# GCSE Mathematics

Paper 3 Higher Tier

Mark scheme

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 Assessment Writer.

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.

Further copies of this mark scheme are available from aqa.org.uk

**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.<br>eg accept 0.5 as well as $\frac{1}{2}$ |
| **[a, b]** | Accept values between a and b inclusive. |
| **[a, b)** | Accept values a ≤ 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.

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **1** | $\begin{pmatrix} -5 \\ -3 \end{pmatrix}$ | B1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **2** | 1 | B1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **3** | $w = \dfrac{y}{2x}$ | B1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **4** | 210° | B1 | |
| | **Additional Guidance** | | |
| | | | |

| | | | |
|---|---|---|---|
| **5** | 200 ÷ 0.4<br>or 200 ÷ 40 × 100<br>or 200 = 0.4 × $n$ | M1 | oe<br>(Heads =) 300<br>200 : 300 |
| | 500 | A1 | |

| Additional Guidance | |
|---|---|
| Build up method must be complete<br><br>eg  200 = 40%, 100 = 20%, 500 (= 100%)<br>200 = 40%, 100 = 20%, 400 = 80%, 100 + 400<br>200 = 40%, 100 = 20%, 400 = 80% | M1A1<br>M1A0<br>M0A0 |
| 0.4 : 0.6  = 200 : 300 | M1A0 |
| 100 = 20%, 300 = 60% | M1A0 |
| 200 ÷ 0.4 = 500, 500 + 200 = 700 incorrect method | M0A0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| | **Alternative method 1** | | |
| | A includes 1 <br> or B does not include 1 | B1 | oe <br> Correct statement about 1 without contradiction |
| | A does not include 6 <br> or B includes 6 | B1 | oe <br> Correct statement about 6 without contradiction |
| | **Alternative method 2** | | |
| **6** | $1 \le x < 6$ <br> or    $1 < x \le 6$ <br><br> or $1 \le x$  and  $1 < x$ <br> or $x < 6$  and  $x \le 6$ <br><br> or A is 1, 2, 3, 4, 5 <br> or B is 2, 3, 4, 5, 6 | M1 | oe <br> eg $x \ge 1$ and $x < 6$ for 1st statement <br><br> A includes 3 and B includes 18 <br><br> A is   3, …   17 <br> and  B is   4, …  18 |
| | A is 1, 2, 3, 4, 5 <br> and B is 2, 3, 4, 5, 6 | A1 | oe <br> eg  A = 1 to 5 and B = 2 to 6 |
| | **Additional Guidance** | | |

| | | |
|---|---|---|
| For 2 marks, must have clearly indicated both sets of integer solutions | | M1A1 |
| For 2 marks, must have clearly indicated both differences | | B1B1 |
| A could be 1 but not 6, B could be 6 but not 1 | | B1B1 |
| A is $x = 1$ and B is $x = 6$ | | B1B1 |
| A: 3, 6, 9, 12, 15 and B: 6, 9, 12, 15, 18 | | M1A0 |
| Comment that inequality signs are switched with no other working | | B0B0 |
| '1 and 6 don't appear in both' – need to be correctly linked to A and B | | B0B0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **7(a)** | 5.5 in the correct position | B1 | oe |
| | 6.5 in the correct position | B1 | oe |

| **Additional Guidance** | | |
|---|---|---|
| 5.50 or $5\frac{1}{2}$ or $\frac{11}{2}$ | | B1 |
| 6.50 or $6\frac{1}{2}$ or $\frac{13}{2}$ | | B1 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **7(b)** | One correctly evaluated trial using (6, 6.5] + (4, 4.5) or (6, 6.5) + (4, 4.5] | M1 | eg 6.3 + 4.1 = 10.4 |
| | or **two** values in the ranges given that work if correctly evaluated | | eg 6.4, 4.2 |
| | One correctly evaluated trial using (6, 6.5) + (4, 4.5) with an answer that rounds to 11 | A1 | eg 6.4 + 4.2 = 10.6 Ignore fw |

| **Additional Guidance** | | |
|---|---|---|
| 6.4 + 4.4 = 10.8 (= 11)  do not need to show 11 | | M1A1 |
| 6.4999 + 4.4999 = 10.9998 | | M1A1 |
| 6.5 + 4.4 = 10.9 | | M1A0 |
| 4.5 + 6.2 = 10.7 | | M1A0 |
| 6 + 4 = 10 | | M0 |
| 6.5 + 4.5 = 11 | | M0 |
| $6.4\dot{9} + 4.4\dot{9} = 11$ | | M0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **8(a)** | Could be true | B1 | |

| **Additional Guidance** | | |
|---|---|---|

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **8(b)** | Must be true | B1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **9(a)** | $\frac{2}{3}$ × 720 or $\frac{3}{5}$ × 700 | M1 | oe<br>Accept use of 0.66… or 0.67 |
| | 480 or 420 | A1 | |
| | 900 | A1 | Ignore fw |
| | **Additional Guidance** | | |
| | 900 with no working | | M1A1A1 |
| | 900 out of 1420 or $\frac{900}{1420}$ (ignore fw) | | M1A1A1 |
| | $\frac{480}{720}$ (480 boys out of 720) or $\frac{420}{1420}$ (420 girls out of 1420 students) | | M1A1A0 |

| Question | Answer | Mark | Comments |
|----------|--------|------|----------|
| | **Alternative method 1** | | |
| | 720 + 700 or 1420<br>or 720 + 700 – their 900<br>or 520 | M1 | oe |
| | $\dfrac{520}{1420}$ or $\dfrac{26}{71}$ | A1ft | oe fraction, decimal or percentage<br>0.36(6…) or 0.37<br>36.(6…)% or 37%<br>ft their part (a)<br>Ignore fw |
| | **Alternative method 2** | | |
| **9(b)** | 720 + 700 or 1420<br><br>or $\dfrac{1}{3}$ × 720 or 240<br><br>or $\dfrac{2}{5}$ × 700 or 280<br><br>or 240 + 280 or 520 | M1 | oe |
| | $\dfrac{520}{1420}$ or $\dfrac{26}{71}$ | A1 | oe fraction, decimal or percentage<br>0.36(6…) or 0.37<br>36.(6…)% or 37%<br>Ignore fw |
| | **Alternative method 3** | | |
| | 720 + 700 or 1420<br><br>or $\dfrac{900}{1420}$ or $\dfrac{45}{71}$<br><br>or $\dfrac{\text{their } 900}{1420}$ | M1 | oe fraction, decimal or percentage<br>0.63… or 0.63<br>63.(…)% or 63% |
| | $\dfrac{520}{1420}$ or $\dfrac{26}{71}$ | A1ft | oe fraction, decimal or percentage<br>0.36(6…) or 0.37<br>36.(6…)% or 37%<br>ft their part (a)<br>Ignore fw |

**Additional guidance is on the next page**

| Question | Answer | Mark | Comments |
|---|---|---|---|

| 9(b) cont | **Additional Guidance** | | |
|---|---|---|---|
| | $\dfrac{520}{1420}$ followed by incorrect simplification of fraction | | M1A1 |

| | $2x + 10 = 3x - 20$ | M1 | oe<br>$180 - (2x + 10) + 3x - 20 = 180$ |
|---|---|---|---|
| | $3x - 2x = 20 + 10$<br>or $x = 30$ | M1dep | oe |
| **10(a)** | $2 \times$ their $30 + 10$<br>or $3 \times$ their $30 - 20$<br>or 70 | M1dep | oe |
| | 110 | A1 | |
| | **Additional Guidance** | | |
| | $x = 30$, $y = 180 - 3(30) + 20 = 110$ | | M1M1M1A1 |
| | $x = 30$, $y = 180 - 3(30) - 20 = 110$  recovered missing bracket | | M1M1M1A1 |
| | $x = 30$, $y = 180 - 3(30) - 20 = 70$ not recovered | | M1M1M0A0 |
| | $2x + 10 = 3x - 20$<br>$3x - 2x = 20 + 10$<br>$x = 10$<br>$2 \times 10 + 10 \; (= 30)$ | | M1M1M1A0 |
| | $2x + 10 = 3x - 20$<br>$x = 10$<br>$2 \times 10 + 10 \; (= 30)$ | | M1M0M0A0 |
| | $y + 2x + 10 = 3x - 20 + y$ | | M1M0M0A0 |
| | $w = 3x - 20$ seen or on diagram | | M0M0M0A0 |
| | $w = 2x + 10$ seen or on diagram | | M0M0M0A0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **10(b)** | $2x + 10 = 60$<br>or $2x = 60 - 10$<br>or $2x = 50$<br>or $x = 25$ | M1 | |
| | $3 \times$ their $25 - 20$ or $55$<br>or $180 - 55$ or $125$ | M1dep | oe |
| | $(y =)$ 125 and bigger<br>or $(y$ is$)$ 15 bigger | A1ft | oe<br>ft their (a) |
| | **Additional Guidance** | | |
| | Note: A complete logical explanation of the effect of lines not being parallel<br>eg<br>$w$ is smaller so $2x + 10$ is smaller so $x$ is smaller so $3x - 20$ is smaller so $y$<br>is bigger | M1M1A1 | |
| | $2 \times 25 + 10 = 60$ | M1M0A0 | |
| | $y$ is bigger ticked but no valid working | M0M0A0 | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| | **Alternative method 1** | | |
| | Any correct scaling of the ratio 5 : 2<br>eg 10 (:) 4 or 20 (:) 8 or 25 (:) 10 | M1 | oe |
| | 22.5 (:) 9<br>or 22.5 (red)<br>or 30 (:) 12<br>or 12 (blue) | M1dep | oe |
| | 31.5 or $31\frac{1}{2}$ or $\frac{63}{2}$ | A1 | |
| | **Alternative method 2** | | |
| | $9 \div 2$ or 4.5<br>or $30 \div 5$ or 6 | M1 | oe<br>$2 \div 9$ or 0.22…<br>$5 \div 30$ or 0.16… or 0.17 |
| **11** | $5 \times$ their 4.5 or 22.5<br>or $7 \times$ their 4.5<br>or $2 \times$ their 6 or 12<br>or $7 \times$ their 6 or 42 | M1dep | oe |
| | 31.5 or $31\frac{1}{2}$ or $\frac{63}{2}$ | A1 | |
| | **Alternative method 3** | | |
| | $\frac{2}{7} \times$ purple = blue<br><br>$\frac{5}{7} \times$ purple = red | M1 | oe $\frac{2}{7} \times$ purple = 9<br><br>$\frac{5}{7} \times$ purple = 30 |
| | $9 \times \frac{7}{2}$<br><br>or $30 \times \frac{7}{5}$ or 42 | M1dep | oe |
| | 31.5 or $31\frac{1}{2}$ or $\frac{63}{2}$ | A1 | |

**Additional guidance is on the next page**

| Question | Answer | Mark | Comments |
|---|---|---|---|

| | **Additional Guidance** | | |
|---|---|---|---|
| **11**<br>**cont** | 28 + 3.5 = 31.5 | | M1M1A1 |
| | 28 + 3.5 | | M1M1A0 |
| | 31.5, answer 31 | | M1M1A1 |
| | 31.5 + 42 = 73.5 | | M1M1A0 |
| | 10   4 | | M1M0A0 |
| | 10,  4 | | M1M0A0 |
| | 10 + 4 | | M1M0A0 |
| | 'He has 2.5 times more red than blue' | | M1M0A0 |
| | 2.5 : 1 | | M1M0A0 |
| | 2.5 | | M0M0A0 |
| | 28 on its own | | M0M0A0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **12** | $a = 2$ | B1 | May be embedded |
| | $b = 5$ | B1 | May be embedded |
| | **Additional Guidance** | | |
| | $(2r^5)^4$ | | B1B1 |
| | $(r^5)^4$ | | B1 |
| | $2^4 = 16$ on its own is not enough | | B0 |
| | $a = 5$ and $b = 2$ | | B0B0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| | **Alternative method 1** | | |
| | 12 × 1.58 or 18.96<br>or<br>28 × 1.52 or 42.56 | M1 | |
| | 28 × 1.52 – 12 × 1.58<br>or their 42.56 – their 18.96<br>or  23.6 | M1dep | oe |
| | their 23.6 ÷ (28 – 12)<br>or their 23.6 ÷ 16 | M1dep | oe<br>dep on M1 M1 |
| | 1.475 or 1.48 | A1 | |
| | **Alternative method 2** | | |
| **13** | $16x$ + 12 × 1.58<br>or $16x$ + 18.96<br>or 28 × 1.52 or 42.56 | M1 | |
| | ($16x =$) their 42.56 – their 18.96<br>or ($16x =$) 23.6 | M1dep | oe |
| | their 23.6 ÷ (28 – 12)<br>or their 23.6 ÷ 16 | M1dep | oe<br>dep on M1 M1 |
| | 1.475 or 1.48 | A1 | |
| | **Additional Guidance** | | |
| | 23.6 ÷ 16 = 1.475 = 1.5 | | M1M1M1A1 |
| | 23.6 ÷ 16 = 1.5 | | M1M1M1A0 |
| | 23.6 ÷ (28 – 12)<br>23.6 ÷ 14 | | M1M1M1A0 |
| | 23.6 ÷ 14 | | M1M1M0A0 |
| | Beware use of 0.06 eg  1.58 – 1.52 = 0.06 | | M0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **14** | $y$ is directly proportional to $\dfrac{1}{x}$ | B1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **15(a)** | 8 | B1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **15(b)** | 3 | B1 | Accept –3 |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **16** | **Alternative method 1** | | |
| | $\frac{25}{100}$ × 18 000 or 4500 and 18 000 – their 4500 or 18 000 × (1 – 0.25) or 18 000 × 0.75 or 13 500 or 0.88 | M1 | oe |
| | their 13 500 × (1 – 0.12)$^4$ or their 13 500 × 0.88$^4$ their 13 500 × (1 – 0.12)$^3$ or their 13 500 × 0.88$^3$ or 9199.87 or 9199.88 or 9199.90 or 9200 | M1dep | oe Complete method for at least 4 years |
| | 8095.88 or 8095.89 or 8095.90 or 8096 or 8096.00 or 8100 or 8100.00 | A1 | Correct money notation |
| | **Alternative method 2** | | |
| | $\frac{25}{100}$ × 18 000 or 4500 and 18 000 – their 4500 or 13 500 or 0.88 | M1 | oe |
| | 13 500, 11 880, 10 454.(…) 9199.(…) | M1dep | oe Complete method for at least 4 years |
| | 8095.88 or 8095.89 or 8095.90 or 8096 or 8096.00 or 8100 or 8100.00 | A1 | Correct money notation |

**Additional guidance is on the next page**

| | **Additional Guidance** | |
|---|---|---|
| **16 cont** | Condone eg £8095.88p | M1M1A1 |
| | 8095.887… | M1M1A0 |
| | Note the values for successive calculations are<br><br>13 500, 11880, 10454.4, 9199.87(2), 8095.88(736)<br><br>The values for successive savings are<br><br>4500, 1620, 1425.6, 1254.52(8), 1103.98 | |
| | For method marks allow rounding or truncating of their totals or savings | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| | **Alternative method 1** | | |
| | 1 mile per minute<br>or 60 miles per hour<br>or 0.15 (hours)<br>or 1.6 (hours) or $1\frac{36}{60}$ (hours) | B1 | |
| | 9 ÷ 50 or 0.18 | M1 | oe |
| | $70 \times 1\frac{36}{60}$<br>or 70 × 1.6 or 112 | M1 | oe |
| | their 112 ÷ 40 or 2.8 | M1dep | dep on 2nd M1 |
| **17** | 2.98<br>or 2.8 and (3 – 0.18 =) 2.82<br>or 0.18 and (3 – 2.8 = ) 0.2 | A1 | Ignore fw |
| | **Alternative method 2** | | |
| | 1 mile per minute<br>or 60 miles per hour<br>or 0.15 (hours)<br>or 1.6 (hours) or $1\frac{36}{60}$ (hours) | B1 | |
| | 9 ÷ 50 or 0.18 | M1 | oe |
| | $70 \times 1\frac{36}{60}$ or 112<br>or 70 × 1.6 or 112 | M1 | |
| | 40 × (3 – their 0.18) or 112.8 | M1dep | dep on 1st M1 |
| | 112.8 and 112 | A1 | Ignore fw |

**Alternative method 3 and additional guidance is on the next page**

| | | | |
|---|---|---|---|
| | **Alternative method 3** | | |
| | 1 mile per minute<br>or 60 miles per hour<br>or 0.15 (hours)<br>or 1.6 (hours) or $1\frac{36}{60}$ (hours) | B1 | |
| | 9 ÷ 50 or 0.18 | M1 | oe |
| | 70 ÷ 40 or 1.75 | M1 | |
| | 70 ÷ 40 × 1.6 or 2.8<br>or their 1.75 × 1.6 | M1dep | oe<br>eg 1.75 + 0.875 + 0.175<br>dep on 2nd M1 |
| | 2.98<br>or 2.8 and (3 – 0.18 =) 2.82<br>or 0.18 and (3 – 2.8 = ) 0.2 | A1 | Ignore fw |
| | **Additional Guidance** | | |
| **17**<br>**cont** | Key facts are :<br><br>First stage:<br>Distance travelled  9 miles (given)<br>Time taken          9 minutes (given) or 0.15 hours<br>Average speed     60 mph<br>Miles per gallon   50 mpg (given),<br>Amount of petrol   9 ÷ 50 = 0.18 gallons<br><br>Second stage:<br>Distance travelled  70  × 1.6 = 112 miles<br>Time taken          1 hour 36 minutes (given)  or 1.6 hours<br>Average speed     70 mph (given)<br>Miles per gallon   40 mpg (given),<br>Amount of petrol   112 ÷ 40 = 2.8 gallons | | |
| | An incorrect conversion of 1 hour 36 minutes to 1.36 can score: eg<br>70 × 1.36 = 95.2, 95.2 ÷ 40 = 2.38<br>70 × 1.36 = 95.2, 95.2 ÷ 40 = 2.38, 0.18 + 2.38 = 2.56 | | B0M0M1M1A0<br>B1M1M1M1A0 |
| | 2.98 = 3  (further work) | | B1M1M1M1A1 |
| | 9 ÷ 50 | | B1M1 |

| Question | Answer | Mark | Comments |
|----------|--------|------|----------|
| **18** | Valid criticism | B1 | eg<br>$(y = )$ 0.5 should be $(y =)$ 1<br>$y = 0.5$ should be when $x = 1$<br>When $x = 0$  $y = 1$<br>0.5 is incorrect<br>Crosses $y$ axis in wrong place<br>Graph should start at 1<br>$0.5^0 = 1$ |

| **Additional Guidance** | |
|-------------------------|---|
| Do not accept statements which are contradictory | |
| He does not have a scale on the $x$ axis | B0 |
| It does not pass through zero | B0 |
| The line should meet the $x$ axis | B0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| | **Alternative method 1** | | |
| | $BDC = 24$ | B1 | May be on the diagram |
| | $DFC = \dfrac{180 - 24}{2}$<br><br>or $DCF = \dfrac{180 - 24}{2}$<br><br>or $\dfrac{156}{2}$ or 78 | B1dep | May be on the diagram<br>Finding a base angle in triangle *CDF* |
| | $(3x =)$ 180 – their 78<br>or $(3x =)$ 24 + their 78<br>or $(3x =)$ 102 | M1 | oe<br>May be on the diagram |
| | 34 | A1 | May be on the diagram |
| **19** | **Alternative method 2** | | |
| | $BDC = 24$ | B1 | May be on the diagram |
| | $DFC = 180 - 3x$ | M1 | May be on the diagram |
| | $2(180 - 3x) + 24 = 180$<br>or $360 - 6x + 24 = 180$<br><br>or $3x + 78 = 180$<br>or $(3x =)$ 102 | M1dep | oe |
| | 34 | A1 | May be on the diagram |
| | **Additional Guidance** | | |
| | If angles in the same segment are not used ie all the working is using triangle *ABF* then award maximum of 2 marks | | |
| | If triangle *ABF* is assumed to be isosceles and there is no evidence of angle $BDC = 24$ being used then award maximum of 2 marks | | |
| | If triangle *ABF* is used as isosceles and correctly justified then all marks are available eg 'triangle *ABF* is similar to triangle *CDF* ' | | |
| | Answer of 34 does not imply full marks | | |

**Additional guidance continues on the next page**

| | | | |
|---|---|---|---|
| **19 cont** | Answer of 34 with no working | | B0B0M1A1 |
| | 'their 78' must come from an attempt to calculate $\dfrac{180 - 24}{2}$ | | |
| | Angles must be clearly identified<br>eg $D$ = 24<br>24 (unless shown on diagram) | | B1<br>B0 |

| | | | |
|---|---|---|---|
| **20** | 522.5 or 527.5 | B1 | oe<br>Accept 527.499(999…) |
| | 77.5 or 78.5 | B1 | oe<br>Accept 78.499(999…) |
| | 527.5 – 77.5 | M1 | their max total – their min Ben<br>their max total must be (525, 530]<br>their min Ben must be [77, 78)<br>Accept 527.4$\overset{\bullet}{9}$ or 527.499(999…) for 527.5 |
| | 450 and Yes with correct working seen | A1 | Accept [449.999, 450] |
| | **Additional Guidance** | | |
| | 525 – 78 = 447 and yes | | B0B0M0A0 |
| | 525 = 520 to 530<br>78 = 77.5 to 78.5<br>520 – 78.5 = 441.5<br>520 – 77.5 = 442.5<br>530 – 78.5 = 451.5<br>530 – 77.5 = 452.5<br>Answer  No | | B0<br>B1<br><br><br><br>M1<br>A0 |

| | | | |
|---|---|---|---|
| **21** | –2.5 < $x$ < 1 | B1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| | **Alternative method 1** | | |
| | Second differences  8 | M1 | Implied by $4n^2$ |
| | Any three values from <br> –2    1    4    7 | M1dep | |
| | $4n^2 + 3n - 5$ | A1 | oe <br> Allow $a = 4$   $b = 3$   $c = -5$ |
| | **Alternative method 2** | | |
| **22** | Any 3 of <br> $a + b + c = 2$ <br> $4a + 2b + c = 17$ <br> $9a + 3b + c = 40$ <br> $16a + 4b + c = 71$ | M1 | Using  $an^2 + bn + c$ |
| | Any 2 equations in 2 unknowns <br> eg $3a + b = 15$ <br> $5a + b = 23$ <br> $7a + b = 31$ <br> $8a + 2b = 38$ <br> $12a + 2b = 54$ <br> $15a + 3b = 69$ | M1dep | Correctly eliminates the same letter using two different pairs of equations |
| | $4n^2 + 3n - 5$ | A1 | oe <br> Allow $a = 4$   $b = 3$   $c = -5$ |

**Alternative method 3 and additional guidance is on the next page**

| | | | |
|---|---|---|---|
| | **Alternative method 3** | | |
| **22 cont** | Second differences  8<br><br>$a = 4$<br><br>or $c = 2 - 7$  or $- 5$ | M1 | Using  $an^2 + bn + c$ |
| | $3a + b = 17 - 2$<br>and<br>substitutes their $a$ | M1dep | oe   eg  $b = 3$<br>May also see  $a + b + c = 2$ used<br>to work out $c$ |
| | $4n^2 + 3n - 5$ | A1 | oe<br>Allow  $a = 4$   $b = 3$   $c = -5$ |
| | **Additional Guidance** | | |
| | Sequence          (–5)    2    17    40    71<br>1$^{st}$ differences are      (7)    15    23    31<br>2$^{nd}$ differences are           8      8      8 | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **23** | $0 = 5^2 + 5b + c$ <br> or $-10 = 0^2 + b(0) + c$ <br> or $c = -10$ | M1 | oe |
| | $b = -3$ <br> or $x^2 - 3x + c$ <br> or $(y =) x^2 - 3x - 10$ | M1dep | oe <br> $(x - 5)(x + k)$ and $-5k = -10$ |
| | $(x - 5)(x + 2)$ <br> or $\dfrac{--3 \pm \sqrt{(-3)^2 - 4 \times 1 \times -10}}{2 \times 1}$ <br> or $\dfrac{3 \pm \sqrt{49}}{2}$ <br> or $(x - \dfrac{3}{2})^2 + ...$ <br> or $2x - 3 = 0$ <br> or $x$-coordinate of $P = -2$ <br> or two symmetrical coordinates | M1dep | oe <br> Correctly factorises the 3-term quadratic expression or correctly substitutes into quadratic formula for the 3-term quadratic <br> dep on M1 M1 <br><br><br><br> eg (1, –12) and (2, –12) |
| | $1\dfrac{1}{2}$ or $\dfrac{3}{2}$ with no incorrect working | A1 | oe <br> Accept (1.5, –12.25) |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **24** | Draws a tangent at 1 second | M1 | |
| | Their gradient at 1 second | A1ft | Must see a tangent on the graph <br> ft their tangent <br> ±0.2 tolerance on vertical reading <br> ±0.1 tolerance on horizontal reading |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **25(a)** | **Alternative method 1** | | |
| | $17^2 - (16 \div 2)^2$ <br> or $17^2 - 8^2$ <br> or $289 - 64$ | M1 | Correct use of Pythagoras' theorem <br> eg <br> $8^2 + 15^2 = 17^2$ <br> or $64 + 225 = 289$ |
| | $\sqrt{17^2 - (16 \div 2)^2}$ (= 15) <br> or $\sqrt{17^2 - 8^2}$ (= 15) <br> or $\sqrt{289 - 64}$ (= 15) | A1 | Correct use of Pythagoras' theorem using a square root |
| | **Alternative method 2** | | |
| | $\sin E = \dfrac{8}{17}$ or $\cos A = \dfrac{8}{17}$ <br><br> or $E = 28.(\ldots)$ or $A = 61.9(\ldots)$ or 62 <br><br> and <br><br> $\cos 28.(\ldots) = \dfrac{EM}{17}$ <br><br> or $\tan 28.(\ldots) = \dfrac{8}{EM}$ <br><br> or $\sin 61.9(\ldots) = \dfrac{EM}{17}$ <br><br> or $\tan 61.9(\ldots) = \dfrac{EM}{8}$ | M1 | |
| | $17 \cos 28.(\ldots)$ or $8 \div \tan 28.(\ldots)$ <br> or $17 \sin 61.9(\ldots)$ or $8 \tan 61.9(\ldots)$ | A1 | |
| | **Additional Guidance** | | |
| | 8, 15, 17 on their own | | M0A0 |
| | $EM^2 = 289 - 64 = 225$, $EM = 15$ | | M1A0 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| | **Alternative method 1** | | |
| | $30^2 + (16 \div 2)^2$<br>or $30^2 + 8^2$<br>or 964 | M1 | oe |
| | $\sqrt{\text{their } 964}$<br>or $2\sqrt{241}$<br>or [31, 31.1] | M1dep | oe<br>*CM* |
| | $\tan x = \dfrac{15}{\text{their } [31, 31.1]}$ | M1dep | oe eg $90 - \tan^{-1}\dfrac{\text{their } [31, 31.1]}{15}$<br><br>dep on M1 M1 |
| **25(b)** | [25.7, 26] | A1 | |
| | **Alternative method 2** | | |
| | $30^2 + 17^2$ or 1189 | M1 | oe |
| | $\sqrt{\text{their } 1189}$<br>or [34.4, 34.5] | M1dep | oe *CE* |
| | $\sin x = \dfrac{15}{\text{their } [34.4, 34.5]}$ | M1dep | oe eg $90 - \cos^{-1}\dfrac{15}{\text{their } [34.4, 34.5]}$<br><br>or $\dfrac{\sin x}{15} = \dfrac{\sin 90}{\text{their } [34.4, 34.5]}$<br><br>dep on M1 M1 |
| | [25.7, 26] | A1 | |

| | | | |
|---|---|---|---|
| **25(b) cont** | **Alternative method 3** | | |
| | $30^2 + (16 \div 2)^2$ or 964 <br> or $30^2 + 17^2$ or 1189 | M1 | oe |
| | $\sqrt{\text{their } 964}$ or $2\sqrt{241}$ or [31, 31.1] <br> or $\sqrt{\text{their } 1189}$ or [34.4, 34.5] | M1dep | oe *CM* <br><br> *CE* |
| | $\cos x = \dfrac{\text{their } [31, 31.1]}{\text{their } [34.4, 34.5]}$ | M1dep | oe eg $90 - \sin^{-1}\dfrac{\text{their } [31, 31.1]}{\text{their } [34.4, 34.5]}$ <br><br> dep on M1 M1 |
| | [25.7, 26] | A1 | |
| | **Alternative method 4** | | |
| | $17^2 - (16 \div 2)^2$ or 225 <br> or $30^2 + (16 \div 2)^2$ or 964 <br> or $30^2 + 17^2$ or 1189 | M1 | oe $EM^2$ <br> $CM^2$ <br> $CE^2$ |
| | $\cos x = $ <br> $\dfrac{\text{their } 964 + \text{their } 1189 - \text{their } 225}{2 \times \sqrt{\text{their } 964} \times \sqrt{\text{their } 1189}}$ | M1dep | oe |
| | $\cos^{-1}$ <br> $\dfrac{\text{their } 964 + \text{their } 1189 - \text{their } 225}{2 \times \sqrt{\text{their } 964} \times \sqrt{\text{their } 1189}}$ | M1dep | oe <br> dep on M1 M1 |
| | [25.7, 26] | A1 | |
| | **Additional Guidance** | | |
| | | | |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **26** | $10(3x + 1)$<br><br>or $9x$<br><br>or $x(9 - 3x - 1)$ or $x(8 - 3x)$<br><br>or $(10 - x)(3x + 1)$<br><br>or $x(3x + 1)$<br><br>or $(10 - x)(9 - 3x - 1)$ | M1 | oe<br><br>One correct area expression in $x$<br><br>May be implied |
| | $10(3x + 1) + x(9 - 3x - 1)$<br><br>or $9x + (10 - x)(3x + 1)$<br><br>or $(10 - x)(3x + 1) + x(9 - 3x - 1)$<br>$+ x(3x + 1)$<br><br>or $10 \times 9 - (10 - x)(9 - 3x - 1)$ | M1dep | oe<br><br>Fully correct unsimplified expression for area |
| | $30x + 10 + 9x - 3x^2 - x$<br><br>or $9x + 30x + 10 - 3x^2 - x$<br><br>or $30x + 10 - 3x^2 - x + 9x - 3x^2 - x$<br>$+ 3x^2 + x$<br><br>or $90 - 90 + 30x + 10 + 9x - 3x^2 - x$<br><br>or $38x + 10 - 3x^2$ | M1dep | oe<br><br>dep on M1 M1<br><br>Full expansion<br><br>All brackets removed |
| | $3x^2 - 38x + 55 (= 0)$ | A1 | oe 3-term equation |
| | $(3x - 5)(x - 11)$<br><br>$\dfrac{-{-38} \pm \sqrt{(-38)^2 - 4 \times 3 \times 55}}{2 \times 3}$<br><br>or $\dfrac{38 \pm \sqrt{1444 - 660}}{6}$<br><br>or $\dfrac{38 \pm \sqrt{784}}{6}$ | M1 | oe<br><br>their 3-term quadratic factorised correctly<br><br>or correct substitution in formula for<br><br>their 3-term quadratic equation |
| | $\dfrac{5}{3}$ or $1\dfrac{2}{3}$ or 1.66(6...) or 1.67 | A1 | oe<br><br>$x = 11$ included is A0 |
| | **Additional Guidance** | | |
| | $3x^2 = 38x - 55$ | | M1M1M1A1 |

| Question | Answer | Mark | Comments |
|---|---|---|---|
| **27** | **Alternative method 1** – completing the square | | |
| | $(x + \frac{1}{2})^2 + \dots$ | M1 | |
| | $(x + \frac{1}{2})^2 - (\frac{1}{2})^2 + 1$ <br><br> or $(x + \frac{1}{2})^2 - \frac{1}{4} + 1$ <br><br> or $(x + \frac{1}{2})^2 + \frac{3}{4}$ | A1 | oe |
| | $(x + \frac{1}{2})^2 \geq 0$ and $\frac{3}{4} > 0$ <br><br> and always positive | A1 | oe |
| | **Alternative method 2** – real roots | | |
| | $\dfrac{-1 \pm \sqrt{1^2 - 4 \times 1 \times 1}}{2 \times 1}$ <br><br> or a correct sketch showing a quadratic curve with turning point above the $x$-axis | M1 | oe |
| | States no values on $x$-axis | A1 | oe |
| | States no values on $x$-axis <br><br> and (minimum value =) $\frac{3}{4}$ | A1 | oe |
| | **Alternative method 3** – Calculus | | |
| | $2x + 1 = 0$ | M1 | |
| | $x = -\frac{1}{2}$ | A1 | |
| | (minimum value =) $\frac{3}{4}$ | A1 | |

| | | | | |
|---|---|---|---|---|
| | **Alternative method 4** – Explanation method | | | |
| **27 cont** | If $x \geq 0$, $x^2 \geq 0$ and $x \geq 0$ (1 > 0) so $x^2 + x + 1 > 0$ <br><br> and <br><br> If $-1 < x < 0$ $x^2 > 0$ and $x + 1 > 0$ so $x^2 + x + 1 > 0$ <br><br> and <br><br> If $x \leq -1$ $x^2 > x$ and $x^2 + x > 0$ so $x^2 + x + 1 > 0$ | B3 | Accept $x > 0$ for $x \geq 0$ <br><br> B2 for two correct statements <br> B1 for one correct statement | |
| | **Additional Guidance** | | | |
| | Calculating pairs of coordinates alone | | | M0A0A0 |