



Pearson

Mark Scheme (Results)

January 2017

International GCSE Mathematics A  
4MA0/3HR

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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If working is crossed out and still legible, then it should be given any appropriate marks, as long as it has not been replaced by alternative work.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 January 2017 – Paper 3HR Mark scheme**

Apart from Questions 11a, 15, 16a where the mark scheme states otherwise, the correct answer, unless clearly obtained by an incorrect method, should be taken to imply a correct method.

| Q | Working           | Answer  | Mark | Notes                     |
|---|-------------------|---------|------|---------------------------|
| 1 | $100^2$ or 10 000 |         |      | M1 e.g. $12 \times 100^2$ |
|   |                   | 120 000 | 2    | A1                        |
|   |                   |         |      | <b>Total 2 marks</b>      |

|   |  |    |   |                      |
|---|--|----|---|----------------------|
| 2 | $360 \div 18$ or $\frac{(2n-4)90}{n} = 162$ or<br>$\frac{(n-2)180}{n} = 162$ |    |   | M1                   |
|   |  | 20 | 2 | A1                   |
|   |  |    |   | <b>Total 2 marks</b> |

|   |  |        |   |   |
|---|--|--------|---|---|
| 3 | $\left(\frac{4+8}{2}, \frac{11+3}{2}\right)$ |        |   | M1 for $\frac{4+8}{2}$ or $\frac{11+3}{2}$ oe or (6, y) or (x, 7) or (7, 6) |
|   |  | (6, 7) | 2 | A1  |
|   |  |        |   | <b>Total 2 marks</b>  |

|          |   |     |   |   |
|----------|---|-----|---|---|
| <b>4</b> | $15 \div 60 (=0.25)$ or $13.25$ or $13 \times 60 + 15 (=795)$ or $13 \times 3600 + 15 \times 60 (=47700)$ |     |   | M1  |
|          | $8740 \div "13.25"$ <b>or</b> $8740 \div "795" \times 60$ or $8740 \div "47700" \times 3600$              |     |   | M1 accept $8740 \div 13.15$ or an answer of 664 - 665 |
|          |   | 660 | 3 | A1 accept 659.6 – 660                                 |
|          |   |     |   | <b>Total 3 marks</b>                                  |

|          |   |    |   |    |   |
|----------|---|----|---|----|---|
| <b>5</b> | $80 \div (3 + 1) (=20)$ <b>or</b> 20 <b>or</b> 60   | 67 | 5 | M1 |   |
|          | $0.15 \times (3 \times "20") (=9)$  |    |   | M1 | M1 for $0.85 \times (3 \times "20") = 51$                                   |
|          | $"20" \div 5 (=4)$  |    |   | M1 | M1 for $\frac{4}{5} \times "20" (=16)$                                      |
|          | $80 - "9" - "4"$  |    |   | M1 | M1 for $"16" + "51"$  |
|          |   |    |   | A1 |   |
|          | <b>or</b>   |    |   |    |   |
| <b>5</b> | $\frac{3}{4} \times \frac{15}{100} (= \frac{9}{80} \text{ or } 0.1125)$                           | 67 | 5 | M1 | M1 $\frac{3}{4} \times \frac{85}{100} (= \frac{51}{80} \text{ or } 0.6375)$ |
|          | $\frac{1}{4} \times \frac{1}{5} (= \frac{1}{20} \text{ or } 0.05)$                                |    |   | M1 | M1 $\frac{1}{4} \times \frac{4}{5} (= \frac{1}{5} \text{ or } 0.2)$         |
|          | $"\frac{9}{80}" + "\frac{1}{20}" \left( = \frac{13}{80} \right)$ or $"0.1125" + "0.05" (=0.1625)$ |    |   | M1 | M1 $\frac{51}{80} + \frac{1}{5}$  |
|          | $(1 - "\frac{13}{80}") \times 80$ or $(1 - "0.1625") \times 80$ or $\frac{67}{80}$                |    |   | M1 | M1 $(\frac{51}{80} + \frac{1}{5}) \times 80$ oe or $\frac{67}{80}$          |
|          |   |    |   | A1 |   |
|          |   |    |   |    | <b>Total 5 marks</b>  |

|     |  |   |   |  |
|-----|--|---|---|--|
| 6 a |  | Reflection in $y = -1$                              | 2 | B1 for reflection<br>-----<br>B1 for $y = -1$<br>NB. If more than one transformation then<br>award no marks  |
| b   |  | Vertices at $(-2, 1)$ $(-2, 6)$ $(-5, 1)$ $(-5, 3)$ | 2 | B2 If not B2 then award B1 for a correct<br>transformation $90^\circ$ clockwise about $(0, 0)$ <b>or</b> 3<br>vertices correct <b>or</b> correct shape in correct<br>orientation but in wrong position |
|     |  |   |   | <b>Total 4 marks</b>   |

|   |   |    |    |   |   |   |    |   |    |   |   |   |   |   |   |   |    |   |   |   |   |   |    |   |   |  |
|---|---|----|----|---|---|---|----|---|----|---|---|---|---|---|---|---|----|---|---|---|---|---|----|---|---|--|
| 7 | <table><tr><td>x</td><td>-2</td><td>-1</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>y</td><td>10</td><td>8</td><td>6</td><td>4</td><td>2</td><td>0</td><td>-2</td></tr></table> |    |    |   |   |   |    | x | -2 | -1  | 0 | 1 | 2 | 3 | 4 | y | 10 | 8 | 6 | 4 | 2 | 0 | -2 | $y = 6 - 2x$ drawn from<br>$x = -2$ to<br>$x = 4$ | 4 | B4 For a correct line between $x = -2$ and $x = 4$ |
|   | x   | -2 | -1 | 0 | 1 | 2 | 3  | 4 |    |   |   |   |   |   |   |   |    |   |   |   |   |   |    |   |   |  |
| y | 10  | 8  | 6  | 4 | 2 | 0 | -2 |   |    |   |   |   |   |   |   |   |    |   |   |   |   |   |    |   |   |  |
|   |   |    |    |   |   |   |    |   |    | B3 For a correct straight line segment through at least 3 of<br>(-2, 10) (-1, 8) (0, 6) (1, 4) (2, 2) (3, 0) (4, -2)<br><br><b>OR</b> for all of (-2, 10) (-1, 8) (0, 6) (1, 4) (2, 2) (3, 0) (4, -2)<br>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) <b>OR</b><br><br>for a line drawn with a negative gradient through (0, 6) <b>OR</b><br>a line with gradient -2  |   |   |   |   |   |   |    |   |   |   |   |   |    |   |   |  |
|   |   |    |    |   |   |   |    |   |    | <b>Total 4 marks</b>  |   |   |   |   |   |   |    |   |   |   |   |   |    |   |   |  |



|          |   |  |      |   |   |
|----------|---|--|------|---|---|
| <b>8</b> | a | $224 \div 8$ oe  | 28   | 2 | M1<br>A1                                    |
|          | b | $523 - 411 (=112)$ <b>or</b> $\frac{523}{411}(=1.273\dots)$ <b>or</b> $\frac{523}{411} \times 100 (=127.3\dots)$<br><hr/> $\frac{112}{411} \times 100$ <b>or</b> $100 \times "1.273" - 100$<br><b>or</b> $"127.3" - 100$ | 27.3 | 3 | M1<br><hr/> M1 dep<br><hr/> A1 27.25 – 27.3 |
|          |   |  |      |   | <b>Total 5 marks</b>                        |

|          |   |  |                    |   |   |
|----------|---|--|--------------------|---|---|
| <b>9</b> | a |  | $100 < w \leq 110$ | 1 | B1  |
|          | b | $85 \times 3 + 95 \times 5 + 105 \times 7 + 115 \times 4 + 125$<br>$255 + 475 + 735 + 460 + 125$ | 2050               | 3 | M2 for frequency $\times$ mid-interval for at least 4 products multiplied consistently and summing<br><br>If not M2 then award M1 for multiplying consistently by value within intervals for at least 4 products (eg. end of interval) and summing products <b>or</b> mid-intervals used but not summed.<br><hr/> A1 SC : B2 for an answer of 102.5 |
|          |   |  |                    |   | <b>Total 4 marks</b>  |

|    |  |     |   |                      |  |
|----|--|-----|---|----------------------|--|
| 10 | $18^2 - (14 \div 2)^2 (=275)$  | 116 | 4 | M1                   | <b>or</b> M1 for $\cos x = \frac{7}{18}$ <b>or</b> $\sin y = \frac{7}{18}$<br><b>or</b> $\cos z = \frac{18^2 + 18^2 - 14^2}{2 \times 18 \times 18}$  |
|    | $\sqrt{18^2 - (14 \div 2)^2}$ <b>or</b> $\sqrt{275}$ <b>or</b> $5\sqrt{11}$ <b>or</b> 16.5... <b>or</b> 16.6 |     |   | M1                   | <b>or</b> M1 for $x = \cos^{-1}\left(\frac{7}{18}\right)$ <b>or</b> $x = 67.1...$<br><b>or</b> $y = \sin^{-1}\left(\frac{7}{18}\right)$ <b>or</b> $y = 22.8...$<br><b>or</b> $z = \cos^{-1}\left(\frac{18^2 + 18^2 - 14^2}{2 \times 18 \times 18}\right)$ <b>or</b> $z = 45.77...$ |
|    | $0.5 \times 14 \times "16.5..."$ <b>or</b> $35\sqrt{11}$   |     |   | M1                   | <b>or</b> M1 for $0.5 \times 14 \times 18 \times \sin("67.1...")$ <b>or</b><br>$0.5 \times 18 \times 18 \times \sin(2 \times "22.8...")$ <b>or</b><br>$0.5 \times 18 \times 18 \times \sin("45.77...")$  |
|    |  |     |   | A1                   | 116 – 116.1<br>NB Allow use of Hero's formula  |
|    |  |     |   | <b>Total 4 marks</b> |  |
|    | <b>Alternative scheme</b>  |     |   |                      |  |
|    | $25(25 - 18)(25 - 18)(25 - 14)(= 13475)$ oe  | 116 | 4 | M2                   |  |
|    | $\sqrt{13475}$ oe  |     |   | M1                   |  |
|    |  |     |   | A1                   |  |
|    |  |     |   | <b>Total 4 marks</b> |  |

|    |   |  |                        |   |               |  |
|----|---|--|------------------------|---|---------------|--|
| 11 | a | e.g. $12x = 36$ <b>or</b> $24y = -60$  | $x = 3$ oe, $y = -2.5$ | 3 | M1            | for addition of given equations <b>or</b> a complete method to eliminate $y$ or $x$ (condone one arithmetic error)               |
|    |   | e.g. $7 \times "3" + 2y = 16$ <b>or</b> $7x + 2 \times -2.5 = 16$  |                        |   | M1            | (dep) for method to find second variable   |
|    |   |  |                        |   | A1            | dep on M1 for both values correct.<br>NB. Candidates showing no working score zero   |
| b  |   | $k^2 + 9k - 5k - 45$   | $k^2 + 4k - 45$        | 2 | M1            | for 3 terms correct <b>or</b> all 4 terms correct ignoring signs <b>or</b> $y^2 + 4k + \dots$ <b>or</b> $\dots + 4k - 45$        |
|    |   |  |                        |   | A1            |  |
| c  |   | eg $\left(\frac{1}{8x^6y^3}\right)^{\frac{1}{3}}$ <b>or</b> $\left(\frac{8x^6y^8}{y^5}\right)^{\frac{1}{3}}$ <b>or</b><br>$\left(\frac{y^{\frac{-5}{3}}}{0.5x^{-2}y^{\frac{-8}{3}}}\right)$ oe | $2x^2y$                | 3 |               | NB: <b>do not</b> accept decimal powers unless recurring dot is shown  |
|    |   | eg $(8x^6y^3)^{\frac{1}{3}}$ <b>or</b> $\left(\frac{1}{8^{\frac{-1}{3}}x^{-2}y^{-1}}\right)$ <b>or</b><br>$\left(\frac{2x^2y^{\frac{8}{3}}}{y^{\frac{5}{3}}}\right)$ oe                        |                        |   | M1oe          | any <b>one</b> of<br>correct simplification of $y$ term <b>or</b><br>reciprocal <b>or</b><br>cube root of at least all variables |
|    |   |  |                        |   | M1oe          | any <b>two</b> of<br>correct simplification of $y$ term <b>or</b><br>reciprocal <b>or</b><br>cube root of at least all variables |
|    |   |  |                        |   | A1oe          | e.g. $\left(\frac{y}{0.5x^{-2}}\right)$ SCB2 for $\left(\frac{1}{2x^2y}\right)$ or $ax^ny^m$ with 2 of<br>$a = 2, n = 2, m = 1$  |
|    |   |  |                        |   | Total 8 marks |  |

|           |   |  |               |   |  |
|-----------|---|--|---------------|---|--|
| <b>12</b> | a |  | correct graph | 2 | B2 Points at end of intervals and joined with curve or line segments<br><br>If not B2 then B1 for 5 or 6 of their points from table plotted consistently within each interval at their correct heights and joined with smooth curve or line segments |
|           | b |  |               | 2 | M1 ft for a cf graph horizontal line or mark drawn at 40 or 40.5 or vertical line at correct place, ft their cf graph  |
|           |   |  | 57 – 59       |   | A1 ft from their cf graph  |
|           | c |  |               | 2 | M1ft for reading from cf axis ft their graph from 90 on time axis <b>or</b> 72 ft  |
|           |   |  | 8             |   | A1ft   |
|           |   |  |               |   | <b>Total 6 marks</b>   |

|           |   |  |                        |   |   |
|-----------|---|--|------------------------|---|---|
| <b>13</b> | a |  | 0.00079                | 1 | B1 cao  |
|           | b |  |                        | 2 | M1 for $20.15 \times 10^9$ <b>or</b> 20 150 000 000<br>or $2.015 \times 10^n$ where $n \neq 10$ |
|           |   |  | $2.015 \times 10^{10}$ |   | A1 For $2 \times 10^{10}$ or better   |
|           |   |  |                        |   | <b>Total 3 marks</b>  |

|           |  |           |   |   |                              |
|-----------|--|-----------|---|---|------------------------------|
| <b>14</b> | $9000 \times 0.018 (= 162)$ <b>or</b><br>$9000 \times 1.018 (=9162)$   | 9494.8(0) | 3 | M1<br>or for $\frac{3 \times 1.8}{100} \times 9000$<br>(=486) or 9486 | M2 for $9000 \times 1.018^3$ |
|           | $(9000 + "162") \times 0.018 (=164.916)$<br>$("9162" + "164.916") \times 0.018 (= 167.88\dots)$<br>$"9162" + "164.916" + "167.88"$ |           |   | M1<br>for complete method   |                              |
|           |  |           |   | A1<br>accept 9494.8 - 9495  |                              |
|           |  |           |   | <b>Total 3 marks</b>  |                              |

|    |   |                         |   |   |
|----|---|-------------------------|---|---|
| 15 | $-4y = 5 - 3x$  | No with correct figures | 4 | M1 isolates term in y   |
|    | $y = 0.75x (+ c)$ <b>or</b> gradient of <b>A</b> = 0.75 oe            |                         |   | M1  |
|    | gradient of <b>B</b> = $\frac{3-7}{-1-4}\left(=\frac{4}{5}\right)$ oe |                         |   | M1 or $y = 0.8x (+ c)$ oe   |
|    |   |                         |   | A1 eg. No gradient of <b>A</b> = 0.75 but gradient of <b>B</b> = 0.8 oe |
|    |   |                         |   | <b>Total 4 marks</b>  |

|    |   |  |                        |   |                      |  |
|----|---|--|------------------------|---|----------------------|--|
| 16 | a | e.g. $3(3x + 1) - 5(x - 4) = 2 \times 15$ <b>or</b><br>$\frac{3(3x+1)}{15} - \frac{5(x-4)}{15} = 2$ <b>or</b><br>$\frac{3(3x+1) - 5(x-4)}{15} = 2$ | 1.75 oe                | 3 | M1                   | deals with fractions eg. finds common denominator (15 or a multiple of 15) or multiplies by common multiple in a correct equation. |
|    |   | e.g. $9x + 3 - 5x + 20 = 30$   |                        |   | M1                   | Expands brackets and multiplies by common denominator in a correct equation  |
|    |   |  |                        |   | A1                   | dep on M1  |
|    | b | $t(3p + 1) = 7 - 2p$   | $p = \frac{7-t}{3t+2}$ | 4 | M1                   | multiplies by $3p + 1$ must have brackets  |
|    |   | $3pt + 2p = 7 - t$   |                        |   | M1                   | isolates terms in $p$  |
|    |   | $p(3t + 2) = 7 - t$  |                        |   | M1                   | takes $p$ out as a common factor   |
|    |   |  |                        |   | A1                   | or $p = \frac{t-7}{-3t-2}$ oe with $p$ as the subject  |
|    |   |  |                        |   | <b>Total 7 marks</b> |  |

|    |  |     |   |  |
|----|--|-----|---|--|
| 17 | e.g. $\frac{12}{3} = \frac{RX}{4}$ or $12 \times 4 = XR \times 3$ or $3x = 48$ | 9.5 | 3 | M1 or $(2r - 3) \times 3 = 12 \times 4$                                |
|    | $(XR = ) 12 \times 4 \div 3 (=16)$   |     |   | M1 or $2r - 3 = 12 \times 4 \div 3$ or $XR = 16$<br>or an answer of 19 |
|    |  |     |   | A1oe e.g. $\frac{19}{2}$   |
|    |  |     |   | Total 3 marks  |

|    |   |  |   |   |
|----|---|--|---|---|
| 18 | $\frac{7\sqrt{p}-p^2}{p\sqrt{p}} \quad \text{or} \quad \frac{7\sqrt{p}-p^2}{\sqrt{p^3}} \times \frac{\sqrt{p^3}}{\sqrt{p^3}} \text{ oe}$  |  | 3 | M1<br>e.g. $\frac{7p^{\frac{1}{2}}-p^2}{p^{\frac{3}{2}}}$   |
|    | $\frac{7\sqrt{p}-p^2}{p\sqrt{p}} \times \frac{\sqrt{p}}{\sqrt{p}} \quad \text{or} \quad \frac{7\sqrt{p}-p\sqrt{p}\sqrt{p}}{p\sqrt{p}}$ $\frac{7\sqrt{p}\sqrt{p^3}-p^2\sqrt{p^3}}{p^3} \text{ oe}$ |  |   | M1<br>e.g. $\frac{7p^2-p^{\frac{7}{2}}}{p^3} \text{ oe}$  |
|    |   |  |   | A1<br>for $\frac{7-p\sqrt{p}}{p}$ or $\frac{7}{p}-\sqrt{p}$ oe or<br>$\frac{7-p^{\frac{3}{2}}}{p}$ oe |
|    |   |  |   | <b>Total 3 marks</b>  |

|           |   |                                 |                  |   |  |
|-----------|---|---------------------------------|------------------|---|--|
| <b>19</b> | a |                                 | 2                | 1 | B1   |
|           | b |                                 | 0.5 oe           | 1 | B1   |
|           | c | $y(2-x) = 3$ or $x(2-y) = 3$ oe | $\frac{2x-3}{x}$ | 2 | M1   |
|           |   |                                 |                  |   | A1 $\frac{3-2x}{-x}$ or $2-\frac{3}{x}$<br>must be in terms of $x$ |
|           | d | $\frac{3}{2-\frac{2x+1}{3}}$ oe | $\frac{9}{5-2x}$ | 2 | M1   |
|           |   |                                 |                  |   | A1   |
|           |   |                                 |                  |   | <b>Total 6 marks</b>   |

|           |   |                      |                  |   |   |
|-----------|---|----------------------|------------------|---|---|
| <b>20</b> | a |                      | $3x^2 - 8x + 5$  | 2 | M1 for any 2 of $3x^2$ or $-8x$ or $+5$ differentiated correctly  |
|           |   |                      |                  |   | A1  |
|           | b | $3x^2 - 8x + 5 = 1$  | $\frac{2}{3}, 2$ | 4 | M1 ft from (a)  |
|           |   | $3x^2 - 8x + 4 = 0$  |                  |   | M1 ft rearrange ready to solve, ft as long as $ax^2 - bx + c$   |
|           |   | eg $(3x-2)(x-2) = 0$ |                  |   | M1 ft correct method to solve quadratic – if using formula, every term to be substituted correctly as long as $ax^2 - bx + c$ |
|           |   |                      |                  |   | A1 cao dep on M2<br>Ignore any attempts to find y values  |
|           |   |                      |                  |   | <b>Total 6 marks</b>  |



|    |  |     |   |               |  |
|----|--|-----|---|---------------|--|
| 21 | $(OB^2 =) 12^2 + 16^2 - 2 \times 12 \times 16 \times \cos(60^\circ)$   | 152 | 5 | M1            | M2 for<br>$\sqrt{(12^2 + 16^2 - 2 \times 12 \times 16 \times \cos(60^\circ))}$ |
|    | $(OB =) \sqrt{208}$ or $4\sqrt{13}$ or 14.4... or $(OB^2) = 208$   |     |   | M1            |  |
|    | $0.5 \times 12 \times 16 \times \sin(60^\circ)$ (= 83.1...or $48\sqrt{3}$ ) or<br>$\frac{38}{360} \times \pi \times "14.4" \times "14.4"$ (=68.9...) or<br>$\frac{38}{360} \times \pi \times "208"$ (=68.9...) |     |   | M1            | ft their 14.4 provided first M1 awarded.                                       |
|    | $0.5 \times 12 \times 16 \times \sin(60^\circ) + \frac{38}{360} \times \pi \times "14.4" \times "14.4"$<br>(68.9....+ 83.1...)   |     |   | M1            | ft their 14.4 provided first M1 awarded.                                       |
|    |  |     |   | A1            | awrt 152   |
|    |  |     |   | Total 5 marks |  |

|    |  |                 |   |  |   |
|----|--|-----------------|---|--|---|
| 22 | $\frac{4}{12} \times \frac{3}{11} \times \frac{4}{10} (= \frac{48}{1320} = \frac{2}{55})$ oe   | $\frac{36}{55}$ | 5 | M1   | M2 for $\frac{4}{12} \times \frac{3}{11} \times \frac{8}{10} (= \frac{96}{1320} = \frac{4}{55})$ oe |
|    | $3 \times \frac{4}{12} \times \frac{3}{11} \times \frac{4}{10}$ <b>or</b> $2 \times \frac{4}{12} \times \frac{3}{11} \times \frac{4}{10}$                      |                 |   | M1   |   |
|    | $3 \times 2 \times \frac{4}{12} \times \frac{3}{11} \times \frac{4}{10}$ oe <b>or</b> $3 \times 3 \times \frac{4}{12} \times \frac{3}{11} \times \frac{4}{10}$ |                 |   | M1   | M1 for $3 \times \frac{4}{12} \times \frac{3}{11} \times \frac{8}{10}$ oe                           |
|    | $3 \times 3 \times 2 \times \frac{4}{12} \times \frac{3}{11} \times \frac{4}{10}$ oe   |                 |   | M1   | M1 for $3 \times 3 \times \frac{4}{12} \times \frac{3}{11} \times \frac{8}{10}$ oe                  |
|    |  |                 |   | A1<br>oe eg. $\frac{864}{1320}$ (0.65(45454...)) |   |
|    | <b>Alternative using 1 – (all different + all the same)</b>  |                 |   |  |   |
|    | $\frac{4}{12} \times \frac{4}{11} \times \frac{4}{10}$ <b>or</b> $\frac{4}{12} \times \frac{3}{11} \times \frac{2}{10}$  | $\frac{36}{55}$ | 5 | M1   |   |
|    | $\frac{4}{12} \times \frac{4}{11} \times \frac{4}{10} \times 6$ <b>or</b> $\frac{4}{12} \times \frac{3}{11} \times \frac{2}{10} \times 3$                      |                 |   | M1   |   |
|    | $\frac{4}{12} \times \frac{4}{11} \times \frac{4}{10} \times 6$ <b>and</b> $\frac{4}{12} \times \frac{3}{11} \times \frac{2}{10} \times 3$                     |                 |   | M1   |   |
|    | $1 - [(\frac{4}{12} \times \frac{4}{11} \times \frac{4}{10} \times 6) + (\frac{4}{12} \times \frac{3}{11} \times \frac{2}{10} \times 3)]$                      |                 |   | M1   |   |
|    |  |                 |   | A1<br>oe eg. $\frac{864}{1320}$ (0.65(45454...)) |   |
|    |  |                 |   | <b>Total 5 marks</b>                             |   |

|           |  |  |   |                      |   |
|-----------|--|--|---|----------------------|---|
|           | <b>SC: With replacement (maximum marks M3)</b>   |  |   | <b>Total 5 marks</b> |   |
| <b>22</b> | $3 \times \frac{4}{12} \times \frac{4}{12} \times \frac{4}{12} (= \frac{192}{1728} = \frac{1}{9})$ <b>or</b> $2 \times \frac{4}{12} \times \frac{4}{12} \times \frac{4}{12} (= \frac{128}{1728} = \frac{2}{27})$ |  | 3 | M1                   | or $\frac{4}{12} \times \frac{4}{12} \times \frac{8}{12}$                       |
|           | $3 \times 2 \times \frac{4}{12} \times \frac{4}{12} \times \frac{4}{12}$ oe <b>or</b> $3 \times 3 \times \frac{4}{12} \times \frac{4}{12} \times \frac{4}{12}$ oe  |  |   | M1                   | or $3 \times \frac{4}{12} \times \frac{4}{12} \times \frac{8}{12}$              |
|           | $3 \times 3 \times 2 \times \frac{4}{12} \times \frac{4}{12} \times \frac{4}{12}$ oe   |  |   | M1                   | M1 for $3 \times 3 \times \frac{4}{12} \times \frac{4}{12} \times \frac{8}{12}$ |
|           |  |  |   |                      |   |

|    |   |  |        |   |  |
|----|---|--|--------|---|--|
| 23 | a | $\overline{CD} = \overline{CB} + \overline{BA} + \overline{AD}$ or $-\mathbf{c} - \mathbf{b} + 3\mathbf{c}$  | 2c - b | 2 | M1   |
|    |   |  |        |   | A1   |
|    | b | $\overline{BP} = \overline{BA} + \frac{2}{3}\overline{AC}$ or $\overline{PD} = \frac{1}{3}\overline{AC} + \overline{CD}$   |        | 4 | M1ft Ft their $\overline{CD}$  |
|    |   | $\overline{BP} = -\mathbf{b} + \frac{2}{3}(\mathbf{b} + \mathbf{c}) (= \frac{2}{3}\mathbf{c} - \frac{1}{3}\mathbf{b})$ or<br>$\overline{PD} = \frac{1}{3}(\mathbf{b} + \mathbf{c}) + 2\mathbf{c} - \mathbf{b} (= \frac{7}{3}\mathbf{c} - \frac{2}{3}\mathbf{b})$   |        |   | M1ft   |
|    |   | $\overline{BP} = -\mathbf{b} + \frac{2}{3}(\mathbf{b} + \mathbf{c}) (= \frac{2}{3}\mathbf{c} - \frac{1}{3}\mathbf{b})$ AND<br>$\overline{PD} = \frac{1}{3}(\mathbf{b} + \mathbf{c}) + 2\mathbf{c} - \mathbf{b} (= \frac{7}{3}\mathbf{c} - \frac{2}{3}\mathbf{b})$<br><b>OR</b><br>$\overline{BP} = -\mathbf{b} + \frac{2}{3}(\mathbf{b} + \mathbf{c}) (= \frac{2}{3}\mathbf{c} - \frac{1}{3}\mathbf{b})$ AND<br>$\overline{BD} = -\mathbf{b} + 3\mathbf{c}$<br><b>OR</b><br>$\overline{PD} = \frac{1}{3}(\mathbf{b} + \mathbf{c}) + 2\mathbf{c} - \mathbf{b} (= \frac{7}{3}\mathbf{c} - \frac{2}{3}\mathbf{b})$ AND<br>$\overline{BD} = -\mathbf{b} + 3\mathbf{c}$ |        |   | M1<br>or $\overline{BP} = \frac{1}{3}(2\mathbf{c} - \mathbf{b})$ and<br>$\overline{CD} = 2\mathbf{c} - \mathbf{b}$ |

|  |  |  |  |   |
|--|--|--|--|---|
|  |  | No with correct appropriate vectors and reason |  | <p>A1</p> <p>E.g. <math>\overrightarrow{BP} = \frac{1}{3}(2\mathbf{c} - \mathbf{b})</math> and <math>\overrightarrow{CD} = 2\mathbf{c} - \mathbf{b}</math> are parallel and therefore not in a straight line</p> <p><b>OR</b></p> <p>Correct simplified vectors for two of <math>BP</math>, <math>BD</math>, <math>PD</math> with explanation that vectors are not a multiple of each other</p> |
|  |  |  |  | <b>Total 6 marks</b>  |

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