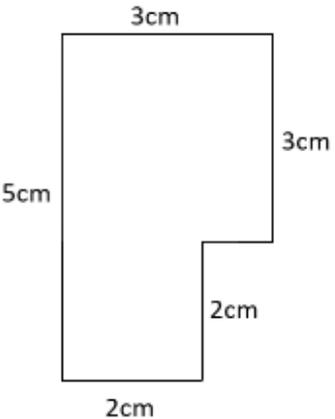
| Q | Answer | Mark | Comments |
|---|--|-------|---|
| 8 | Alternative method 1 | | |
| | 198×0.45 or 89.1 | M1 | |
| | their $89.1 \div 6.25$ | M1 | their 89.1 must come from a division or multiplication using 198 and 0.45 only |
| | 14.256 or 14.26 or 14.3 | A1 | SC1 556.875 or 556.88 or 556.9 or 70.4 |
| | Alternative method 2 | | |
| | $198 \div 6.25$ or 31.68 | M1 | |
| | their 31.68×0.45 | M1 | their 31.68 must come from a division or multiplication using 198 and 6.25 only |
| | 14.256 or 14.26 or 14.3 | A1 | SC1 556.875 or 556.88 or 556.9 or 70.4 |
| | Alternative method 3 | | |
| | $0.45 \div 6.25$ or 0.072 | M1 | |
| | $198 \times$ their 0.072 | M1dep | |
| | 14.256 or 14.26 or 14.3 | A1 | SC1 556.875 or 556.88 or 556.9 or 70.4 |
| | Alternative method 4 | | |
| | $6.25 \div 0.45$ or $13.\dot{8}$ or 13.8(...) or 13.9 | M1 | |
| | $198 \div$ their $13.\dot{8}$ | M1dep | |
| | 14.256 or 14.26 or 14.3 | A1 | SC1 556.875 or 556.88 or 556.9 or 70.4 |

Additional guidance for this question is on the next page

| | | Additional Guidance | |
|-------------------------|--|--|------|
| 8 cont | | $198 \times 0.45 \div 6.25$ oe | M1M1 |
| | | $198 \times 0.45 \times 6.25$ (which gives 556.875) | M1M0 |
| | | $198 \div 0.45 \div 6.25$ (which gives 70.4) | M0M1 |
| | | $198 \div 0.45 \times 6.25$ (which gives 2750) | M0M0 |
| | | Do not allow 6.25^2 for 6.25 eg $198 \div 6.25 \div 6.25$ | M0 |
| | | Ignore rounding or truncation after correct answer seen | |
| | | | |

| Q | Answer | Mark | Comments |
|--|---|-------|--|
| 9 | ($x =$) 4×2 or ($x =$) 8 or area of top right rectangle is 12×2 or $12 \div 4 \times$ their 8 or 24 or area of bottom left rectangle is $56 \div 2$ or $4 \times 56 \div$ their 8 or 28 | M1 | may be on diagram implied by length of bottom left or bottom right vertical section is 7 |
| | Area of top right rectangle is 12×2 or $12 \div 4 \times$ their 8 or 24 and area of bottom left rectangle is $56 \div 2$ or $4 \times 56 \div$ their 8 or 28 or Total area is $(4 +$ their 8) $\times (12 \div 4 + 56 \div$ their 8) or 12×10 or 120 | M1dep | may be on diagram |
| | (Total shaded area is) 52 | A1 | implied by 52 : 68 |
| | $13 : 17$ or $1 : \frac{17}{13}$ or $\frac{13}{17} : 1$ | B1ft | ft simplification of their ratio or conversion into the form $1 : n$ or $n : 1$ with M2A0 or M1M0A0 scored |
| Additional Guidance | | | |
| If their ratio cannot be simplified by dividing by a common factor they can only score B1ft by converting into the form $1 : n$ or $n : 1$ | | | |
| $\frac{52}{120} : \frac{68}{120}$ | | | M1M1A1B0 |
| 68 : 52 simplified to 17 : 13 | | | M1M1A0B1ft |
| $13 \text{ cm}^2 : 17 \text{ cm}^2$ | | | M1M1A1B0 |
| For B1, accept values as decimals rounded or truncated to 2 dp or better eg $1 : 1.31$ or $0.76 : 1$ | | | B1 |

| Q | Answer | Mark | Comments |
|-------|---|-------------------------------|--|
| 10(a) | Rectangle with horizontal sides 3 cm and vertical sides 2 cm | B1 | accept internal vertical line 1 cm from the right, but no other internal lines |
| | Additional Guidance | | |
| |  | with dimensions 3 cm and 2 cm | B1 |
| | Do not accept other internal lines | | |
| | Mark intention | | |

| Q | Answer | Mark | Comments |
|-------|--|------|-----------------|
| 10(b) |  | B1 | any orientation |
| | Additional Guidance | | |
| | Do not accept internal lines | | |
| | Do not accept a reflection | | |
| | Mark intention | | |

| Q | Answer | Mark | Comments |
|---|---|----------|---|
| 11 | 23 or 29 | B1 | implied by correct answer |
| | $\frac{23}{125} (\times 100)$ or $\frac{29}{125} (\times 100)$ or $\frac{\text{their number}}{125} (\times 100)$ or their number = $\frac{125x}{100}$ | M1 | oe their number can be any integer value |
| | 18.4 or 23.2 or correct evaluation of their number as a percentage of 125 | A1ft | ft B0M1 oe their number must be an integer [20, 30] or any prime number |
| | Additional Guidance | | |
| | 18.4 or 23.2 | B1M1A1 | |
| | 18.4 and 23.2 | B1M1A1 | |
| | 23 or 29 must be clearly indicated as their prime number | | |
| | Any integer [20, 30] used can score B0M1A1ft eg $25 \div 125 \times 100$ with answer 20 | B0M1A1ft | |
| | Any prime number used can score B0M1A1ft eg $7 \div 125 \times 100$ with answer 5.6 | B0M1A1ft | |
| | 24% of 125 is 30 with answer 24 | B0M1A1ft | |
| | 29% of 125 is 36.25 (36.25 is not an integer) | B1M0A0ft | |
| 28% of 125 is 35 with answer 28 (35 is an integer out of range) | B0M1A0ft | | |
| 28% of 125 is 35 scores M1 (35 is an integer) | | | |
| 25% of 125 is 31.25 scores M0 (31.25 is not an integer) | | | |

| Q | Answer | Mark | Comments |
|----|--|------|------------------------------|
| 12 | 360 \div 15 or 24 or (15 – 2) \times 180 or 2340 | M1 | oe may be seen on diagram |
| | 156 | A1 | |

| Q | Answer | Mark | Comments |
|----|--|-------|--------------------------------------|
| 13 | Alternative method 1 | | |
| | $4 \times 26 \times 15$ or 1560 | M1 | |
| | $\pi \times (26 \div 2)^2 \times 15 (\div 2)$ or $\pi \times 13^2 \times 15 (\div 2)$ or $2535\pi (\div 2)$ or $\pi \times (26 \div 2)^2 \div 2 (\times 15)$ or $\pi \times 13^2 \div 2 (\times 15)$ or $\frac{169\pi}{2} (\times 15)$ or $84.5 \pi (\times 15)$ or $[265.3, 265.5] (\times 15)$ or $[7959.9, 7965] (\div 2)$ | M1 | oe accept [3.14, 3.142] for π |
| | $\frac{2535\pi}{2}$ or 1267.5π or $[3979.95, 3982.5]$ | M1dep | dep on previous mark |
| | [5539, 5543] | A1 | |
| | Alternative method 2 | | |
| | 4×26 or 104 | M1 | |
| | $\pi \times (26 \div 2)^2 \div 2$ or $\pi \times 13^2 \div 2$ or $\frac{169\pi}{2}$ or $[265.3, 265.5]$ | M1 | accept [3.14, 3.142] for π |
| | (their 104 + their $\frac{169\pi}{2}$) $\times 15$ or $[369.3, 369.5] \times 15$ | M1dep | dep on M1M1 |
| | [5539, 5543] | A1 | |

| Q | Answer | Mark | Comments |
|--|--|--------|-----------------------|
| 14 | Alternative method 1 | | |
| | 13.2×0.9 or 11.88 | M1 | oe |
| | $13.2(0) \div 1.1$ or 12 | M1 | oe |
| | 11.88 and 12 and No | A1 | |
| | Alternative method 2 | | |
| | 1.1 or 0.9 seen | M1 | |
| | 1.1×0.9 or 0.99 | M1dep | |
| | 0.99 and No | A1 | oe 1% decrease and No |
| | Alternative method 3 | | |
| | 13.2×0.9 or 11.88 | M1 | |
| | their 11.88×1.1 or 13.068 | M1dep | |
| | 13.068 and No | A1 | accept 13.07 or 13.06 |
| | Additional Guidance | | |
| | $12 \times 1.1 = 13.20$, $13.2 \times 0.9 = 11.88$ and No | | M1M1A1 |
| $13.2 \times 1.1 = 14.52$, $14.52 \times 0.9 = 13.068$ and No | | M0M0A0 | |

| Q | Answer | Mark | Comments |
|--|--|--------|--|
| 15 | $0.5k + 7k - 0.15 + 2.5k = 1$ | M1 | oe eg $10k - 0.15 = 1$ |
| | $k = 0.115$ | A1 | oe |
| | 0.655 | A1ft | oe eg $\frac{131}{200}$ or 65.5% ft their 0.115 to 3 dp or better with M1 scored if their 0.115 and their answer are both in the range (0, 1) |
| | Additional Guidance | | |
| | Accept working in percentages | | |
| | $10k - 0.15 = 1$, $10k = 0.85$, $k = 0.085$, answer 0.445 | | M1A0A1ft |
| $10k + 0.15 = 1$, $10k = 0.85$, $k = 0.085$, answer 0.445 | | M0A0A0 | |

| Q | Answer | Mark | Comments |
|--|--|-------|--|
| 16 | (Gradient of $PQ =$) $\frac{14-8}{2-6}$ or $\frac{8-14}{6-2}$ or -1.5 or $\frac{-3}{2}$ or (gradient of $QR =$) $\frac{8-5}{6-2}$ or $\frac{5-8}{2-6}$ or 0.75 or $\frac{3}{4}$ or $\frac{-3}{-4}$ | M1 | oe |
| | (Gradient of $PQ =$) -1.5 or $\frac{-3}{2}$ and (gradient of $QR =$) 0.75 or $\frac{3}{4}$ or $\frac{-3}{-4}$ | M1dep | oe |
| | No and $-1.5 \times 0.75 \neq -1$ or No and $-1.5 \times 0.75 = -1.125$ | A1ft | oe eg No and $\frac{-3}{2} \times \frac{3}{4} = -\frac{9}{8}$ ft their two gradients with M1 scored accept No and -1.5 is not the negative reciprocal of 0.75 |
| | Additional Guidance | | |
| Accept $-\frac{3}{2}$ or $\frac{3}{-2}$ for $\frac{-3}{2}$ | | | |
| Gradient of $PQ = \frac{-3}{2}$, gradient of $QR = \frac{4}{3}$, No and $\frac{-3}{2} \times \frac{4}{3} = -2$ | | | M1M0A1ft |
| Answers involving Pythagoras' theorem or scale drawing | | | M0M0A0 |

| Q | Answer | Mark | Comments |
|----|----------------|------|----------|
| 17 | $-\frac{7}{2}$ | B1 | |

| Q | Answer | Mark | Comments |
|----|--------|------|----------|
| 18 | w | B1 | |

| Q | Answer | Mark | Comments |
|----|--------------|------|----------|
| 19 | $2\sqrt{11}$ | B1 | |

| Q | Answer | Mark | Comments |
|----|---|-------|--|
| 20 | $b = 2c$ or $b = 16$ or $\frac{a}{b} \times \frac{b}{c} = 3c \times 2$ | M1 | oe eg $\frac{a}{2c} = 3c$ or $\frac{a}{16} = 3c$ |
| | $(a =) 6c^2$ or $3 \times 8 \times 2 \times 8$ or 24×16 or 6×8^2 or 6×64 | M1dep | oe |
| | 384 | A1 | |
| | Additional Guidance | | |
| | $\frac{b}{8} = 2$ | | M0 |
| | $\frac{a}{b} = 24$ | | M0 |

| Q | Answer | Mark | Comments |
|----|--|-------|--------------------------|
| 21 | (Class widths are) 5, 5, 10, 30 | M1 | |
| | 18 ÷ 5 or 3.6 or 23 ÷ 5 or 4.6 or 17 ÷ 10 or 1.7 or 21 ÷ 30 or 0.7 | M1 | implied by correct bar |
| | Any three of 18 ÷ 5 or 3.6 and 23 ÷ 5 or 4.6 and 17 ÷ 10 or 1.7 and 21 ÷ 30 or 0.7 | M1dep | implied by correct bars |
| | All bars correct | A1 | $\pm \frac{1}{2}$ square |
| | Additional Guidance | | |
| | Four correct frequency density values imply first M1 | | |

| Q | Answer | Mark | Comments |
|----|--|------|--|
| 22 | $\frac{2n}{3n+1}$ | B3 | oe eg $\frac{2n}{2n+(n+1)}$ B2 any two correct n th terms from $2n$ or $n+1$ or $3n+1$ B1 any one correct n th term from $2n$ or $n+1$ or $3n+1$ |
| | Additional Guidance | | |
| | May be seen in a fraction or added eg $2n + (n+1)$ | | B2 |
| | Do not accept $2n$ embedded in an incorrect expression eg $2n-2$ | | B0 |

| Q | Answer | Mark | Comments |
|-------|----------|------|----------|
| 23(a) | (2, 256) | B1 | |

| Q | Answer | Mark | Comments |
|-------|----------------------------|------|-----------------------------|
| 23(b) | -1 | B1 | accept $(-1, \frac{1}{16})$ |
| | Additional Guidance | | |
| | $16^{-1} = \frac{1}{16}$ | | B0 |

| Q | Answer | Mark | Comments |
|----|-------------------------------|------|---|
| 24 | Any correct pair of values | B1 | eg $a = 9 \quad b = \frac{1}{2}$ $a = 27 \quad b = \frac{1}{3}$ $a = 81 \quad b = \frac{1}{4}$ |
| | Additional Guidance | | |
| | $a = 9 \quad b = \frac{1}{3}$ | | B0 |
| | $a = 3 \quad b = \frac{1}{1}$ | | B0 |
| | $a = 3 \quad b = 1$ | | B0 |

| Q | Answer | Mark | Comments |
|----|--|-------|---|
| 25 | Alternative method 1 – multiplies $(x - 3)(x + 2)$ first | | |
| | $x^2 - 3x + 2x - 6$ or $x^2 - x - 6$ | M1 | four terms with at least three correct implied by $x^2 - x \pm k$ where k is a non-zero constant |
| | $x^3 - 3x^2 + 2x^2 - 6x + 5x^2 - 15x + 10x - 30$ or $x^3 - x^2 - 6x + 5x^2 - 5x - 30$ | M1dep | full expansion with correct multiplication of their 3 or 4 terms by x and 5 |
| | $x^3 + 4x^2 - 11x - 30$ | A1 | |
| | Alternative method 2 – multiplies $(x - 3)(x + 5)$ first | | |
| | $x^2 - 3x + 5x - 15$ or $x^2 + 2x - 15$ | M1 | four terms with at least three correct implied by $x^2 + 2x \pm k$ where k is a non-zero constant |
| | $x^3 - 3x^2 + 5x^2 - 15x + 2x^2 - 6x + 10x - 30$ or $x^3 + 2x^2 - 15x + 2x^2 + 4x - 30$ | M1dep | full expansion with correct multiplication of their 3 or 4 terms by x and 2 |
| | $x^3 + 4x^2 - 11x - 30$ | A1 | |
| | Alternative method 3 – multiplies $(x + 2)(x + 5)$ first | | |
| | $x^2 + 2x + 5x + 10$ or $x^2 + 7x + 10$ | M1 | four terms with at least three correct implied by $x^2 + 7x \pm k$ where k is a non-zero constant |
| | $x^3 + 2x^2 + 5x^2 + 10x - 3x^2 - 6x - 15x - 30$ or $x^3 + 7x^2 + 10x - 3x^2 - 21x - 30$ | M1dep | full expansion with correct multiplication of their 3 or 4 terms by x and -3 |
| | $x^3 + 4x^2 - 11x - 30$ | A1 | |
| | Additional Guidance | | |
| | Do not ignore further incorrect simplification or attempt to solve after correct answer seen | | |

| Q | Answer | Mark | Comments |
|---|--|-------|-----------------------|
| 26 | Alternative method 1 | | |
| | 4.5 ÷ 2 or 2.25 | M1 | |
| | $\sqrt{\text{their } 2.25}$ or 1.5 | M1dep | |
| | 1 : 1.5 or 1 : 1 $\frac{1}{2}$ or 1 : $\frac{3}{2}$ | A1 | |
| | Alternative method 2 | | |
| | $\sqrt{2} : \sqrt{4.5}$ | M1 | |
| | 1 : $\frac{\sqrt{\text{their } 4.5}}{\sqrt{\text{their } 2}}$ | M1dep | |
| | 1 : 1.5 or 1 : 1 $\frac{1}{2}$ or 1 : $\frac{3}{2}$ | A1 | |
| | Alternative method 3 | | |
| | $\sqrt{4} : \sqrt{9}$ | M1 | |
| | 2 : 3 | M1dep | |
| | 1 : 1.5 or 1 : 1 $\frac{1}{2}$ or 1 : $\frac{3}{2}$ | A1 | |
| | Alternative method 4 | | |
| | 2 ÷ 4.5 or $\frac{4}{9}$ or 0.4 $\dot{4}$ | M1 | accept 0.44 or better |
| | $\sqrt{\text{their } \frac{4}{9}}$ or $\frac{2}{3}$ or 0.6 $\dot{6}$ and $\frac{2}{3} : 1$ | M1dep | accept 0.66 or better |
| | 1 : 1.5 or 1 : 1 $\frac{1}{2}$ or 1 : $\frac{3}{2}$ | A1 | |
| Additional Guidance | | | |
| 1 : 1.5 on answer line with no evidence of incorrect method | M1M1A1 | | |

| Q | Answer | Mark | Comments |
|-------|---|------|---|
| 27(a) | Alternative method 1: $DH + HX$ | | |
| | $HE = a - b$ | M1 | implied by $HX = \frac{1}{4}a - \frac{1}{4}b$ |
| | $\left(b + \frac{1}{4}(a - b)\right) = b + \frac{1}{4}a - \frac{1}{4}b$ $= \frac{1}{4}a + \frac{3}{4}b$ | A1 | |
| | Alternative method 2: $DE + EX$ | | |
| | $EH = b - a$ | M1 | implied by $EX = \frac{3}{4}b - \frac{3}{4}a$ |
| | $\left(a + \frac{3}{4}(b - a)\right) = a + \frac{3}{4}b - \frac{3}{4}a$ $= \frac{1}{4}a + \frac{3}{4}b$ | A1 | |

| Q | Answer | Mark | Comments |
|-------|--|------|--|
| 27(b) | Alternative method 1: DF from $DE + EF = DE + \frac{1}{4} EG$ | | |
| | $(EG =) -a + 9b$ or $(EF =) -\frac{1}{4}a + \frac{9}{4}b$ | M1 | oe |
| | $(EF =) -\frac{1}{4}a + \frac{9}{4}b$ and $(DF =) a - \frac{1}{4}a + \frac{9}{4}b$ | M1 | oe |
| | $(DF =) \frac{3}{4}a + \frac{9}{4}b$ | A1 | |
| | $(DF =) 3(\frac{1}{4}a + \frac{3}{4}b)$ and Yes | A1 | oe using a different correct scalar multiple for DF and DX |

Mark scheme for Question 27(b) continues on next page

| Q | Answer | Mark | Comments |
|-----------------------|---|------|--|
| 27(b) cont | Alternative method 2: DF from $DG + GF = DG + \frac{3}{4}GE$ | | |
| | $(GE =) -9b + a$ or $(GF =) -\frac{27}{4}b + \frac{3}{4}a$ | M1 | oe |
| | $(GF =) -\frac{27}{4}b + \frac{3}{4}a$ and $(DF =) 9b - \frac{27}{4}b + \frac{3}{4}a$ | M1 | oe |
| | $(DF =) \frac{3}{4}a + \frac{9}{4}b$ | A1 | |
| | $(DF =) 3(\frac{1}{4}a + \frac{3}{4}b)$ and Yes | A1 | oe using a different correct scalar multiple for DF and DX |

Mark scheme for Question 27(b) continues on next page

| Q | Answer | Mark | Comments |
|-----------------------|--|------|--|
| 27(b) cont | Alternative method 3: XF from $XE + EF = \frac{3}{4}HE + \frac{1}{4}EG$ | | |
| | $(XE =) \frac{3}{4}a - \frac{3}{4}b$ or $(EF =) -\frac{1}{4}a + \frac{9}{4}b$ | M1 | oe |
| | $(XF =) \frac{3}{4}a - \frac{3}{4}b - \frac{1}{4}a + \frac{9}{4}b$ | M1 | oe |
| | $(XF =) \frac{2}{4}a + \frac{6}{4}b$ or $(XF =) \frac{1}{2}a + \frac{3}{2}b$ | A1 | |
| | $(XF =) 2(\frac{1}{4}a + \frac{3}{4}b)$ and Yes | A1 | oe using a different correct scalar multiple for XF and DX |

Mark scheme for Question 27(b) continues on next page

| Q | Answer | Mark | Comments |
|---------------|---|------|--|
| 27(b) cont | Alternative method 4: XF from $XH + HG + GF = \frac{1}{4}EH + HG + \frac{3}{4}GE$ | | |
| | $(XH=) = -\frac{1}{4}\mathbf{a} + \frac{1}{4}\mathbf{b}$ or $(GF=) -\frac{27}{4}\mathbf{b} + \frac{3}{4}\mathbf{a}$ | M1 | oe |
| | $(XF=) -\frac{1}{4}\mathbf{a} + \frac{1}{4}\mathbf{b} + 8\mathbf{b} - \frac{27}{4}\mathbf{b} + \frac{3}{4}\mathbf{a}$ | M1 | oe |
| | $(XF=) \frac{2}{4}\mathbf{a} + \frac{6}{4}\mathbf{b}$ or $(XF=) \frac{1}{2}\mathbf{a} + \frac{3}{2}\mathbf{b}$ | A1 | |
| | $(XF=) 2(\frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b})$ and Yes | A1 | oe using a different correct scalar multiple for XF and DX |
| | Additional Guidance | | |
| | Method marks may be awarded for correct work seen on diagram or in working, with no or incorrect answer, even if this is seen amongst multiple attempts | | |

| Q | Answer | Mark | Comments |
|---|--|------|--|
| 28 | 4.715 or 4.725 or 157.5 or 158.5 | B1 | accept $4.724\dot{9}$ or 4.7249... accept $158.4\dot{9}$ or 158.49... |
| | their 4.725 \div their 157.5 | M1 | their 4.725 must be (4.72, 4.725] their 157.5 must be [157.5, 158) |
| | 0.03 and correct working | A1 | oe eg $\frac{3}{100}$ |
| | Additional Guidance | | |
| | Answer 0.03 with no correct working | | B0M0A0 |
| 4.7249 exact value with no continuation dots seen | | B0 | |

| Q | Answer | Mark | Comments |
|-----------|--|-------|---------------------------------------|
| 29 | Alternative method 1 | | |
| | OBD and OCD are right angles and BOC (obtuse) = $180 - x$ | M1 | may be on diagram |
| | $BAC = 90 - \frac{x}{2}$ | M1dep | oe may be on diagram |
| | BOC (reflex) = $180 + x$ and $ABO + ACO = 360 - (90 - \frac{x}{2} + 180 + x)$ or $90 - \frac{x}{2}$ and $ABO = \frac{1}{2}(90 - \frac{x}{2})$ $= 45 - \frac{x}{4}$ with M2 scored | A1 | oe $360 - 90 + \frac{x}{2} - 180 - x$ |
| | All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles around a point add to 360° | A1 | |

Mark scheme for Question 29 continues on next page

| Q | Answer | Mark | Comments |
|--------------------|--|-------|-------------------------|
| 29 cont | Alternative method 2 | | |
| | OBD and OCD are right angles and BOC (obtuse) = $180 - x$ | M1 | may be on diagram |
| | $BAC = 90 - \frac{x}{2}$ | M1dep | oe may be on diagram |
| | BOC (reflex) = $180 + x$ and $BAD = \frac{1}{2}(90 - \frac{x}{2})$ or $45 - \frac{x}{4}$ and $ABO = 180 - (45 - \frac{x}{4}) - (90 + \frac{x}{2})$ = $45 - \frac{x}{4}$ with M2 scored | A1 | |
| | All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles in a triangle add up to 180° | A1 | |

Mark scheme for Question 29 continues on next page

| Q | Answer | Mark | Comments |
|--------------------|--|-------|-------------------------|
| 29 cont | Alternative method 3 | | |
| | OBD and OCD are right angles and BOC (obtuse) = $180 - x$ | M1 | may be on diagram |
| | $BAC = 90 - \frac{x}{2}$ | M1dep | oe may be on diagram |
| | $ABC = \frac{1}{2} [180 - (90 - \frac{x}{2})]$ $= 45 + \frac{x}{4}$ and $OBC = \frac{1}{2} [180 - (180 - x)]$ $= \frac{x}{2}$ and $ABO = 45 + \frac{x}{4} - \frac{x}{2}$ $= 45 - \frac{x}{4}$ with M2 scored | A1 | |
| | All reasons given tangent meets the radius at 90° angles in a quadrilateral add up to 360° angle at the circumference is half the angle at the centre angles in a triangle add up to 180° (base angles in an) isosceles triangle (are equal) | A1 | |

Mark scheme for Question 29 continues on next page

| Q | Answer | Mark | Comments |
|--------------------|---|----------|-------------------|
| 29 cont | Alternative method 4 | | |
| | OBD is a right angle and $BDO = \frac{x}{2}$ | M1 | may be on diagram |
| | $BOD = 90 - \frac{x}{2}$ | M1dep | may be on diagram |
| | $OAB + ABO = 90 - \frac{x}{2}$ and $ABO = 45 - \frac{x}{4}$ with M2 scored | A1 | |
| | All reasons given tangent meets the radius at 90° the diagram is symmetrical or angles in a triangle add up to 180° exterior angle of a triangle is equal to the sum of the opposite interior angles OA and OB are radii, so triangle ABO is isosceles (base angles in an) isosceles triangle (are equal) | A1 | |
| | Additional Guidance | | |
| | Using a value for x | MOM0A0A0 | |

| Q | Answer | Mark | Comments |
|-------|--|------|---|
| 30(a) | $(r_2 =) 5.84(3\dots)$ | B1 | |
| | $(r_3 =) 6.39(5\dots)$ or $6.4(0)$ | B1ft | ft their $5.84(3\dots)$ to 2 dp or better |
| | Additional Guidance | | |
| | eg $r_2 = 6.39(5\dots)$ and $r_3 = 6.11(3\dots)$ | | B0B1ft |

| Q | Answer | Mark | Comments |
|-------|----------------------------|------|----------|
| 30(b) | 6.2 | B1 | |
| | Additional Guidance | | |
| | 6.20 | | B0 |