

# Mark Scheme (Results)

January 2017

International GCSE Mathematics A 4MA0/3H

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January 2017

Publications Code 4MA0\_3H\_1701\_MS

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- **Types of mark**
  - M marks: method marks
  - A marks: accuracy marks
  - B marks: unconditional accuracy marks (independent of M marks)
- **Abbreviations**
  - cao – correct answer only
  - ft – follow through
  - isw – ignore subsequent working
  - SC - special case
  - oe – or equivalent (and appropriate)
  - dep – dependent
  - indep – independent
  - eeo – each error or omission

- **No working**

If no working is shown then correct answers normally score full marks

If no working is shown then incorrect (even though nearly correct) answers score no marks.

- **With working**

If there is a wrong answer indicated on the answer line always check the working in the body of the script (and on any diagrams), and award any marks appropriate from the mark scheme.

If it is clear from the working that the “correct” answer has been obtained from incorrect working, award 0 marks.

Any case of suspected misread loses A (and B) marks on that part, but can gain the M marks.

If working is crossed out and still legible, then it should be given any appropriate marks, as long as it has not been replaced by alternative work.

If there is a choice of methods shown, then no marks should be awarded, unless the answer on the answer line makes clear the method that has been used.

If there is no answer on the answer line then check the working for an obvious answer.

- **Ignoring subsequent work**

It is appropriate to ignore subsequent work when the additional work does not change the answer in a way that is inappropriate for the question: eg. Incorrect cancelling of a fraction that would otherwise be correct.

It is not appropriate to ignore subsequent work when the additional work essentially makes the answer incorrect eg algebra.

Transcription errors occur when candidates present a correct answer in working, and write it incorrectly on the answer line; mark the correct answer.

- **Parts of questions**

Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded in another.

**International GCSE Maths**

Apart from questions 3, 5d, 17, 18, 20 & 23 (where the mark scheme states otherwise) the correct answer, unless clearly obtained from an incorrect method, should be taken to imply a correct method.

| Q            | Working                                                                                                                                                    | Answer | Mark | Notes                                                                                                                                               |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1</b> (a) | 18 ÷ 60 oe <b>or</b><br>7.3 <b>or</b> $7\frac{18}{60}$ <b>or</b> $7\frac{3}{10}$ <b>or</b> $7 \times 60 + 18 (=438)$                                       |        | 3    | M1 for changing time to a decimal (7.3)                                                                                                             |
|              | $750 \times "7.3"$ oe <b>or</b> $750 \times \frac{"438"}{60}$ oe                                                                                           |        |      | M1 for speed × time<br>(allow $750 \times 7.18$ <b>or</b> answer of 5385)                                                                           |
|              |                                                                                                                                                            | 5475   |      | A1                                                                                                                                                  |
| (b)          | for at least one correct operation<br>eg. $750 \times 1000$ , $750 \div 60$ <b>or</b><br>$\frac{1000}{60 \times 60} (= 0.27....)$ <b>or</b> $\frac{5}{18}$ |        | 3    | M1 for <b>one or two</b> of $\times 1000$ , $\div 60$ , $\div 60$<br>(can be implied by 750 000 <b>or</b> 12.5 <b>or</b> 12500<br><b>or</b> 0.2083) |
|              | $\frac{750 \times 1000}{60 \times 60}$ oe                                                                                                                  |        |      | M1 complete correct method                                                                                                                          |
|              |                                                                                                                                                            | 208    |      | A1<br>accept answers in range 208 – $208.\dot{3}$                                                                                                   |
|              |                                                                                                                                                            |        |      |                                                                                                                                                     |
|              | <b>Alternative mark scheme ft from (a)</b>                                                                                                                 |        |      |                                                                                                                                                     |
|              | "5475" × 1000 (=5475000) <b>OR</b><br>$7 \times 60 + 18 = 438$ <b>and</b> $438 \times 60 (=26280 \text{ (sec)})$                                           |        | 3    | M1                                                                                                                                                  |
|              | "5475000" ÷ 26280                                                                                                                                          |        |      | M1 dep<br>complete correct method                                                                                                                   |
|              |                                                                                                                                                            | 208    |      | A1<br>accept answers in range 208 – $208.\dot{3}$                                                                                                   |
|              |                                                                                                                                                            |        |      | <b>Total 6 marks</b>                                                                                                                                |

|   |                    |          |   |                                                                                                                                                                                 |
|---|--------------------|----------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2 | $3 \times 7 (=21)$ |          | 2 | M1 <b>or</b> for 3 numbers with a total of 21<br><b>or</b> 3 numbers with a median of 5<br><b>or</b> 3 numbers with a range of 14<br><b>or</b> $(a + c =) 3 \times 7 - 5 (=16)$ |
|   |                    | 1, 5, 15 |   | A1 numbers can be in any order                                                                                                                                                  |
|   |                    |          |   | <b>Total 2 marks</b>                                                                                                                                                            |

|   |                                                                                             |       |   |                                                                                                                                                                             |
|---|---------------------------------------------------------------------------------------------|-------|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | $\frac{17}{3} - \frac{19}{5}$                                                               |       | 3 | M1 for correct improper fractions (subtraction sign not necessary)<br><b>OR</b> two improper fractions with a common denominator with at least one of the fractions correct |
|   | E.g. $\frac{85}{15} - \frac{57}{15}$ <b>or</b><br>$\frac{17 \times 5 - 3 \times 19}{15}$ oe |       |   | M1 for correct fractions with a common denominator a multiple of 15<br>i.e. in form $\frac{85a}{15a} - \frac{57a}{15a}$                                                     |
|   |                                                                                             | shown |   | A1 dep on M2 for correct conclusion to $1\frac{13}{15}$ from correct working <b>with</b> sight of the result of the subtraction e.g. $\frac{28}{15}$                        |
|   | <b>Alternative method</b>                                                                   |       |   |                                                                                                                                                                             |
|   | $(5)\frac{10}{15} - (3)\frac{12}{15}$                                                       |       | 3 | M1 for two correct fractions with a common denominator a multiple of 15                                                                                                     |
|   | $-\frac{2}{15}$                                                                             |       |   | M1                                                                                                                                                                          |
|   |                                                                                             | shown |   | A1 dep on M2 for correct conclusion to $1\frac{13}{15}$ from correct working <b>with</b> sight of the result of the subtraction e.g. $\frac{28}{15}$ or $2 - \frac{2}{15}$  |
|   | <b>Alternative method</b>                                                                   |       |   |                                                                                                                                                                             |
|   | E.g. $5\frac{10}{15} - 3\frac{12}{15}$                                                      |       | 3 | M1 for two correct fractions with a common denominator a multiple of 15                                                                                                     |
|   | E.g. $4\frac{25}{15} - 3\frac{12}{15}$                                                      |       |   | M1 for a complete correct method                                                                                                                                            |
|   |                                                                                             | shown |   | A1 dep on M2 for correct conclusion to $1\frac{13}{15}$ from correct working                                                                                                |
|   |                                                                                             |       |   | <b>Total 3 marks</b>                                                                                                                                                        |

|   |                                                                         |     |   |                                    |
|---|-------------------------------------------------------------------------|-----|---|------------------------------------|
| 4 | $\pi \times (70 - 2 \times 15)$ <b>or</b> $\pi \times 40$ (=125(.6...)) |     | 4 | M1 oe                              |
|   | $4 \times 15$ (=60) <b>and</b> $4 \times 70$ (=280) <b>or</b> 340       |     |   | M1 independent                     |
|   | “125.6...” + “60” + “280”                                               |     |   | M1 dep on M2                       |
|   |                                                                         | 466 |   | A1 for answer in range 465.6 – 466 |
|   |                                                                         |     |   | <b>Total 4 marks</b>               |

|                |     |                                                                             |             |   |                                                                                                                                                                                 |
|----------------|-----|-----------------------------------------------------------------------------|-------------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5              | (a) |                                                                             | $h(7 + h)$  | 1 | B1                                                                                                                                                                              |
|                | (b) | $4p + 20 + 7p - 14$                                                         |             | 2 | M1 Any 3 terms correct                                                                                                                                                          |
|                |     |                                                                             | $11p + 6$   |   | A1<br>cao<br>NB $11p + 6$ followed by, for example, $17p$ scores M1 A0                                                                                                          |
|                | (c) | $7 \times (-2)^2 + 5$ <b>or</b> $7 \times 4 + 5$ <b>or</b><br>$7(-2)^2 + 5$ |             | 2 | M1 for correct substitution<br><b>or</b> $7 \times 4$ <b>or</b> 28                                                                                                              |
|                |     |                                                                             | 33          |   | A1                                                                                                                                                                              |
|                | (d) | $5q - 15 (= 12 - q)$<br><b>or</b> $q - 3 = \frac{12}{5} - \frac{q}{5}$      |             | 3 | M1                                                                                                                                                                              |
|                |     | E.g. $5q + q = 12 + 15$ <b>or</b> $6q = 27$                                 |             |   | M1 For a correct equation with the $q$ terms collected on one side of the equation and the non $q$ terms on the other side.<br><br>ft from $5q - 3 = 12 - q$ for this mark only |
|                |     |                                                                             | 4.5         |   | A1<br>for 4.5 <b>or</b> $\frac{9}{2}$ oe dep on at least M1                                                                                                                     |
|                | (e) | $-7t \geq 31 - 3$ <b>or</b> $7t \leq 3 - 31$ oe                             |             | 2 | M1 $-7t \geq 31 - 3$ <b>or</b> $7t \leq 3 - 31$ <b>or</b> $-4$<br><b>or</b> $t \geq -4$<br>accept an equation or the wrong inequality sign in the working                       |
|                |     |                                                                             | $t \leq -4$ |   | A1 or for $-4 \geq t$                                                                                                                                                           |
| Total 10 marks |     |                                                                             |             |   |                                                                                                                                                                                 |

|   |                                                                                                                                                                                 |     |   |                                                                                                                                                                                                                                                                                                                                                                     |
|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6 | $2.5 \times 28 + 7.5 \times 32 + 12.5 \times 20 + 17.5 \times 14 + 22.5 \times 6$ <b>or</b><br>$70 + 240 + 250 + 245 + 135$ <b>or</b><br>940                                    |     | 4 | M2 $f \times d$ for at least 4 products with correct mid-interval values <b>and</b> intention to add.<br><br>If not M2 then award M1 for $d$ used consistently for at least 4 products within interval (including end points) <b>and</b> intention to add<br><b>or</b><br>for at least 4 correct products with correct mid-interval values with no intention to add |
|   | $(2.5 \times 28 + 7.5 \times 32 + 12.5 \times 20 + 17.5 \times 14 + 22.5 \times 6) \div 100$ <b>or</b><br>$(70 + 240 + 250 + 245 + 135) \div 100$ <b>or</b><br>“940” $\div 100$ |     |   | M1 dep on M1<br>NB: accept their 100 if addition shown                                                                                                                                                                                                                                                                                                              |
|   |                                                                                                                                                                                 | 9.4 |   | A1 SC: B2 for answer of 9.44<br>(B1 for 944 in working)                                                                                                                                                                                                                                                                                                             |
|   |                                                                                                                                                                                 |     |   | <b>Total 4 marks</b>                                                                                                                                                                                                                                                                                                                                                |

|   |                                                                                            |     |   |                      |                                |
|---|--------------------------------------------------------------------------------------------|-----|---|----------------------|--------------------------------|
| 7 | $96 \div 3 (= 32)$                                                                         |     | 3 | M1                   | M2 for $\frac{5}{3} \times 96$ |
|   | $9 \times '32' (=288)$ <b>or</b> $4 \times '32' (=128)$<br><b>or</b> $(9 - 4) \times '32'$ |     |   | M1 dep               |                                |
|   |                                                                                            | 160 |   | A1                   |                                |
|   |                                                                                            |     |   | <b>Total 3 marks</b> |                                |

|     |     |                                                            |                                              |                                                                                                                            |                                                                                                                                                                                                               |
|-----|-----|------------------------------------------------------------|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8   | (a) | (-1, 6) (0, 4) (1, 2)<br>(2, 0) (3, -2) (4, -4)<br>(5, -6) | Correct line between<br>$x = -1$ and $x = 5$ | 4                                                                                                                          | B4 For a correct line between $x = -1$ and $x = 5$                                                                                                                                                            |
|     |     |                                                            |                                              |                                                                                                                            | B3 For a correct line through at least 3 of (-1, 6) (0, 4) (1, 2) (2, 0) (3, -2) (4, -4) (5, -6)<br><b>OR</b><br>for all of (-1, 6) (0, 4) (1, 2) (2, 0) (3, -2) (4, -4) (5, -6) plotted but not joined.      |
|     |     |                                                            |                                              |                                                                                                                            | B2 For at least 2 correct points plotted                                                                                                                                                                      |
|     |     |                                                            |                                              |                                                                                                                            | B1 For at least 2 correct points stated (may be in a table) or seen in working<br><b>OR</b><br>for a line drawn with a negative gradient through (0, 4)<br><b>OR</b><br>for a line with the correct gradient. |
| (b) |     |                                                            |                                              | 3                                                                                                                          | M1 for $y = -4$ drawn; accept full or dashed line<br>NB A shaded rectangle implies a choice of lines so M0                                                                                                    |
|     |     |                                                            |                                              |                                                                                                                            | M1 for $x = 1$ drawn; accept full or dashed line<br>NB A shaded rectangle implies a choice of lines so M0                                                                                                     |
|     |     | For correct region identified                              |                                              | A1ft for correct region identified.<br>Condone no label if region clear.<br>ft from an incorrect straight line in part (a) |                                                                                                                                                                                                               |
|     |     |                                                            |                                              |                                                                                                                            | Total 7 marks                                                                                                                                                                                                 |

|   |                                                   |                   |   |                      |                                                                                                                                                  |
|---|---------------------------------------------------|-------------------|---|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| 9 | $4x^2 + 6x + 6x + 9$ <b>or</b> $4x^2 + 12x + 9$   |                   | 3 | M1                   | for at least 3 terms correct in expansion of first pair of brackets                                                                              |
|   | $2x^2 - 10x + 3x - 15$ <b>or</b> $2x^2 - 7x - 15$ |                   |   | M1                   | for at least 3 terms correct in expansion of second pair of brackets <b>or</b> all 4 terms correct ignoring signs<br><br>allow $-2x^2 - 7x - 15$ |
|   |                                                   | $2x^2 + 19x + 24$ |   | A1                   |                                                                                                                                                  |
|   | <b>Alternative method</b>                         |                   |   |                      |                                                                                                                                                  |
|   | $(2x + 3)[(2x + 3) - (x - 5)]$                    |                   |   | M1                   |                                                                                                                                                  |
|   | $(2x + 3)(x + 8)$                                 |                   |   | M1                   |                                                                                                                                                  |
|   |                                                   | $2x^2 + 19x + 24$ |   | A1                   |                                                                                                                                                  |
|   |                                                   |                   |   | <b>Total 3 marks</b> |                                                                                                                                                  |

|    |                                                              |           |   |                      |                                     |
|----|--------------------------------------------------------------|-----------|---|----------------------|-------------------------------------|
| 10 | $0.82x = 25.83$ <b>or</b> $82\% = 25.83$                     |           | 3 | M1                   | or for use of 0.82 in a calculation |
|    | $\frac{25.83}{0.82}$ <b>or</b> $\frac{25.83}{82} \times 100$ |           |   | M1                   |                                     |
|    |                                                              | $31.5(0)$ |   | A1                   |                                     |
|    |                                                              |           |   | <b>Total 3 marks</b> |                                     |

|    |     |                                                            |                        |   |                      |                                                                                                                                                                                                                                                     |
|----|-----|------------------------------------------------------------|------------------------|---|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 11 | (a) | 4, 16, 42, 84, 96, 100                                     | 4, 16, 42, 84, 96, 100 | 1 | B1                   | cao                                                                                                                                                                                                                                                 |
|    | (b) | (20, 4) (40, 16) (60, 42) (80, 84)<br>(100, 96) (120, 100) |                        | 2 | M1                   | (ft from sensible table i.e. clear attempt at addition)<br><br>for at least 4 points plotted correctly at end of interval<br><b>or</b><br>for all 6 points plotted consistently within each interval in the <b>freq table</b> at the correct height |
|    |     |                                                            | correct cf graph       |   | A1                   | accept curve or line segments<br>accept curve that is not joined to (0,0)                                                                                                                                                                           |
|    | (c) |                                                            | 46 - 48                | 1 | B1                   | ft from a cumulative frequency graph                                                                                                                                                                                                                |
|    | (d) | E.g. reading from graph at $t = 70$                        |                        | 2 | M1                   | for evidence of using graph at $t = 70$<br><br>ft from a cumulative frequency graph provided method is shown                                                                                                                                        |
|    |     |                                                            | 36 – 38                |   | A1                   | 100 – ‘63’ ft from a cf graph<br><br>ft from a cumulative frequency graph provided method is shown                                                                                                                                                  |
|    |     |                                                            |                        |   | <b>Total 6 marks</b> |                                                                                                                                                                                                                                                     |

|                      |         |               |                                                                                                     |   |                                                                                                                                                                                                                                        |
|----------------------|---------|---------------|-----------------------------------------------------------------------------------------------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>12</b>            | (a)(i)  | $2 \times 48$ | 96                                                                                                  | 1 | B1                                                                                                                                                                                                                                     |
|                      | (ii)    |               | The <u>angle</u> at the <u>centre</u> is <u>double</u> the <u>angle</u> at the <u>circumference</u> | 1 | B1 NB : accept twice, double, origin (O)<br>accept ' <u>angle at circumference</u> is <u>half</u> the <u>angle</u> at the <u>centre</u> ' oe                                                                                           |
|                      | (b) (i) | $180 - 48$    | 132                                                                                                 | 1 | B1                                                                                                                                                                                                                                     |
|                      | (ii)    |               | The <u>opposite angles</u> in a <u>cyclic quadrilateral</u> total <u><math>180^\circ</math></u>     | 1 | B1 accept supplementary angles<br>accept<br>The <u>angle</u> at the <u>centre</u> is <u>double</u> the <u>angle</u> at the <u>circumference</u><br><b>with</b><br><u>angles</u> at a <u>point</u> sum to <u><math>360^\circ</math></u> |
| <b>Total 4 marks</b> |         |               |                                                                                                     |   |                                                                                                                                                                                                                                        |

|                      |                                                                                                               |         |   |                                                                                  |                                  |
|----------------------|---------------------------------------------------------------------------------------------------------------|---------|---|----------------------------------------------------------------------------------|----------------------------------|
| <b>13</b>            | $0.0275 \times 4000 (=110)$                                                                                   |         | 3 | M1 for interest for first year<br><b>or</b><br>330 <b>or</b><br>answer of 4330   | M2 for $1.0275^3 \times 4000$ oe |
|                      | E.g.<br>$0.0275 \times (4000 + "110") (=113.025)$<br><b>and</b><br>$0.0275 \times (4000 + "110" + "113.025")$ |         |   | M1 for a complete method                                                         |                                  |
|                      |                                                                                                               | 4339.16 |   | A1 Accept answer in range 4339 – 4340<br>NB: Answer in range 339 – 340 gets M2A0 |                                  |
| <b>Total 3 marks</b> |                                                                                                               |         |   |                                                                                  |                                  |

|    |     |                                                                        |                  |   |                                                                                                                                                                          |
|----|-----|------------------------------------------------------------------------|------------------|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14 | (a) | $T = k\sqrt{x}$                                                        |                  | 3 | M1 or for $T = \sqrt{mx}$<br>$k$ may be numeric (but not 1)                                                                                                              |
|    |     | $400 = k\sqrt{625}$ or $k = 16$ or<br>$400 = \sqrt{m625}$ or $m = 256$ |                  |   | M1 implies the first M1                                                                                                                                                  |
|    |     |                                                                        | $T = 16\sqrt{x}$ |   | A1 accept $T = \sqrt{256x}$<br>Award 3 marks if $T = k\sqrt{x}$ but $k$ is evaluated correctly in part (a) or (b).<br>SC: B2 for correct formula for $x$ in terms of $T$ |
|    | (b) |                                                                        | 120              | 1 | B1 ft for a correct answer from a substitution into an equation (or expression) in the form ( $T =$ ) $k\sqrt{x}$ except for $k = 1$                                     |
|    |     |                                                                        |                  |   | <b>Total 4 marks</b>                                                                                                                                                     |

|    |                                                                               |      |   |                                             |
|----|-------------------------------------------------------------------------------|------|---|---------------------------------------------|
| 15 | $(x^2 =) 17^2 + 14^2 - 2 \times 17 \times 14 \times \cos(123^\circ)$          |      | 4 | M1                                          |
|    | E.g. $(x^2 =) 744(.248.....)$ <b>or</b><br>$(x^2 =) 17^2 + 14^2 - 259(.2...)$ |      |   | M1 for correct order of operations          |
|    | $(x =) 27.28.....$                                                            |      |   | A1 for missing side in range<br>27.2 – 27.3 |
|    |                                                                               | 58.3 |   | B1ft dep on M1 ft for “27.28” + 31          |
|    | <b>Alternative scheme</b>                                                     |      |   |                                             |
|    | $(\text{height} =) 14 \times \sin(180 - 123) (=11.7...)$                      |      |   | M1                                          |
|    | $14 \times \cos(180 - 123) (=7.6...)$                                         |      |   | M1                                          |
|    | $\sqrt{11.7^2 + (17 + 7.6)^2} (=27.28)$                                       |      |   | A1                                          |
|    |                                                                               | 58.3 |   | B1ft dep on M1 ft for “27.28” + 31          |
|    |                                                                               |      |   | <b>Total 4 marks</b>                        |

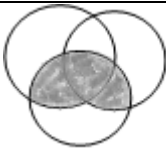
|    |     |                                                                                                                                                                    |     |   |                                                                                        |
|----|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|---|----------------------------------------------------------------------------------------|
| 16 | (a) | $\sqrt[3]{\frac{264}{891}}$ or $\sqrt[3]{\frac{891}{264}}$ or $\frac{2}{3}$ or or $\frac{3}{2}$ oe or $2:3$<br>or<br>$\sqrt[3]{264}:\sqrt[3]{891}$ (= 6.415:9.622) |     | 2 | M1 correct linear scale factor<br>or correct ratio<br>(numbers may be in either order) |
|    |     |                                                                                                                                                                    | 12  |   | A1 cao                                                                                 |
|    | (b) | $459 \times \left(\frac{2}{3}\right)^2$ oe or $459 \div \left(\frac{3}{2}\right)^2$ oe or<br>$459 \times 41(.153\dots) \div 92(.594\dots)$                         |     | 2 | M1 correct method to find the surface<br>area of A                                     |
|    |     |                                                                                                                                                                    | 204 |   | A1 cao                                                                                 |
|    |     |                                                                                                                                                                    |     |   | Total 4 marks                                                                          |

|    |                                                                                                                                                                                                                                                                                              |             |   |                                                                                                                                                                                                                                                    |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17 | $\frac{-8 \pm \sqrt{524}}{10} \quad \text{or}$ $\frac{-8 \pm \sqrt{8^2 - 4 \times 5 \times -23}}{2 \times 5} \quad \text{oe or}$ $\frac{-8 \pm 2\sqrt{131}}{10}$ <p>NB: denominator must be 2×5 or 10 <b>and</b> there must be evidence for correct order of operations in the numerator</p> |             | 3 | <p>M2 If not M2 then M1 for</p> $\frac{-8 \pm \sqrt{8^2 - 4 \times 5 \times -23}}{2 \times 5}$ <p>condone one sign error in substitution;<br/>allow partial correct evaluation</p>                                                                 |
|    |                                                                                                                                                                                                                                                                                              | 1.49, −3.09 |   | <p>A1 for answers in range<br/>1.489 to 1.489105 <b>and</b> −3.089 to −3.0891045</p> <p>Award M2 A1 for answers in range<br/>1.489 to 1.489105 <b>and</b> −3.089 to −3.0891045<br/>with sufficient correct working that would gain at least M1</p> |
|    |                                                                                                                                                                                                                                                                                              |             |   |                                                                                                                                                                                                                                                    |
|    | <b>Alternative scheme</b>                                                                                                                                                                                                                                                                    |             |   |                                                                                                                                                                                                                                                    |
|    | $5[(x + \frac{4}{5})^2 - \frac{16}{25}] \quad \text{oe}$                                                                                                                                                                                                                                     |             | 3 | M1 for completing the square                                                                                                                                                                                                                       |
|    | $-\frac{4}{5} \pm \sqrt{\frac{23}{5} + \frac{16}{25}} \quad \text{oe}$                                                                                                                                                                                                                       |             |   | M1                                                                                                                                                                                                                                                 |
|    |                                                                                                                                                                                                                                                                                              | 1.49, −3.09 |   | A1 for answers in range<br>1.489 to 1.489105 <b>and</b> −3.089 to −3.0891045                                                                                                                                                                       |
|    |                                                                                                                                                                                                                                                                                              |             |   | <b>Total 3 marks</b>                                                                                                                                                                                                                               |

|    |                                                                                    |                     |   |                                                                                                                              |                                                            |
|----|------------------------------------------------------------------------------------|---------------------|---|------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
| 18 | $\left(\frac{dy}{dx} = \right) 20x + 9$                                            |                     |   | M1 for differentiating $10x^2$ or $9x$ correctly                                                                             | M2 for $\frac{-9}{2 \times 10}$<br>(from $\frac{-b}{2a}$ ) |
|    | $20x + 9 = 0$                                                                      |                     |   | M1 equating their $\frac{dy}{dx}$ (of the form $ax + b$ ) to zero, dep on previous M1                                        |                                                            |
|    | $x = -0.45$ oe                                                                     |                     |   | A1 dep on at least M1 for $x = -0.45$ oe                                                                                     |                                                            |
|    |                                                                                    | $(-0.45, 2.975)$ oe | 4 | A1ft dep on M2 accept fractions $\left(-\frac{9}{20}, 2\frac{39}{40}\right)$ or $\left(-\frac{9}{20}, \frac{119}{40}\right)$ |                                                            |
|    | <b>Alternative scheme</b><br>(completing the square)                               |                     |   |                                                                                                                              |                                                            |
|    | $\left(x + \frac{9}{20}\right)^2 + \dots$                                          |                     |   | M1                                                                                                                           |                                                            |
|    | $\left(x + \frac{9}{20}\right)^2 - \left(\frac{9}{20}\right)^2 + \frac{5}{10} = 0$ |                     |   | M1                                                                                                                           |                                                            |
|    | $x = -0.45$ oe                                                                     |                     |   | A1 dep on at least M1 for $x = -0.45$ oe                                                                                     |                                                            |
|    |                                                                                    | $(-0.45, 2.975)$ oe | 4 | A1ft dep on M2 accept fractions $\left(-\frac{9}{20}, 2\frac{39}{40}\right)$ or $\left(-\frac{9}{20}, \frac{119}{40}\right)$ |                                                            |

|           |                                                                                                    |                         |   |                                                                      |
|-----------|----------------------------------------------------------------------------------------------------|-------------------------|---|----------------------------------------------------------------------|
| <b>19</b> | $k^2 = \frac{5m+2e}{3e}$ <b>or</b> $k\sqrt{3e} = \sqrt{5m+2e}$                                     |                         | 4 | M1 Squaring both sides <b>or</b> clearing fraction                   |
|           | $3ek^2 = 5m + 2e$                                                                                  |                         |   | M1 Clearing fraction <b>and</b> squaring both sides                  |
|           | $3ek^2 - 2e = 5m$ <b>or</b> $-5m = 2e - 3ek^2$<br>$e(3k^2 - 2) = 5m$ <b>or</b> $-5m = e(2 - 3k^2)$ |                         |   | M1 Isolating terms in $e$ in a correct equation                      |
|           |                                                                                                    | $e = \frac{5m}{3k^2-2}$ |   | A1 for $e = \frac{5m}{3k^2-2}$ <b>or</b> $e = \frac{-5m}{2-3k^2}$ oe |
|           |                                                                                                    |                         |   | <b>Total 4 marks</b>                                                 |

|           |                                                                                    |                                    |   |                                                                                                                                                    |
|-----------|------------------------------------------------------------------------------------|------------------------------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>20</b> | 3.5 <b>or</b> 2.5 <b>or</b> 5.25 <b>or</b> 5.35<br><b>or</b> 8.365 <b>or</b> 8.375 |                                    | 3 | M1 accept 3.49 <b>or</b> 3.499... <b>or</b> 5.349 <b>or</b> 5.3499... <b>or</b> 8.3749 <b>or</b> 8.37499..                                         |
|           | $3.5(8.375 - 5.25)$ <b>or</b><br>$3.5 \times 8.375 - 3.5 \times 5.25$              |                                    |   | M1 <b>or</b> for $UB_1 \times (UB_2 - LB)$ oe where<br><br>$3 < UB_1 \leq 3.5$ <b>and</b> $8.37 < UB_2 \leq 8.375$ <b>and</b> $5.25 \leq LB < 5.3$ |
|           |                                                                                    | $\frac{175}{16}$ <b>or</b> 10.9375 |   | A1 dep on M2 – correct working must be seen                                                                                                        |
|           |                                                                                    |                                    |   | <b>Total 3 marks</b>                                                                                                                               |

|               |     |                       |                                                                                     |   |                        |
|---------------|-----|-----------------------|-------------------------------------------------------------------------------------|---|------------------------|
| 21            | (a) |                       | 12                                                                                  | 1 | B1                     |
|               | (b) |                       | 7                                                                                   | 1 | B1                     |
|               | (c) | Correct region shaded |  | 1 | B1 Must be unambiguous |
| Total 3 marks |     |                       |                                                                                     |   |                        |

|    |                                                                                                                                                                         |      |   |    |                                                                                                                                                                            |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 22 | $\frac{75}{360} \times \pi \times d (2r) = 7.2$                                                                                                                         |      | 4 | M1 | for a correct equation linking the angle and arc length<br><br>NB: 0.208(3... ) may be used in place of $\frac{75}{360}$<br><br><b>or</b> 4.8 in place of $\frac{360}{75}$ |
|    | $\frac{7.2 \times 360}{75 \times \pi}$ <b>oe or</b> $\frac{7.2 \times 360}{75 \times 2 \times \pi}$ <b>oe or</b><br><br>$d = 11(.0\dots)$ <b>or</b> $r = 5.5(0\dots)$   |      |   | M1 | for a complete method to find the radius or diameter.                                                                                                                      |
|    | $\frac{75}{360} \times \pi \times \left(\frac{11}{2}\right)^2$ <b>or</b> $\frac{75}{360} \times \pi \times 5.5^2$ <b>or</b><br><br>$\frac{75}{360} \times 95(.04\dots)$ |      |   | M1 | dep on previous M1                                                                                                                                                         |
|    |                                                                                                                                                                         | 19.8 |   | A1 | for answer in range 19.8 – 19.82                                                                                                                                           |
|    | Total 4 marks                                                                                                                                                           |      |   |    |                                                                                                                                                                            |

|    |  |                                                                                                                                                                                        |                                                                   |   |                                                                                                                                                                                                                                                                                   |
|----|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 23 |  | $x^2 + (8-2x)^2 = 52$                                                                                                                                                                  |                                                                   | 6 | M1 for elimination of one variable<br>$\left(\frac{8-y}{2}\right)^2 + y^2 = 52$                                                                                                                                                                                                   |
|    |  | $x^2 + 4x^2 - 16x - 16x + 64 = 52$                                                                                                                                                     |                                                                   |   | M1 (indep) for a correct expansion of<br>$(8-2x)^2$ <b>or</b> $\left(\frac{8-y}{2}\right)^2$<br>$\left(\frac{64-8y-8y+y^2}{4}\right) + y^2 = 52$                                                                                                                                  |
|    |  | $5x^2 - 32x + 12 (= 0)$                                                                                                                                                                |                                                                   |   | A1 for correct simplified 3 term quadratic equation in any form<br>(may not be equated to zero)<br>$5y^2 - 16y - 144 (= 0)$                                                                                                                                                       |
|    |  | $(5x-2)(x-6) (=0)$<br><b>or</b> $\frac{- -32 \pm \sqrt{(-32)^2 - 4 \times 5 \times 12}}{2 \times 5}$<br>(may be partially evaluated, condone lack of brackets around negative numbers) |                                                                   |   | M1 $(5y-36)(y+4) (=0)$<br><br><b>or</b> $\frac{- -16 \pm \sqrt{(-16)^2 - 4 \times 5 \times -144}}{2 \times 5}$<br>(may be partially evaluated, condone lack of brackets around negative numbers)<br><br>NB: can fit for this mark only provided M1 awarded and a 3 term quadratic |
|    |  | $x = \frac{2}{5}$ or $x = 6$                                                                                                                                                           |                                                                   |   | A1 for <b>both</b> x values (or <b>both</b> y values)<br>$y = \frac{36}{5}$ or $y = -4$                                                                                                                                                                                           |
|    |  |                                                                                                                                                                                        | $x = \frac{2}{5}$ oe, $y = \frac{36}{5}$ oe<br>$x = 6$ , $y = -4$ |   | A1 for both solutions with x and y values correctly paired                                                                                                                                                                                                                        |
|    |  |                                                                                                                                                                                        |                                                                   |   | <b>Total 6 marks</b>                                                                                                                                                                                                                                                              |

|    |                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |   |                                                   |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---|---------------------------------------------------|
| 24 | $\frac{6}{9} \times \frac{7}{10} \times \frac{7}{10} \left( = \frac{49}{150} \right)$ oe <b>or</b> $\frac{3}{9} \times \frac{4}{10} \times \frac{4}{10} \left( = \frac{4}{75} \right)$ oe <b>OR</b><br>$\frac{6}{9} \times \frac{7}{10} \times a$ <b>and</b> $\frac{3}{9} \times \frac{4}{10} \times b$<br>$a$ and $b$ must both be a single fraction where<br>$0 < a, b < 1$ and $a \neq \frac{7}{10}, b \neq \frac{4}{10}$ |                 | 3 | M1                                                |
|    | $\frac{6}{9} \times \frac{7}{10} \times \frac{7}{10}$ oe <b>and</b> $\frac{3}{9} \times \frac{4}{10} \times \frac{4}{10}$ oe                                                                                                                                                                                                                                                                                                 |                 |   | M1 Both products correct<br>(addition not needed) |
|    |                                                                                                                                                                                                                                                                                                                                                                                                                              | $\frac{19}{50}$ |   | A1<br>oe E.g. $\frac{342}{900}$                   |
|    |                                                                                                                                                                                                                                                                                                                                                                                                                              |                 |   | <b>Total 3 marks</b>                              |

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