

Higher

GCSE

Mathematics - Paper 4

J560/04: Paper 4 (Higher tier)

General Certificate of Secondary Education

Mark Scheme for June 2023

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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**MARKING INSTRUCTIONS
PREPARATION FOR MARKING
SCORIS**

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *scoris assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal <http://www.rm.com/support/ca>
3. Log-in to scoris and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

MARKING

4. Mark strictly to the mark scheme.
5. Marks awarded must relate directly to the marking criteria.
6. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
7. If you are in any doubt about applying the mark scheme, consult your Team Leader via the RM Assessor messaging system.
8. Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners should give candidates the benefit of the doubt and mark the crossed out response where legible.
9. When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.
10. On each blank page the annotation **BP** must be inserted to confirm that the page has been checked. For additional objects (if present), a tick must be inserted on each page to confirm that it has been checked.

11. There is a NR (No Response) option. Award NR (No Response)
- if there is nothing written at all in the answer space
 - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
 - OR if there is a mark (e.g. a dash, a question mark) which is not an attempt at the question.

The hash key (#) on your keyboard will enter NR.

Note: Award 0 marks for an attempt that earns no credit (including copying out the question).

12. The RM Assessor **comments box** is used by the Principal Examiner or your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**

If you have any questions or comments for your Team Leader, use the RM Assessor messaging system.

13. Assistant Examiners should send a brief report on the performance of candidates to their Team Leader (Supervisor) by the end of the marking period. Please follow the direction of your Team Leader about which questions you should report on and how to submit your report. Your report should contain notes on particular strengths displayed as well as common errors or weaknesses.
14. Annotations available in RM Assessor. These **must** be used whenever appropriate during your marking.

Annotation	Meaning
	Correct
	Incorrect
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working (after correct answer obtained), provided method has been completed
M0	Method mark awarded 0
M1	Method mark awarded 1

M2	Method mark awarded 2
A1	Accuracy mark awarded 1
B1	Independent mark awarded 1
B2	Independent mark awarded 2
MR	Misread
SC	Special case
^	Omission sign
BP	Blank page
SEEN	Seen

For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required. For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Subject-Specific Marking Instructions

15. **M** marks are for using a correct method and are not lost for purely numerical errors.
A marks are for an accurate answer and depend on preceding **M** (method) marks. Therefore **M0 A1** cannot be awarded.
B marks are independent of **M** (method) marks and are for a correct final answer, a partially correct answer, or a correct intermediate stage.
SC marks are for special cases that are worthy of some credit.
16. The following abbreviations are commonly found in GCSE Mathematics mark schemes.
- **figs 237**, for example, means any answer with only these digits. You should ignore leading or trailing zeros and any decimal point e.g. 237000, 2.37, 2.370, 0.00237 would be acceptable but 23070 or 2374 would not.
 - **isw** means **ignore subsequent working** after correct answer obtained and applies as a default.
 - **nfw** means **not from wrong working**.
 - **oe** means **or equivalent**.
 - **rot** means **rounded or truncated**.
 - **soi** means **seen or implied**.
 - **dep** means that the marks are **dependent** on the marks indicated. You must check that the candidate has met all the criteria specified for the mark to be awarded.
 - **with correct working** means that full marks **must not** be awarded without some working. The required minimum amount of working will be defined in the guidance column and **SC** marks given for unsupported answers.
17. Anything in the mark scheme which is in square brackets [...] is not required for the mark to be earned, but if present it must be correct.
18. Unless the command word requires that working is shown and the working required is stated in the mark scheme, then if the correct answer is clearly given and is not from wrong working **full marks** should be awarded.
- Do not award the marks if the answer was obtained from an incorrect method, i.e. incorrect working is seen and the correct answer clearly follows from it.
19. Where follow through (**FT**) is indicated in the mark scheme, marks can be awarded where the candidate's work follows correctly from a previous answer whether or not it was correct. For questions with FT available you must ensure that you refer back to the relevant previous answer. You may find it easier to mark these questions candidate by candidate rather than question by question.

Figures or expressions that are being followed through are sometimes encompassed by single quotation marks after the word *their* for clarity, e.g. $FT\ 180 \times (their\ '37' + 16)$, or $FT\ 300 - \sqrt{(their\ '52 + 72)}$. Answers to part questions which are being followed through are indicated by
e.g. $FT\ 3 \times their\ (a)$.

20. In questions **with no final answer line**, make no deductions for wrong work after an acceptable answer (i.e. **isw**) unless the mark scheme says otherwise, indicated by the instruction 'mark final answer'.
21. In questions **with a final answer line and incorrect answer given**:
- (i) If the correct answer is seen in the body of working and the answer given on the answer line is a clear transcription error allow full marks unless the mark scheme says 'mark final answer'. Place the annotation ✓ next to the correct answer.
 - (ii) If the correct answer is seen in the body of working but the answer line is blank, allow full marks. Place the annotation ✓ next to the correct answer.
 - (iii) If the correct answer is seen in the body of working but a completely different answer is seen on the answer line, then accuracy marks for the answer are lost. Method marks could still be awarded if there is no other method leading to the incorrect answer. Use the **M0**, **M1**, **M2** annotations as appropriate and place the annotation ✕ next to the wrong answer.
22. In questions **with a final answer line**:
- (i) If one answer is provided on the answer line, mark the method that leads to that answer. A correct step, value or statement that is not part of the method that leads to the given answer should be awarded **M0** and/or **B0**.
 - (ii) If more than one answer is provided on the answer line and there is a single method provided, award method marks only.
 - (iii) If more than one answer is provided on the answer line and there is more than one method provided, award marks for the poorer response unless the candidate has clearly indicated which method is to be marked.
23. In questions with **no final answer line**:
- (i) If a single response is provided, mark as usual.
 - (ii) If more than one response is provided, award marks for the poorer response unless the candidate has clearly indicated which response is to be marked.

24. When the data of a question is consistently misread in such a way as not to alter the nature or difficulty of the question, please follow the candidate's work and allow follow through for **A** and **B** marks. Deduct 1 mark from any **A** or **B** marks earned and record this by using the **MR** annotation. **M** marks are not deducted for misreads. If a candidate corrects the misread in a later part, do not continue to follow through, but award **A** and **B** marks for the correct answer only.
25. Unless the question asks for an answer to a specific degree of accuracy, always mark at the greatest number of significant figures even if this is rounded or truncated on the answer line. For example, an answer in the mark scheme is 15.75, which is seen in the working. The candidate then rounds or truncates this to 15.8, 15 or 16 on the answer line. Allow full marks for the 15.75.
26. Ranges of answers given in the mark scheme are always inclusive.
27. For methods not provided for in the mark scheme give as far as possible equivalent marks for equivalent work. If in doubt, consult your Team Leader.
28. If in any case the mark scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Mark	Part Marks and Guidance	
1			7.57	2	B1 for 7.56[8...] or $\frac{2\sqrt{358}}{5}$ or 7.570 If 0 scored SC1 for <i>their</i> positive answer to more than 3 figures correctly rounded to 3 s.f.	Must see unrounded value
2			22.7[2...] or 22.73 or 23 or $\frac{250}{11}$	3	M2 for $(1 - \frac{1.02}{1.32}) [\times 100]$ oe or $\frac{1.32-1.02}{1.32} [\times 100]$ oe or $\frac{1.02-1.32}{1.32} [\times 100]$ oe or M1 for $\frac{1.02}{1.32} [\times 100]$ oe e.g. $\frac{17}{22}$	condone -22.7[2...] or -22.73 or -23 for 3 marks M2 implied by 0.227[2...] or 0.2273 or 0.23 or $\frac{5}{22}$ M1 implied by 0.7727..., 0.77[3], 77.27, 77[.3] or 2270, 2272, 2273, 2300 Accept fully correct non-calculator methods
3	(a)		960	2	M1 for $\frac{720}{3} [\times 4]$ may be implied by 240 nfw	
	(b)		16	3	accept any correct method M2 for e.g. <i>their</i> $(3 + 5) \times 2$ oe or $\frac{2}{3} \{3 \times (3 + 5)\}$ oe or $[c=] 3(3 + 5) - (3 + 5)$ or M1 for e.g. $\frac{c}{3+5+c} = \frac{2}{3}$ oe or $3 \times c = 2(3 + 5 + c)$ or $c = \frac{2}{3}(3 + 5 + c)$ oe or $3 + 5 = \frac{1}{2}c$ or $\frac{1}{3}$ linked with 3 + 5	trials : M1 for each correct trial to a max of M2, we need to see the value c tried and the appropriate fraction

Question			Answer	Marks	Part Marks and Guidance																																																					
4	(a)		5850	3	M2 for $[4500 +] 4500 \times [0].075 \times 4$ oe or M1 for $4500 \times [0].075$ oe	implied by 1350 implied by 337.5[0] or 4837.5[0] If they use compound interest, put MR M2 for $4500 \times (1 + \frac{7.5}{100})^4$ oe implied by 6009.6[1...] or 6010 or M1 for $4500 \times (1 + \frac{7.5}{100})^k$ ($k = 2, 3$ or 5) or interest only implied by e.g. 1509.6[1...] (see appendix)																																																				
	(b)		27	3	M2 for $\frac{13\,500 - 4500}{\text{their } 337.50}$ oe or any correct method e.g. $\frac{13\,500 - \text{their } 5850}{\text{their } 337.50} + 4$ or M1 for $13\,500 - 4500$ or $9\,000$ or $13\,500 - \text{their } 5850$ <u>Alternative method using trials</u> M1 for each correct trial over 4 evaluated correctly and rot to at least 3 s.f. to a maximum of M2 If 0 scored SC1 for answer of 40 or 41 from $\frac{13\,500}{337.50}$ oe	Condone 26.66... or 26.[7] as answer for 3 marks. <table><tr><td>5</td><td>6187.50</td><td>18</td><td>10575.00</td></tr><tr><td>6</td><td>6525.00</td><td>19</td><td>10912.50</td></tr><tr><td>7</td><td>6862.50</td><td>20</td><td>11250.00</td></tr><tr><td>8</td><td>7200.00</td><td>21</td><td>11587.50</td></tr><tr><td>9</td><td>7537.50</td><td>22</td><td>11925.00</td></tr><tr><td>10</td><td>7875.00</td><td>23</td><td>12262.50</td></tr><tr><td>11</td><td>8212.50</td><td>24</td><td>12600.00</td></tr><tr><td>12</td><td>8550.00</td><td>25</td><td>12937.50</td></tr><tr><td>13</td><td>8887.50</td><td>26</td><td>13275.00</td></tr><tr><td>14</td><td>9225.00</td><td>27</td><td>13612.50</td></tr><tr><td>15</td><td>9562.50</td><td>28</td><td>13950.00</td></tr><tr><td>16</td><td>9900.00</td><td>29</td><td>14287.50</td></tr><tr><td>17</td><td>10237.50</td><td>30</td><td>14625.00</td></tr></table> If they use compound interest, put MR M1 for each correct trial over 4 evaluated correctly and rot to at least 3 s.f. to a maximum of M2 (See appendix)	5	6187.50	18	10575.00	6	6525.00	19	10912.50	7	6862.50	20	11250.00	8	7200.00	21	11587.50	9	7537.50	22	11925.00	10	7875.00	23	12262.50	11	8212.50	24	12600.00	12	8550.00	25	12937.50	13	8887.50	26	13275.00	14	9225.00	27	13612.50	15	9562.50	28	13950.00	16	9900.00	29	14287.50	17	10237.50	30	14625.00
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Question			Answer	Marks	Part Marks and Guidance	
5	(a)		3.86×10^{-3}	1		Condone trailing zeros
	(b)		29 635[.2] or 29 640 or 29 600	2	M1 for $3.43 \times 10^{-1} \times 60^2 \times 24$ oe If 0 scored SC1 for 14 817.6, 14 818, 14 820 or 14 800	Note: $60^2 \times 24 = 86\,400$
	(c)		5 with correct working	3	M2 for $\sqrt[3]{\frac{4.41 \times 10^9}{120 \times 3.00 \times 10^5}}$ oe OR M1 for $\frac{4.41 \times 10^9}{3.00 \times 10^5}$ oe or $\frac{4.41 \times 10^9}{120}$ oe or $120 \times 3.00 \times 10^5$ oe If 0 scored SC1 for answer 5 with no or insufficient working	“Correct working” requires evidence of at least M1 or M2 if trials are used M2 implied by 4.966... or 4.97 or $\sqrt[3]{122.5}$ or $n^3 = 122.5$ condone use of a value $119 \leq \text{value} \leq 120$ instead of 120 which should lead to 4.98 M1 may be seen within a larger calculation e.g. $\frac{4.41 \times 10^9}{120 \times 3.00 \times 10^5}$ or $\sqrt[3]{\frac{4.41 \times 10^9}{3.00 \times 10^5}}$ M1 implied by 14 700 or 3.675×10^7 oe or 3.6×10^7 oe or 122.5 <u>use of trials</u> M1 for each correct trial using integer values of n up to a maximum of M2 e.g. $\frac{\text{their } 14700}{5^3}$ oe and 117 to 118 or 1.95 to 1.97 $\frac{\text{their } 14700}{4^3}$ oe and 229[. ..] or 3.8[...] <i>their</i> 14 700 comes from 3×10^5 and 4.41×10^9 (see appendix for more examples)

Question			Answer	Marks	Part Marks and Guidance	
6			$[f =] 7$ $[n =] 15$	4	B1 for $[f =] 7$ AND B3 for $[n =] 15$ or M2 for $50 \times 5.5 - (1 \times 12 + 3 \times 2 + 5 \times 9 + 6 \times 16 + 8 \times \text{their } 7) [\div 4]$ or better or forming an equation and attempting to solve it correctly e.g. $(1 \times 12) + (3 \times 2) + (5 \times 9) + (6 \times 16) + (8 \times \text{their } f) + (n \times 4) = 5.5 \times 50$ or better or M1 for 50×5.5 or 275 or $1 \times 12 + 3 \times 2 + 5 \times 9 + 6 \times 16 + 8 \times \text{their } 7$ or 215	Note : if f is an error FT <i>their</i> f for the M marks M2 implied by 60 or 275 – <i>their</i> 215 better = $12 + 6 + 45 + 96 + \text{their } 56$ Common error is $1 + 3 + 5 + 6 + 8 = 23$ $5.5 \times 6 = 33$ and $33 - 23 = 10$ scores M0
7	(a)		Two accurate curves	3	B2 for 7 or 8 points plotted accurately or B1 for 5 or 6 points plotted accurately	Ignore the curve beyond points but the curve <u>must not cross or touch the y-axis</u> tolerance $\pm \frac{1}{2}$ small square from correct points radially no excessive feathering, no ruled lines, no excessive ‘tram lines’ overlay gives guidance only
	(b)		A correct and accurate reading from <i>their</i> graph	1FT DEP.	Dep. on a graph in (a) with at least one positive solution and strict FT <i>their</i> curve.	If curve crosses x-axis between two grid lines accept either grid line value as correct answer If <i>their</i> curve has more than one positive solution accept any of <i>their</i> correct solutions Do not accept answers to more than 1d.p., $\sqrt{3}$ or answers clearly rounded from this. CONDONE whole numbers where appropriate e.g. 2 for 2.0 Do not accept 0 as positive.

Question	Answer	Marks	Part Marks and Guidance	
8	5.36 to 5.4 and correct working	6	B5 for the correct answer in the wrong format with correct working e.g. 0.0536 OR M5 for $\frac{12^2 - \pi \times 6^2}{12^2 \times 4} [\times 100]$ oe OR <u>Square</u> M1 for 12^2 or 144 or 6^2 or 36 (must be consistent with $\frac{1}{4} \times \pi \times 6^2$) and <u>Circle</u> M2 for $\pi \times 6^2$ or $\frac{1}{4} \times \pi \times 6^2$ or M1 for radius of 6 may be implied e.g. $2 \times \pi \times 6$ (with π) and M1 for $(\text{their } 12^2 - \text{their } (\pi \times 6^2)) [\div 4]$ or $\text{their } (\pi \times 6^2) \div \text{their } 12^2$ or $\text{their } (6^2 - \text{their } (\frac{1}{4} \times \pi \times 6^2)) [\div \text{their } 12^2]$ or $\text{their } (\frac{1}{4} \times \pi \times 6^2) \div \frac{\text{their } 12^2}{4}$ If 0 or M1 or M2 scored, instead award SC3 for answer 5.36 to 5.4 with no or insufficient working If 0 or M1 scored, instead award SC2 for 30.88 to 31 or 7.72 to 7.75 or 0.785 to 0.786 with no or insufficient working	“Correct working” requires evidence of at least M1 AND M2 AND M1 . <i>their</i> 144 must come from attempt at area of a square M2 implied by 113.04 to 113.12 or 28.26 to 28.28 6 [cm] could be on diagram FT <i>their</i> incorrect 6 identified as radius implied by 30.88 to 31 or 7.72 to 7.75 implied by 0.785 to 0.786 implied by 7.72 to 7.75 implied by 0.785 or 0.7852 to 0.7856 <i>their</i> area of the circle has to be an attempt at πr^2 not $2\pi r$ so that, if they do not, the most they can be awarded is M1 for 144 and M1 for radius = 6 cm

Question		Answer	Marks	Part Marks and Guidance	
9	(a)	16, 30, 34 in any order with correct working	5	M1 for $x + 5 + 3x + 1 + 2x + 8 = 80$ may be implied by a subsequent correct equation M1 for simplifying <i>their</i> equation to $ax + b = c$ implied by $6x + 14 = 80$ M1 for the first correct step in solving <i>their</i> $ax + b = c$ e.g. $6x = 80 - 14$ M1 for substituting <i>their</i> 11 into $x + 5$, $3x + 1$ and $2x + 8$ <u>Alternative method using trials</u> M2 for at least one complete correct evaluation of $x + 5 + 3x + 1 + 2x + 8$ If 0 or 1 scored, instead award SC2 for 16, 30, 34 in any order with no or insufficient working If 0 scored SC1 for $x = 11$ with no or insufficient working	“Correct working” requires evidence of at least M1 leading to $x = 11$ or M2 if using trials Note for all methods: $x = 11$ scores M1M1M1 if there is some supporting work but on its own scores SC1 <u>Alternative method</u> M2 for $80 - 5 - 1 - 8$ oe or 66 or M1 for $5 + 1 + 8$ or 14 M1 for <i>their</i> $66 \div \text{their } 6$ implied by 11 M1 for substituting <i>their</i> 11 into $x + 5$, $3x + 1$ and $2x + 8$
	(b)	<i>Their</i> fully correct conclusion after M2 scored	3	M2 for $\sqrt{(\text{their}16)^2 + (\text{their}30)^2}$ correctly evaluated or for $(\text{their}16)^2 + (\text{their}30)^2$ and $(\text{their}34)^2$ both correctly evaluated OR M1 for $\sqrt{(\text{their}16)^2 + (\text{their}30)^2}$ either not evaluated or incorrectly evaluated or for $(\text{their}16)^2 + (\text{their}30)^2$ and $(\text{their}34)^2$ either not evaluated or incorrectly evaluated or for $(\text{their}16)^2 + (\text{their}30)^2$ correctly evaluated	eg 3 marks for Yes, $\sqrt{16^2 + 30^2} = 34$ Yes, $16^2 + 30^2 = 1156$ and $34^2 = 1156$ or eg after 15, 30, 34 No, $15^2 + 30^2 = 1125$ and $34^2 = 1156$ Adapt the scheme for equivalent correct methods e.g. Pythagoras using hypotenuse and subtraction

Question			Answer	Marks	Part Marks and Guidance	
10	(a)		$\begin{array}{ccc} 36 & 19 & 41 \\ & & 4 \end{array}$	3	B2 for 36 or 19 or 41 correctly placed or B1 for the total of $F = 55$ or for the total of $S = 60$ or $F \cap S' + (F \cap S) + F' \cap S = 96$	Do not accept a blank region as 0, for any marks we need to see a number in each region
	(b)	(i)	$\frac{77}{100}$ or 0.77 or 77%	2	FT $\frac{their(36+41)}{100}$ from <i>their (a)</i> for 2 or 1 marks or M1 for <i>their</i> $(36 + 41)$ or 77	FT if $their(36 + 41) < 100$ and $0 < \text{fraction} < 1$
		(ii)	$\frac{19}{60}$ or 0.316 to 0.317 or 0.32	2	FT $\frac{their(19)}{their(19+41)}$ from <i>their (a)</i> for 2 or 1 marks B1 for 0.19 oe or $\frac{their19}{k}$ or $\frac{k}{their60}$ (k is an integer)	Accept e.g. 32% or 31.6 to 31.7% for 2 marks from <i>their (a)</i> and $0 < \text{fraction} < 1$
11			Rotation [centre] (2, 1) 180° OR Enlargement [centre] (2,1) [sf =] -1	3	B1 for each part If 0 scored M1 for the correct object after rotation or after both transformations	More than one transformation scores 0 or M1 Ignore direction of angle

Question		Answer	Mark	Part Marks and Guidance	
12	(a)	$3(x + 5)$ oe final answer	1		Equivalent includes $3x + 15$
	(b)	-7 with correct working	5	accept any correct method B1 for [output =] $2 \times \text{their}\{3(x + 5)\} - 1$ oe or output through inverse of B as $x + 1$ B1dep for $\text{their}\{2 \times 3(x + 5) - 1\} = 2x + 1$ oe or output through inverse of A as $\frac{x+1}{3} - 5$ or $x + 1 = \text{their}\{3(x + 5)\}$ M1 for e.g. $\text{their } 6x + 30 - 1 = 2x + 1$ or $\text{their } 3x = x + 1 - 15$ or inverse method $\frac{x+1}{3} - 5 = x$ M1 for $\text{their}\{4x = -28 \text{ or } -2x = 14\}$ oe <u>Alternative method using trials</u> M2 for at least two complete correct evaluations of both $6x + 29$ oe(or functions) and $2x + 1$ or M1 at least one complete correct evaluation of both $6x + 29$ oe and $2x + 1$ If 0 or 1 scored SC3 for answer -7 with no or insufficient working	“Correct working” requires evidence of at least B1B1 or B1M1 or M2 if using trials B1 implied by $2 \times 3(x + 5) - 1$ or better e.g. $6x + 30 - 1$ dep. on previous B1 Note: $3x + 15 + 2x - 1 = 2x + 1$ scores B0B0 M1 B1 B1 implied by $6x + 29 = 2x + 1$ The first M1 is for dealing with bracket(s) correctly in a linear equation and the second M1 is for correctly getting the linear equation, with x’s on both sides, into the form $ax = b$. We can only follow through an equation with x’s on both sides for M1 or x’s on both sides and a bracket for M2.
13	(a)	An error in the numerators identified	1		See appendix
	(b)	This question was discounted and all candidates were awarded 1 mark.	1		

Question	Answer	Mark	Part Marks and Guidance
14	$\frac{1332}{2520}$ oe or 0.53 or 0.529 or 0.5286 or 0.52857... or 53% or 52.9%, 52.86% or 52.857% with correct working	5	M4 for $1 - \frac{12}{14} \times \frac{9}{12} \times \frac{11}{15}$ oe OR M3 for $\frac{12}{14} \times \frac{9}{12} \times \frac{11}{15}$ OR M1 for $\frac{2}{14} \times \frac{3}{12} \times \frac{4}{15}$ OR M1 for [total choices=] $14 \times 12 \times 15$ implied by 2520 and M3 for $(2 \times 12 \times 15) + (12 \times 3 \times 15) + (12 \times 9 \times 4)$ or $360 + 540 + 432$ implied by 1332 or M2 for $(2 \times 12 \times 15) + (14 \times 3 \times 15) + (14 \times 12 \times 4)$ or $360 + 630 + 672$ implied by 1662 or M1 for one bracketed term correct from the M3 expression e.g $2 \times 12 \times 15$ OR M1 for [total choices=] $14 \times 12 \times 15$ implied by 2520 and M2 for [choices no languages=] $(14 - 2) \times (12 - 3) \times (15 - 4)$ implied by 1188 or M1 for this expression with one error and M1 for <i>their</i> 2520– <i>their</i> 1188 or 1332 If 0 or M1 scored SC2 for correct answer with no or insufficient working Note : For MR see appendix “Correct working requires evidence of at least M3 or M1M1M1 Equivs. Include $\frac{666}{1260}, \frac{333}{630}, \frac{111}{210}, \frac{37}{70}$ condone $\frac{1}{14} \times \frac{1}{12} \times \frac{1}{15} [= \frac{1}{2520}]$ for M1 [total choices] <u>Alternative equivalent methods</u> M4 for fully correct method leading to <i>their</i> 2520 and <i>their</i> 1332 or M1 for [total choices=] $14 \times 12 \times 15$ implied by 2520 and M3 for $(2 \times 3 \times 4) + (12 \times 3 \times 4 + 2 \times 9 \times 4 + 2 \times 3 \times 11) + (2 \times 9 \times 11 + 12 \times 3 \times 11 + 12 \times 9 \times 4)$ or $(24) + (144 + 72 + 66) + (198 + 396 + 432)$ implied by 1332 or M2 for this expression with at least two of the bracketed terms correct or M1 for at least one of the bracketed terms correct or any three of the individual terms correct e.g $2 \times 3 \times 4$ <u>Use of tree diagrams</u> See appendix

Question			Answer	Mark	Part Marks and Guidance	
15			21	3	M1 for $y = \frac{k}{\sqrt{x}}$ oe e.g. $7 = \frac{k}{\sqrt{144}}$ (k anywhere) M1 for $y = \frac{\text{their } k}{\sqrt{16}}$ or B1 for $k = 84$	Alternative : M1 for $144 \div 16 [= 9]$ M1 for $7 \times \sqrt{\text{their } 9}$ Note : Direct proportionality leads to an answer of $\frac{7}{3}$ oe
16	(a)		Tuesday [0].65 oe and [0].35 oe in the correct places and Wednesday [0].65 oe with [0].35 oe and [0].3 oe with [0].7 oe in the correct places	2	B1 for one pair of probabilities correct in one branch e.g Tuesday or one of the Wednesday branches	
	(b)		[0].5275 or [0].528 or 0.53 or $\frac{211}{400}$ oe nfw	3	M2 for $[0].65 \times [0].65 + [0].35 \times [0].3$ oe or M1 for $[0].65 \times [0].65$ or $[0].35 \times [0].3$ oe implied by .4225 or .105 or $\frac{169}{400}$ or $\frac{21}{200}$ oe	If (a) is not correct FT <i>their</i> tree for 3 marks, M2 and M1 Allow 52.75%, 52.8% 53% for 3 marks
17	(a)	(i)	[a] 67° and [angles in] alternate segment [are equal]	2	B1 for 67	Note : 0 for 59 (or any other value) and alternate segment Allow for reason : angle between chord and tangent equals angle in opposite segment
		(ii)	[b] 23° [angle between] radius and tangent is 90° oe	1 1	FT 90 – <i>their</i> a (providing the answer is positive)	Condone these terms : diameter, perpendicular, right-angle
	(b)	(i)	2x [because] angle [subtended] at centre is twice angle at circumference oe 360 – 2x 180 – x	1 1FT 1dep	STRICT FT e.g. 360 – <i>their</i> 2x Dep. on 2x and 360 – 2x	Condone “inscribed angle theorem” and “central angle theorem” For 180 – x condone $\frac{360-2x}{2}$ Do not accept working back from (b)(ii) unless whole part is complete and correct
		(ii)	Opposite angles [in a] cyclic quadrilateral [sum to] 180°	1		

Question		Answer	Mark	Part marks and Guidance	
18	(a)	$[1^3 + 1^2 - 5] = -3$ $[2^3 + 2^2 - 5] = 7$ Sign change [so solution between $x = 1$ and $x = 2$] or $-3 < 0 < 7$	M1 M1 A1	Must indicate their input and output Dep. on at least M1 and different signs <u>Alternative method 1</u> for $x^3 + x^2 = 5$ M2 for $1^3 + 1^2 = 2$ and $2^3 + 2^2 = 12$ or M1 for $1^3 + 1^2 = 2$ or $2^3 + 2^2 = 12$ may be implied by 2 or 12 and A1 for e.g. $2 < 5 < 12$ dep. on at least M1 and 5 lies inbetween <i>their</i> two values <u>Alternative method 2</u> SC3 for using an iterative equation that converges to a value between 1.35 and 1.45 and concluding statement such as $1 < 1.35$ to $1.45 < 2$ or SC2 for using an iterative equation that converges to a value between 1.35 and 1.45	Accept other values of x used between 1 and 2 (see table in part (b)). For full marks, the two values need to produce a sign change. Acceptable answers for third mark are $x = 1$ gives answer < 0 and $x = 2$ gives answer > 0 Note: so answer lies between 1 and 2 is not sufficient on its own or answer is in the middle is insufficient If within part (a) a candidate refers to their working in part (b) you must award the marks for this method

Question		Answer	Mark	Part marks and Guidance																																																																	
18	(b)	Two correct evaluations in the range $1.35 \leq \text{values} \leq 1.49$, one which gives a positive value and the other giving a negative value 1.4	M3 A1	M2 for two correct evaluations $1 < \text{values} < 2$, one which gives a positive value and the other giving a negative value or M1 for one correct evaluation between $1 < \text{value} < 2$ Dependent on achieving at least M2 <u>Alternative method 1</u> See appendix for values of $x^3 + x^2$. <u>Alternative method 2</u> M1 rearranges to a correct iterative formula (converging or diverging) M1 attempts first iteration (either substitution seen or found to at least 2dp rot) M1 continues iteration to reach x in the range 1.35 to 1.45 A1 for 1.4 Dep. on M2 OR If 0 scored SC1 for 1.4 with no worthwhile working	figures may be rot to at least 2 s.f. <table><tr><th>x</th><th>x^3+x^2-5</th><th>x</th><th>x^3+x^2-5</th></tr><tr><td>1.1</td><td>-2.459</td><td>1.35</td><td>-0.71712</td></tr><tr><td>1.2</td><td>-1.832</td><td>1.36</td><td>-0.63494</td></tr><tr><td>1.3</td><td>-1.113</td><td>1.37</td><td>-0.55175</td></tr><tr><td>1.4</td><td>-0.296</td><td>1.38</td><td>-0.46753</td></tr><tr><td>1.5</td><td>0.625</td><td>1.39</td><td>-0.38228</td></tr><tr><td>1.6</td><td>1.656</td><td>1.40</td><td>-0.29600</td></tr><tr><td>1.7</td><td>2.803</td><td>1.41</td><td>-0.20868</td></tr><tr><td>1.8</td><td>4.072</td><td>1.42</td><td>-0.12031</td></tr><tr><td>1.9</td><td>5.469</td><td>1.43</td><td>-0.03089</td></tr><tr><td></td><td></td><td>1.44</td><td>0.05958</td></tr><tr><td></td><td></td><td>1.45</td><td>0.15113</td></tr><tr><td></td><td></td><td>1.46</td><td>0.24374</td></tr><tr><td></td><td></td><td>1.47</td><td>0.33742</td></tr><tr><td></td><td></td><td>1.48</td><td>0.43219</td></tr><tr><td></td><td></td><td>1.49</td><td>0.52805</td></tr></table> 	x	x^3+x^2-5	x	x^3+x^2-5	1.1	-2.459	1.35	-0.71712	1.2	-1.832	1.36	-0.63494	1.3	-1.113	1.37	-0.55175	1.4	-0.296	1.38	-0.46753	1.5	0.625	1.39	-0.38228	1.6	1.656	1.40	-0.29600	1.7	2.803	1.41	-0.20868	1.8	4.072	1.42	-0.12031	1.9	5.469	1.43	-0.03089			1.44	0.05958			1.45	0.15113			1.46	0.24374			1.47	0.33742			1.48	0.43219			1.49	0.52805
x	x^3+x^2-5	x	x^3+x^2-5																																																																		
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Question			Answer	Mark	Part Marks and Guidance	
19			16.5 with correct working	5	M1 for 11.55×20 implied by 231 AND M2 for $\frac{1}{2} (20 + (15 - 7)) \times v$ implied by $14v$ or $\frac{28v}{2}$ or M1 for an attempt at area e.g. one of the three areas correct e.g. $\frac{1}{2} \times 7 \times v$ M1 for <i>their</i> $231 \div \text{their } 14$ oe If 0 or M1 scored, instead award SC2 for answer 16.5 with no or insufficient working	“Correct working” requires evidence of at least M1 AND M2 Condone letters other than v and working could be on the diagram. in parts $\frac{1}{2} \times 7 \times v + (15 - 7) \times v + \frac{1}{2} \times (20 - 15) \times v$ For M2 allow a proportionality argument e.g. $\frac{1}{2} \times 7 \text{ mins} + (15 - 7) \text{ mins} + \frac{1}{2} \times (20 - 15) \text{ mins}$ [= 14 mins at v m/min] <i>their</i> 231 is any number derived from 11.55 and implied by 0.825 and <i>their</i> 14 has got to be an attempt at the whole ‘area’ implied by e.g 20 condone the use of trials, we must see one at 16.5, award M2 for a trial at 16.5 and M1 for any other positive trial (see appendix)
20	(a)		[cos BAC =] $\frac{10.6^2 + 12.5^2 - 8.2^2}{2 \times 10.6 \times 12.5}$ oe or better 40.54...	M2 A1	M1 for $8.2^2 = 10.6^2 + 12.5^2 - 2 \times 10.6 \times 12.5 \times \cos[.]$ oe and M1dep for $0.7598\dots$ or $265 \cos[.] = 201.37$ Dep. on at least M1 scored If 0 scored award SC1 for 40.54...	Do not reward work from use of 40.5°. M2 implied by $\frac{201.37}{265}$ oe and accept 67.24 for 8.2^2 etc Dep. on previous M1 For M2 and M1 accept alternative methods which must be correct and complete.
	(b)		43.02 to 43.07 or 43[.0] or 43.1	2	M1 for $\frac{1}{2} \times 10.6 \times 12.5 \times \sin 40.5\dots$	For M1 accept alternative methods which must be correct and complete e.g using a different angle

APPENDIX

Question 4

In trials they must have a figure that is accurate to 3 figures. Some are using compound interest so they will get

0	4500.00
1	4837.50
2	5200.31
3	5590.34
4	6009.61
5	6460.33
6	6944.86
7	7465.72
8	8025.65
9	8627.57
10	9274.64
11	9970.24
12	10718.01
13	11521.86
14	12386.00
15	13314.95
16	14313.57
17	15387.09
18	16541.12

- (b) Note : Neat solution: $\log(3) \div \log(1.075) = 15.19....$ oe hence 16 but it is not in our specification. If you see it award **M2**.
OR $1.075^t = 3$ scores **M1** and a further trial will score **M1**

A different method is :

$$13500 = 4500\left(1 + \frac{7.5}{100} \times t\right)$$

$$3 = 1 + \frac{7.5}{100} \times t$$

$$2 = \frac{7.5}{100} \times t$$

$$200 = 7.5t$$

$$t = \frac{200}{7.5}$$

$$t = 26.6666\ldots$$

Question 4(b)

Question 5(c)

Other trials, condone rot :

$$\frac{\text{their } 14700}{2^3} \text{ oe and } 1837[.5\ldots] \text{ or } 30[.6\ldots]$$

$$\frac{\text{their } 14700}{3^3} \text{ oe and } 544[.4\ldots] \text{ or } 9[.07\ldots]$$

$$\frac{\text{their } 14700}{6^3} \text{ oe and } 68[.05\ldots] \text{ or } 1[.1\ldots]$$

Or they might try to see how far they go at each warp speed in 2 minutes (rot at least 2 figures):

$$\text{Warp 2 : } 2^3 \times 3 \times 10^5 \times 120 = 288\,000\,000$$

$$\text{Warp 3 : } 3^3 \times 3 \times 10^5 \times 120 = 972\,000\,000$$

$$\text{Warp 4 : } 4^3 \times 3 \times 10^5 \times 120 = 2\,304\,000\,000$$

$$\text{Neptune } 4\,410\,000\,000$$

$$\text{Warp 5 : } 5^3 \times 3 \times 10^5 \times 120 = 4\,500\,000\,000$$

$$\text{Warp 6 : } 6^3 \times 3 \times 10^5 \times 120 = 7\,776\,000\,000$$

Mark as trials so M1 each correct trial.

Question 9(b)Alternative methods

Cosine rule : $[\cos \dots] = \frac{16^2 + 30^2 - 34^2}{2 \times 16 \times 30} = 0$ hence angle $\dots = 90$

M1 for correct cos rule statement for angle, **M1** for 0 OR $\cos^{-1}$ or arc cos with 90 and **A1** for “Yes” (**A1** dep on **M2**)

Algebra :

M1 for both $(x + 5)^2 + (2x + 8)^2 = x^2 + 10x + 25 + 4x^2 + 32x + 64 = 5x^2 + 42x + 89$ and $(3x + 1)^2 = 9x^2 + 6x + 1$ [leading to $4x^2 - 36x - 88 = 0$ and $(x - 11)(4x + 8)]$

and **M1** for substituting $x = 11$ into $5x^2 + 42x + 89$ and $9x^2 + 6x + 1$ and getting 1156 or for accepting $x = 11$ and rejecting $x = -2$ for correct reason “Yes”

Trigonometry(not cos rule) :

The use of sin, cos or tan to find the other two acute angles will not lead to an exact angle of 90° therefore award just **M1** for two correct statements, one about each angle e.g $\sin[\dots] = \frac{16}{34}$ and $\sin[\dots] = \frac{30}{34}$ and **M1** for two angles to at least 2 dp e.g. 28.07[2...] and 61.92[7...] or 61.93 an award max. of **M2** because this method will not show exactly that it is a right-angle. The one exception is $\sin^{-1}(\frac{16}{34}) + \sin^{-1}(\frac{30}{34})$ etc which, if seen, could score **3** marks.

Exemplar responses for Q13(a)

Response	Mark
Swop brackets in the numerator	1
They multiplied the 2 by $(x - 1)$ it should have been $(x + 4)$	1
The brackets have been multiplied by the wrong number it should be $2(x + 4)$	1
The $(x - 1)$ and $(x + 4)$ should be the other way round	1
The numerators have been multiplied by the wrong/own denominators	1
(Correct answer is given)	1
They have multiplied the wrong numerator by the wrong denominator	1
It should be this $\frac{2(x+4)+3(x-1)}{(x-1)(x+4)}$ (single fraction only)	1
They multiply the numerator and the denominator rather than the opposite denominator	1(BOD)
They did not cross multiply	0
They have multiplied their denominators by their numerators instead of adding them	0

Question 14Using tree diagrams :**M4** for method A: $1 - \frac{12}{14} \times \frac{9}{12} \times \frac{11}{15}$ oee.g. method B : $\frac{2}{14} \times \frac{3}{12} \times \frac{4}{15} + \frac{2}{14} \times \frac{3}{12} \times \frac{11}{15} + \frac{2}{14} \times \frac{9}{12} \times \frac{4}{15} + \frac{12}{14} \times \frac{3}{12} \times \frac{4}{15} + \frac{2}{14} \times \frac{9}{12} \times \frac{11}{15} + \frac{12}{14} \times \frac{9}{12} \times \frac{11}{15} + \frac{12}{14} \times \frac{3}{12} \times \frac{11}{15} + \frac{12}{14} \times \frac{4}{15} \times \frac{11}{15}$ **M3** for $\frac{12}{14} \times \frac{9}{12} \times \frac{11}{15}$ or method B with at least five relevant branches correct

or

M2 for method B with at least four relevant branches correct

or

M1 for method B with at least one relevant branch correctMisreads

Some candidates read this as 16, 15 and 19 subjects. Treat this as a misread (MR) so the mark scheme for them will be (max. of 4 marks):

M4 for $1 - \frac{14}{16} \times \frac{12}{15} \times \frac{15}{19}$ oe implied by answer $\frac{2040}{4560} = \frac{102}{228} = \frac{51}{114} = \frac{17}{38}$ or 0.447368.....etc rot to at least 3 s.f.

OR

M3 for $\frac{14}{16} \times \frac{12}{15} \times \frac{15}{19}$ oe implied by $\frac{2520}{4560} = \frac{126}{228} = \frac{63}{114} = \frac{21}{38}$ or 0.55263...etc rot to at least 3 s.f.

OR

M1 for [total choices=] $16 \times 15 \times 19$ implied by 4560

AND

M3 for $2 \times 15 \times 19 + 14 \times 3 \times 19 + 14 \times 12 \times 4$ or $570 + 798 + 672$ implied by 2040or **M2** for $2 \times 15 \times 19 + 16 \times 3 \times 19 + 16 \times 15 \times 4$ or $570 + 912 + 960$ implied by 2442or **M1** for this expression with one term correct or at least 5 numbers correct

OR

M1 for [total choices=] $16 \times 15 \times 19$ implied by 4560**M2** for [choices no langs =] $(16 - 2) \times (15 - 3) \times (19 - 4)$ implied by 2520 or **M1** for this expression with one error and**M1** for *their* 4560 – *their* 2520Alternative equivalent methods**M4** for fully correct method leading to *their* 4560 and *their* 2040

or

M1 for [total choices=] $16 \times 15 \times 19$ implied by 4560

and

M3 for $(2 \times 3 \times 4) + (14 \times 3 \times 4 + 2 \times 12 \times 4 + 2 \times 3 \times 15) + (2 \times 12 \times 15 + 14 \times 3 \times 15 + 14 \times 12 \times 4)$

or $(24) + (168 + 96 + 90) + (360 + 630 + 672)$ or 2040

or

M2 for two of the bracketed terms

or

M1 for one of the bracketed terms or any three of the individual terms correct

Exemplar responses for Q17(a)(i)

Response	Mark
Angles in the alternate segment are equal	1
Angles on a tangent which meet a triangle in a circle equal the alternate angle in the triangle	0

Exemplar responses for Q17(a)(ii)

Response	Mark
Angle between tangent and radius is 90	1
Radius meets tangent at 90	1
Tangent is perpendicular to radius	1
Tangent and diameter form a perpendicular bisector	1
Tangent subtends a 90 angle at the radius	1
Angles on a tangent on a radius are 90	1(BOD)
Line from centre to tangent at the point where the tangent touches the circle is 90°	1(BOD)
Radius to line SPT will form a right angle	0
Angle between tangent and circle is 90	0
Angle between tangent and a straight line is 90	0
Angles at a right angle add up to 90	0
Right angle between centre and tangent	0
Angles on a tangent add up to 90	0
Tangent meets the chord at 90	0

Exemplar responses for Q17(b)(i)

Response	Mark
Angles at centre is twice angle at circumference	1
Angles from the same chord are double at the centre than at the circumference	1
Angles on the perimeter are half the centre angle	1
Angle at the centre of a cyclic quadrilateral is twice the angle at the opposite point	0
Angles at centre is twice angle at the edge	0

Exemplar responses for Q17(b)(ii)

Response	Mark
Opposite angles in a cyclic quadrilateral add up to 180/supplementary	1
Opposite angles in a cyclic quadrilateral = 180	1(BOD)
Opposite angles in a quadrilateral add up to 180	0
Angles in a [cyclic] quadrilateral add up to 360	0
It is a cyclic quadrilateral	0
Cyclic quadrilateral theorem	0

Question 18(b)Table for $x^3 + x^2$

x	x^3+x^2	x	x^3+x^2
1.1	2.541	1.35	4.28288
1.2	3.168	1.36	4.36506
1.3	3.887	1.37	4.44825
1.4	4.704	1.38	4.53247
1.5	5.625	1.39	4.61772
1.6	6.656	1.40	4.70400
1.7	7.803	1.41	4.79132
1.8	9.072	1.42	4.87969
1.9	10.469	1.43	4.96911
		1.44	5.05958
		1.45	5.15113
		1.46	5.24374
		1.47	5.33742
		1.48	5.43219
		1.49	5.52805

Trials are for values of v and evaluate the area $\div 20$ so here are some :

v	average speed
1	0.7
2	1.4
3	2.1
4	2.8
5	3.5
6	4.2
7	4.9
8	5.6
9	6.3
10	7
11	7.7
12	8.4
13	9.1
14	9.8
15	10.5
16	11.2
17	11.9
18	12.6
19	13.3
20	14
16.5	11.55

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