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Mark Scheme (Results)

Summer 2023

Pearson Edexcel International GCSE
In Mathematics B (4MB1)
Paper 01R

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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
  - awrt – answer which rounds to
  - eeoo – 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.

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- **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.

  If a candidate misreads a number from the question: eg. Uses 252 instead of 255; method marks may be awarded provided the question has not been simplified. Examiners should send any instance of a suspected misread to review.

  If there is a choice of methods shown, mark the method that leads to the answer on the answer line; where no answer is given on the answer line, award the lowest mark from the methods shown.

  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.

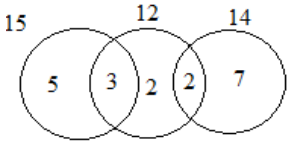
  It is not appropriate to ignore subsequent work when the additional work essentially makes the answer incorrect eg algebra.

  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 to another.

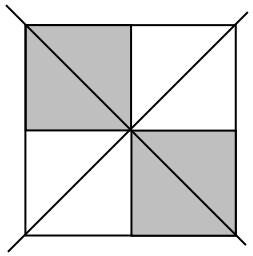
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<table>
<tr><th colspan="2">Question</th><th>Working</th><th>Answer</th><th>Mark</th><th>Notes</th></tr>
<tr><td>1</td><td></td><td>Two from
$12 = 2^2 \times 3$(or $12 = 4 \times 3$), $14 = 2 \times 7$ or $15 = 3 \times 5$
or
<table><tr><td></td><td>12</td><td>14</td><td>15</td></tr><tr><td>2</td><td>6</td><td>7</td><td></td></tr><tr><td>2</td><td>3</td><td></td><td></td></tr><tr><td>3</td><td>1</td><td></td><td>5</td></tr><tr><td>5</td><td></td><td></td><td>1</td></tr><tr><td>7</td><td></td><td>1</td><td></td></tr></table>or
</td><td></td><td>2</td><td>M1 for correct prime factors for 12 and one of 14 or 15. We are accepting $12 = 4 \times 3$ (may be seen on factor tree)
or a list of at least 5 multiples including 420 for 12 and one of 14 or 15
or
Use of table method for 12 and one of 14 or 15. Do not need all the rows but the final number in the columns should be prime eg
<table><tr><td></td><td>12</td><td>14</td><td>15</td></tr><tr><td>3</td><td>4</td><td></td><td>5</td></tr><tr><td>2</td><td>2</td><td>7</td><td></td></tr></table>or Venn diagram for 12 and one of 14 or 15
</td></tr>
<tr><td></td><td></td><td>Working required</td><td>420</td><td></td><td>A1oe ISW eg $2^2 \times 3 \times 5 \times 7$ or $2 \times 2 \times 3 \times 5 \times 7$</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Total 2 marks</td></tr>
</table>

<table>
<tr><th colspan="2">Question</th><th>Working</th><th>Answer</th><th>Mark</th><th>Notes</th></tr>
<tr><td>2</td><td></td><td>$\frac{6}{5} \times \frac{7}{12}$</td><td></td><td>2</td><td>M1 Correct multiplication of an improper fraction.
ALT $[1\times]\frac{7}{12} + \frac{1}{5} \times \frac{7}{12}$</td></tr>
<tr><td></td><td></td><td>Working required</td><td>$\frac{\cancel{6}^{1}}{5} \times \frac{7}{\cancel{12}_{2}} = \frac{7}{10}$
or $\frac{1}{5} \times \frac{7}{2} = \frac{7}{10}$
or $\frac{42}{60} = \frac{7}{10}$</td><td></td><td>A1 cao dep on M1 scored and must see one of cancelling fractions prior to multiplication or a correct uncancelled single fraction eg
$\frac{\cancel{6}}{5} \times \frac{7}{\cancel{12}_{2}} = \frac{7}{10}$ or $\frac{7}{5 \times 2} = \frac{7}{10}$ for ALT method allow
$\frac{35}{60} + \frac{7}{60} = \frac{7}{10}$ ISW</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Total 2 marks</td></tr>
</table>

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Question		Working	Answer	Mark	Notes
3	**(a)**		$8x^2$	1	B1 cao Do not ISW
	(b)		$6y^5$	1	B1 cao Do not ISW
					Total 2 marks

Question		Working	Answer	Mark	Notes
4	**(a)**			1	B1 cao two lines(allow dashed or dotted) joining opposite corners drawn on diagram. No extra incorrect lines must be drawn unless clearly crossed out
	(b)		3	1	B1 cao must be a single number
					Total 2 marks

Question		Working	Answer	Mark	Notes
5	**(a)**		38, 45	1	B1 Ignore extra terms. Accept 45, 38
	(b)		80	1	B1
					Total 2 marks

Question		Working	Answer	Mark	Notes
6		$(x-7)(x+2)$		2	M1 Factorised form must expand to give 2 terms of the quadratic. eg $(x-2)(x+7)=x^2+5x-14$
			$(x-7)(x+2)$ or $(x+2)(x-7)$		A1 Do not ISW This must be the answer on the answer line or if no answer on the answer line their final answer which may be shown for example by circling or underlining.
					Total 2 marks

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Question		Working	Answer	Mark	Notes
7	**(a)**		5	1	B1 cao no other numbers must be given
	(b)	2,3,5,5,5,7,8,9,10,11		2	M1 place numbers in order (at least 6 with none missing) or sight of $\frac{5+7}{2}$ May be seen in part (a) or in question. Allow with signs eg + between
		Correct answer scores full marks (*unless from obvious incorrect working*)	6		A1 cao
					Total 3 marks

Question		Working	Answer	Mark	Notes
8		$360 \div 24$ [= 15] oe or $24 \times 180 - 360$ [= 3960] or $(2 \times 24 - 4) \times 90$ [= 3960] or $(24-2) \times 180 [= 3960]$ oe		3	M1 for a correct method to find an exterior angle or total of the interior angles. Implied by seeing 15 or 3960 or 165
		$180 - "15"$ or $\frac{"3960"}{24}$ oe			M1 dep on M1 correct method to find one interior angle. This may be implied by seeing 165
		Correct answer scores full marks (*unless from obvious incorrect working*)	165		A1 cao do **not** ISW This must be the answer on the answer line or if no answer on the answer line their final answer which may be shown for example by circling or underlining.
					Total 3 marks

Question		Working	Answer	Mark	Notes
9		$T^2 = \frac{2r}{g}$ or $T^2 g = 2r$ or $\sqrt{g} = \frac{\sqrt{2r}}{T}$		2	M1 correctly remove square root sign or make root g the subject.
		Correct answer scores full marks (*unless from obvious incorrect working*)	$g = \frac{2r}{T^2}$		A1 cao Condone missing "$g =$" on answer line if fully correct expression seen in working. Allow $g = \left(\frac{\sqrt{2r}}{T}\right)^2$ or $g = 2rT^{-2}$
					Total 2 marks

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Question		Working	Answer	Mark	Notes
10		$\left[x^2(3x+1)=\right]3x^3+x^2$		3	M1 correct expansion of brackets before differentiating. eg $3x^3+1x^2$
		$\left[\frac{dy}{dx}=\right]20x^3+9x^2+2x$			M1 at least one correct term
		Correct answer scores full marks (*unless from obvious incorrect working*)	$20x^3+9x^2+2x$		A1 oe eg $20x^3+9x^2+2x^1$
					Total 3 marks

Question		Working	Answer	Mark	Notes
11		$\frac{120}{360}\pi r^2=48\pi\left[\Rightarrow r=12\right]$		3	M1 for forming an equation involving the radius using the given area. eg $\frac{1}{3}\pi r^2=48\pi$ or $\frac{1}{3}r^2=48$
		$\left[\text{Arc length}=\right]\frac{120}{360}\times 2\pi\times\text{"12"}\left[=8\pi\right]$			M1 Find an expression for the arc length *ABC*, ft their radius. Allow awrt 25.1 May be seen as part of working eg $\frac{1}{3}\times 2\times\pi\times\text{"12"}+2\times\text{"12"}$ where 12 is their radius
		Correct answer scores full marks (*unless from obvious incorrect working*)	$8\pi+24$		A1 oe eg $8(3+\pi)$ **allow** awrt 15.6π (need not be simplified) eg $\frac{120}{360}\times 2\pi\times 12+12+12$ **ISW**
					Total 3 marks

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Question		Working	Answer	Mark	Notes
12		eg $2(x+2)+3(x-3)=60$ or $4(x+2)+6(x-3)=120$ or $\frac{2(x+2)}{12}+\frac{3(x-3)}{12}[=5]$ or $\frac{4(x+2)}{24}+\frac{6(x-3)}{24}[=5]$ or $\frac{x}{6}+\frac{1}{3}+\frac{x}{4}-\frac{3}{4}[=5]$ oe		3	M1 Clear intention to multiply all terms by a multiple of 12 If correct expression with brackets in is not seen allow a maximum of one incorrect term if the brackets are expanded **or** express the LHS as two fractions over a multiple of 12 or as a single fraction with a denominator which is a multiple of 12 eg $\frac{2(x+2)+3(x-3)}{12}=5$ If correct expression with brackets in is not seen allow a maximum of one incorrect term if the brackets are expanded No need for = 5 **or** expressing the LHS as 4 fractions. No need for = 5
		$5x=60-4+9$ or $10x=120-8+18$ $\frac{5x}{12}=5-\frac{1}{3}+\frac{3}{4}$ oe			M1 indep for a correct equation with the terms in x combined eg $\frac{5x-5}{12}=5$ or $5x=65$ or $\frac{5}{12}x=\frac{65}{12}$
		Working required	x = 13		A1 dependent on at least one M mark being awarded
					Total 3 marks

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Question		Working	Answer	Mark	Notes
13			$p = 15$	3	B1 cao
		$-5-2p$ or $-5-2\times"15"$ **or** $-5\mathbf{b}-2p\mathbf{b}=q\mathbf{b}$ **or** $2p+q=-5$ oe			M1 compare coefficients of **b** Allow one sign error in $-5-2p$ eg $-5+2p$ or allow ft of their p value and one sign error ie $5-2\times"15"$ or $-5+2\times"15"$ or $-5\mathbf{b}+2p\mathbf{b}=q\mathbf{b}$ or $5\mathbf{b}-2p\mathbf{b}=q\mathbf{b}$ or $-5\mathbf{b}-2p\mathbf{b}=-q\mathbf{b}$ oe Allow p = "15" subst
		Correct answer scores full marks (*unless from obvious incorrect working*)	$q = -35$		A1
					SC if p and q are correct but not written on the answer line, at least one must be labelled in their working to award full marks. If both values are correct but neither labelled or they are on the wrong answer lines they get 2/3 marks
					Total 3 marks

Question		Working	Answer	Mark	Notes
14	**(a)**		$0.07y$	1	B1 cao oe $\left(\frac{7}{100}y\right)$
	(b)	number bottle $B = 0.12y$ increase = $0.05y$ or 5%		1	M1 for sight of $0.12y$ or $\frac{12}{100}y$ or $0.05y$ or $\frac{5}{100}y$ or 5% $12\%-7\%$ or $12\%y-7\%y$
		$0.12y-"0.07y"=60$ or $0.05y=60$ or $60\div5\times100$ or 5% = 60 or $5\%y=60$ or $12\%-7\%=60$ or $12\%y-7\%y=60$		1	M1 oe follow through their result from part (a)
			1200	1	A1 cao Must come from a correct equation Correct answer with no working gains full marks
					Total 4 marks

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Question		Working		Answer	Mark	Notes
15		$20x + 7y = 4$ $\underline{20x - 20y = -50}$ $27y = 54$	$40x + 14y = 8$ $\underline{14x - 14y = -35}$ $54x = -27$		4	M1 eliminating either x or y (equate coefficient and use correct operation) Allow 1 error either one incorrect term in equating the coefficients eg –4 instead of 8 **or** one error when eliminating either x or y **or** substitute for x or y to form an equation in only one variable. Allow 1 sign slip only
		or $20\left(\frac{2y-5}{2}\right)+7y=4$ or $20x+7\left(\frac{2x+5}{2}\right)=4$ or $2\left(\frac{4-7y}{20}\right)-2y=-5$ or $2x-2\left(\frac{4-20x}{7}\right)=-5$ oe				
				$x = -\frac{1}{2}$ or $y = 2$		A1 dep on M1
		$20 \times "-\frac{1}{2}" + 7y = 4$ or $20x + 7 \times "2" = 4$ or $2 \times "-\frac{1}{2}" - 2y = -5$ or $2x - 2 \times "2" = -5$ oe				M1dep on previous method mark For repeating first method (allow one sign error) or substitute their x or y into a correct equation
		Working required		$x = -\frac{1}{2}$ and $y = 2$		A1 dep on M1 M1
						Total 4 marks

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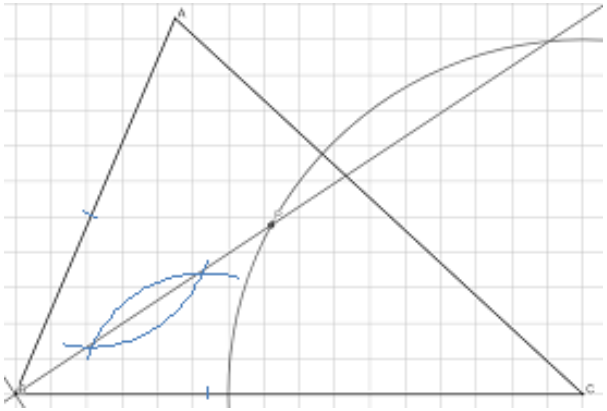
Question		Working	Answer	Mark	Notes
16		Let t = total number of students and c = number of students who travel by car Allow any letters for t and c			
		$[t =]\frac{208}{0.104}$ **or** $[t =]718+0.896t-510$ **or** $\frac{208}{208+510+c}=0.104$ **or** $[c =]\frac{208}{0.104}$ – 208 – 510 **or** $[c =]0.896\times\frac{208}{0.104}-510$ **or** $[c =]\frac{208}{0.104}-718$ **or** $0.896\times(718+c)=510+c$ **or** $\frac{510}{208}\times 10.4$		4	M1 correct method to find t or c **or** correct equation (any form) in terms of t or c **or** correct method to find the % that represents 510 students May be implied by seeing 25.5 or 1282 or 2000
		[t =] 2000 or [c =] 1282 or 25.5			A1 correct value for t **or** c **or** percentage
		$\frac{"1282"}{2000}\times 100$ or $\frac{"1282"}{"1282"+208+510}\times 100$ or $\frac{1282}{"2000"}\times 100$ or 100 – 10.4 – "25.5" or 100 – 10.4 – $\frac{510}{"2000"}\times 100$			M1 For an attempt at a correct method to find the percentage. Allow $\frac{n}{2000}\times 100$ **or** $\frac{n}{n+718}\times 100$ where $n<2000$ **or** $\frac{1282}{m}\times 100$ where $m>1282$ **or** $\frac{r-718}{r}\times 100$ where $r>718$ **or** $100 - 10.4 - \frac{510}{"p"}\times 100$ where $p>510$ or $100-10.4-q$ where $20<q<30$ may be implied by 64.1 Condone rounded figures.
		Correct answer scores full marks (*unless from obvious incorrect working*)	64.1		A1 cao Allow 64 Do **not** ISW This must be the answer on the answer line or if no answer on the answer line their final answer which may be shown for example by circling or underlining.
					Total 4 marks

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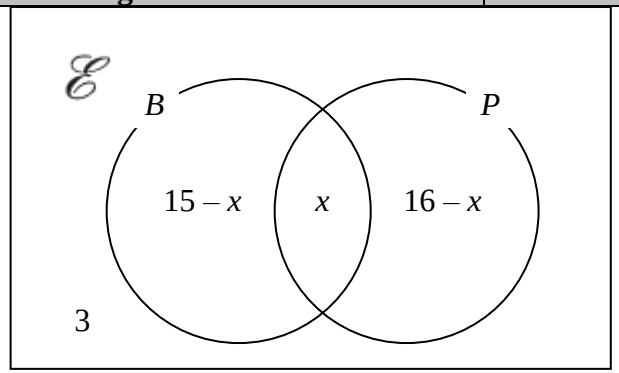
Question		Working	Answer	Mark	Notes	
17	**(a)**	eg $\frac{16.1}{48}$ [= 0.335] or $\frac{1610}{48}$ or $\frac{16.1}{12/25}$ or $\frac{x}{16.1}=\frac{1}{48}$ or $\frac{x}{1610}=\frac{1}{48}$ or $\frac{x}{16.1}=\frac{25}{12}$ oe		2	M1 correct method or equation to find length in m or cm. Implied by 0.335	
		Correct answer scores full marks (unless from obvious incorrect working)	33.5		A1 awrt 33.5	
	(b)	48^3 [= 110 592] or 0.48^3 [= 0.110 592]		3	M1 Consideration of cube of scale factor seen. eg $\left(\frac{16.1}{(a)}\right)^3$ or $\left(\frac{1610}{(a)}\right)^3$ or $\frac{995}{V}=\frac{(a)^3}{1610^3}$	M2 for $\frac{995}{100^3}\times 48^3$
		$\frac{995}{100^3}$ [= 0.000995] or [995×"110 592"]÷100^3 0.48^3 [= 0.110 592]			M1 for unit conversion by dividing by 100^3	
		Correct answer scores full marks (unless from obvious incorrect working)	110		A1 awrt 110	
						Total 5 marks

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Question		Working	Answer	Mark	Notes
18			angle bisector constructed accurately	4	B2 for a line within the limits and a pair of suitable arcs. One arc centred on a point *D* on *BC* and one centred on the point *E* on *AB* such that *BE* = *BD* **or** 2 arcs centred at *B* with the cross to find the middle. (B1 for a line within the limits (Can be any length - does not need to cross *AC* but should remain within the guidelines if it were to be extended) **or** a pair of suitable arcs
			Accurate arc drawn from *C*		B1 for an arc within the limits indicated. It does not need to cross *AC* or *BC*
			P correctly labelled		B1ft dependent on at least B1 for the angle bisector and B1 for the arc. Must clearly identify it is the point.
					Total 4 marks



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Question		Working	Answer	Mark	Notes
19	**(a)**			2	B2 $15-x$, $16-x$ and 3 in correct regions on Venn diagram B1 2 of $15-x$, $16-x$ and 3 in correct regions or all 3 values correct, one in correct region. Allow 11 for $15 - x$ and 12 for $16 - x$ **SC** B1 x is replaced with a number $x \neq 4$ and they use this incorrect value, to find $15 - x$ and $16 - x$
	(b)	$3+"15-x"+x+"16\ -x"=\ 30$ oe		2	M1 Correct equation formed, in x, ft their values for $B' \cap P$ and $B \cap P'$ May see only one of these values used eg $3+15+"16\ -x"=30$
		Correct answer scores full marks (*unless from obvious incorrect working*)	4		A1 cao
	(c)		$\frac{11}{30}$	1	B1 ft follow through their answer to part (b), if 0 < part(b) < 15 only ie $\frac{15-"their(b)"}{30}$ with numerator a single number. Allow awrt 0.367
					Total 5 marks

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Question	Working	Answer	Mark	Notes	
20	**Throughout this question condone mis-labelling. eg if they label the volume of the cone as being the hemisphere**				
	$\frac{2}{3}\pi\times10^3\left[=\frac{2000\pi}{3}=2094.395...\right]$		5	M1 Allow for $\frac{4}{3}\pi\times10^3\left[=\frac{4000\pi}{3}=4188.790\ldots\right]$ Allow sight of 4189, awrt 4190 or awrt 2090 or exact fraction May be embedded within other working. Ignore labelling	
	$\frac{1}{3}\pi\times10^2x\left[=\frac{100\pi}{3}x=104.719\ldots x\right]$			M1 or $\frac{1}{3}\pi10^2(h-10)$ Allow sight of 104, awrt 105 or exact fraction. Allow any letter for x. (Condone h for x) Ignore labelling	
	$\frac{1}{3}\pi\times10^2x=\frac{3}{4}\times\left(\frac{2}{3}\pi\times10^3\right)$ or $"\frac{100\pi}{3}"x=\frac{3}{4}\times\left("\frac{2000\pi}{3}"\right)$ or $\frac{\frac{1}{3}\pi\times10^2x}{\frac{2}{3}\pi\times10^3}=\frac{3}{4}$ oe			M1 using $V_{cone}=\frac{3}{4}\times V_{hemisphere}$ oe with at least one of the volumes correct Allow $h-10$ or any letter for x (condone h) You may ft their values eg $"2094"x=\frac{3}{4}\times"105"$ **NB** x = 15 **NB useful number** $\frac{3}{4}\times\left(\frac{2}{3}\pi\times10^3\right)=1570.795...$	M2 for $\frac{\frac{1}{3}\pi10^2(h-10)}{\frac{2}{3}\pi\times10^3}=\frac{3}{4}$ or $\frac{\frac{100\pi}{3}(h-10)}{\frac{2000\pi}{3}}=\frac{3}{4}$ oe
	"15"+10			M1 For using $h-10$ anywhere **OR** if all 3 previous method marks awarded allow for "their x" + 10	
	Correct answer scores full marks (*unless from obvious incorrect working*)	25		A1 awrt 25	
	SC r = 10 not substituted could get **M1 M1 M0 M1 A0** 1st M1 for $\frac{\frac{1}{3}\pi r^2x}{\frac{2}{3}\pi r^3x}=\frac{3}{4}$ (allow sphere) 2nd M1 $\frac{x}{2\times r}=\frac{3}{4}$ or $\frac{x}{4\times r}=\frac{3}{4}$ 4th M1 for using $h-10$ or adding 10 A0				
					Total 5 marks

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Question		Working	Answer	Mark	Notes	
21	**(a)**	$[AG^2 =]12^2 + 4^2 (=160)$ or $[AC^2 =]12^2 + 3^2 (=153)$ or $[AE^2 =]4^2 + 3^2 (=25)$		3	M1 A correct method to find AG^2, AC^2, AE^2, AG, AC or AE. Allow use of trig but must be fully correct method eg $[\angle GAB =]\tan^{-1}\left(\frac{4}{12}\right)[=18.434....]$ **and** $[AG =]\frac{12}{\cos"18.434..."}$ Ignore incorrect labels labels	M2 for $[AF^2 =]3^2 + 12^2 + 4^2$
		$[AF^2 =]3^2 + "160"$ or $3^2 + \left("4\sqrt{10}"\right)^2$ $[AF^2 =]4^2 + "153"$ or $4^2 + \left("3\sqrt{17}"\right)^2$ $[AF^2 =]12^2 + "25"$ or $[AF^2 =]169$			M1 full method to find AF^2 For this mark allow values correct to 3sf. but condone truncation eg $4^2 + (\text{awrt } 12.3)^2$ or $3^2 + (\text{awrt } 12.64)^2$ Ignore incorrect labels **NB** $\sqrt{160} = 12.649...$ $\sqrt{153} = 12.369...$	
		Working required	13		A1dependedent on both method marks awarded. For a full method to find *AF* with no incorrect working seen and 13 stated Must see 169 or a correct expression for AF^2 with exact values used.	
	(b)	$\sin GAF = \frac{3}{"13"}$ or $\tan GAF = \frac{3}{"\sqrt{160}"}$ or $\cos GAF = \frac{"\sqrt{160}"}{"13"}$ oe		2	M1 A correct method to find $\angle GAF$ or trig ratio of $\angle GAF$ May ft values from part (a) including their *AF* if it is not 13 if it is clearly labelled or comes from a correct calculation Allow ($\tan AFG = \frac{\sqrt{160}}{3}$ **or** $\sin AFG = \frac{\sqrt{160}}{13}$ **or** $\cos AFG = \frac{3}{13}$) **and** $90 - \angle AFG$ Allow use of cosine or sine rule eg $3^2 = 160 + 13^2 - 2 \times \sqrt{160} \times 13 \cos GAF$	
	Correct answer scores full marks (*unless from obvious incorrect working*)		13.3		A1 awrt 13.3 Allow awrt 13.4	
						Total 5 marks

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Question		Working	Answer	Mark	Notes
22		$(-k)^3 + 4(-k)^2 - 20(-k) - (-k)[= 0]$ or $-k^3 + 4k^2 + 20k + k[= 0]$ oe		5	M1 substitutes $x = -k$ Allow 1 sign error if brackets removed or long division to obtain 2 correct terms $x^2 + (4 - k)x + (-20 - 4k + k^2)$ or two of 1 **or** $4 - k$ **or** $-20k - 4k + k^2$ attempt to expand $(x + k)(x^2 + gx + 1)$ with at least 4 out of 6 terms correct cubic is $x^3 + kx^2 + gx^2 + gkx + x + k$ oe
		$-k^3 + 4k^2 + 21k = 0$ or $-20 - 4k + k^2 = 1$ or $k + g = 4$ and $1 + kg = -20$ oe			A1 correct simplified 3 term cubic equation or a correct quadratic equation or both correct equations from comparing x^2 and x coefficients.
		(k) ($-k^2 + 4k + 21$) = 0 or $k^2 - 4k - 21 = 0$ oe			M1 dep on first M mark. Divide by or take k out as a common factor from a cubic in k to form a 3-term quadratic equation. An answer of 7 or –3 can imply this mark
		$(k)(-k + 7)(k + 3) = 0$ or $(k - 7)(k + 3) = 0$			M1dep on second M mark. Correct method for solving their 3-term quadratic – either by formula, completing the square or factorising. By factorising: brackets must expand to give 2 out of 3 correct terms By formula: correct substitution into fully correct formula (allow 1 sign error) By completing the square: must see $(k - 2)^2 \pm ...$ An answer of 7 or –3 can imply this mark
		Correct answer scores full marks (*unless from obvious incorrect working*)	7, –3		A1 cao (both) condone 0, 7, –3 but do not allow any other incorrect extras
					Total 5 marks

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Question		Working	Answer	Mark	Notes
23	**(a)**	$[ON^2 =]19.5^2 - 18^2$ or $19.5^2 = ON^2 + 18^2$ or $39^2 - 36^2$ or $[ON =]19.5\cos(67.3801\ldots)$ or $[ON =]19.5\sin(22.6198\ldots)$ oe		2	M1 use of Pythagoras **or** trig seen – allow angles given to at least 3sf Allow $XD = \sqrt{39^2 - 36^2}$ where *BX* is the diameter
		Working required	$\sqrt{19.5^2 - 18^2} = 7.5$		A1 allow $\sqrt{56.25} = 7.5$ or $19.5\cos(67.3801\ldots) = 7.5$ or $\frac{\sqrt{39^2 - 36^2}}{2}$ oe or $19.5\sin(22.6198\ldots) = 7.5$ or $ON^2 = 56.25 \Rightarrow ON = 7.5$ Allow angles given to 3sf
					NB verification using 7.5 is M0 A0
	(b)	$EN = 36 - 18 - 8[=10]$ **or** $EN = \frac{36}{2} - 8$ $AE \times EC = 8 \times 28$ **or** $AE \times EC = 224$ $\frac{AC}{2} + 7.5$ and $\frac{AC}{2} - 7.5$		4	M1 Find *EN* either labelled or comes from correct working may be seen on diagram **or** $AE \times EC = 224$ or $AC/2 + 7.5$ and $AC/2 - 7.5$ identified as *AB* and *BC* or used in a formula. Allow $x + 7.5$ and $x - 7.5$ may be implied by the 2nd M1
		$[AM^2 =]\ 19.5^2 - "10"^2 [= 280.25]$ or $\left(\frac{AC}{2} + 7.5\right)\left(\frac{AC}{2} - 7.5\right) = 8 \times 28$			M1 correct use of Pythagoras involving *AM* where *M* is the mid-point of *AC* NB $AM = \sqrt{280.25}[= 16.7406\ldots]$ ft their 10 if clearly labelled or comes from $36 - 18 - 8$ Correct use of intersecting chord theorem Allow $(x + 7.5)(x - 7.5) = 8 \times 28$
		$[AC] = 2 \times \sqrt{19.5^2 - "10"^2}$ or $[AC =]\frac{8 \times 28}{("16.7406..." + 7.5)} + ("16.7406..." + 7.5)$ $\left(\frac{AC}{2}\right)^2 = 224 + 7.5^2$ or			M1 dep on previous method marks awarded. For using $AC = 2 \times "\text{their } AM"$ ft their 10 if clearly labelled or comes from $36 - 18 - 8$ or their awrt 16.7 if clearly labelled or comes from $\sqrt{19.5^2 - "10"^2}$ find value for $(AC/2)^2$
		Correct answer scores full marks (*unless from obvious incorrect working*)	33.5		A1 awrt 33.5
					Total 6 marks

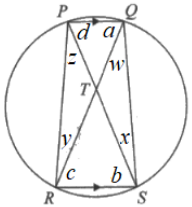
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Question		Working	Answer	Mark	Notes
24		1.95 or 2.05 seen		6	B1
		$215[\times 1]+362\times 2+181\times 3+$ $94\times 4+15\times 5[=1933]$			M1 Find total number of children, at least 4 correct products seen added (215 + 724 + 543 + 376 + 75) or 1933 seen
		$\frac{"1933"}{867+k}=1.95$ **or** $\frac{"1933"}{1.95}-867$ **or** $\frac{"1933"}{867+k}=2.05$ **or** $\frac{"1933"}{2.05}-867$ **oe**			M1 for $\frac{"1933"}{867+k}=b$ where $1.5\leqslant b\leqslant 2.5$ **or** $\frac{"1933"}{b}-867$ oe Allow < or > or $\leqslant$ or $\geqslant$ for = Allow equivalent **NB** $k+215+362+181+94+15\equiv k+867$
		$\frac{"1933"}{867+k_{\min}}=1.95$ or $\frac{"1933"}{1.95}-867$ oe **and** $\frac{"1933"}{867+k_{\max}}=2.05$ or $\frac{"1933"}{2.05}-867$ oe			M1 Form two equations/expression for their mean. $\frac{"1933"}{867+k}=b$ **or** $\frac{"1933"}{b}-867$ where $1.95\leqslant b<2$ for one **and** $\frac{"1933"}{867+k}=b$ **or** $\frac{"1933"}{b}-867$ where $2<b\leqslant 2.05$ for the other equation. Allow < or > or $\leqslant$ or $\geqslant$ for =
		$[k=]\frac{1933}{1.95}-867\left[=\frac{4847}{39}\text{ or }124.282...\right]$ and $[k=]\frac{1933}{2.05}-867\left[=\frac{3113}{41}\text{ or }75.926...\right]$			A1 both equations fully correct followed by awrt 124 and awrt 75.9 **or** for a fully correct expression for **both** values of *k* seen allow 2.0499 for 2.05
			$76\leqslant k\leqslant 124$		A1 The 3rd M1 must be awarded. Allow [76, 124]
					Total 6 marks

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Question		Working	Answer	Mark	Notes
25	**(a)**	$[\mathbf{AC}=]\begin{pmatrix}3&1\\5&2\end{pmatrix}\begin{pmatrix}2&-1\\-5&3\end{pmatrix}$ or $[\mathbf{CA}=]\begin{pmatrix}2&-1\\-5&3\end{pmatrix}\begin{pmatrix}3&1\\5&2\end{pmatrix}$ or $3\times2-1\times5$ or $3\times2-(-1)\times(-5)$ or $6-5$		2	M1 for writing down either of the multiplications or the correct method shown to find the determinant of **A** or **C**.
		working must be shown	$\begin{pmatrix}2&-1\\-5&3\end{pmatrix}$ **or** $\begin{pmatrix}3&1\\5&2\end{pmatrix}$ **or** $\begin{pmatrix}3&1\\5&2\end{pmatrix}\begin{pmatrix}2&-1\\-5&3\end{pmatrix}=\begin{pmatrix}1&0\\0&1\end{pmatrix}$ **or** $\begin{pmatrix}2&-1\\-5&3\end{pmatrix}\begin{pmatrix}3&1\\5&2\end{pmatrix}=\begin{pmatrix}1&0\\0&1\end{pmatrix}$		A1 for writing down an inverse or matrices multiplied = identity matrix
	(b) (i)		$\begin{pmatrix}20&7\\35&13\end{pmatrix}$	2	B2 fully correct (B1 2 numbers correct) ignore order of matrices
	(ii)		$\begin{pmatrix}5&1\\5&4\end{pmatrix}\begin{pmatrix}3&1\\5&2\end{pmatrix}$	1	B1 for seeing the matrices given in the correct order
	(c)	$\mathbf{AB = BA}$ or $\mathbf{C^{-1}B = BC^{-1}}$		2	M1 for either expression implied by a fully correct expression required for the A1 (no need to see **BC = CB)**
			$\mathbf{A^{-1}ABA^{-1} = A^{-1}BAA^{-1}}$ or $\mathbf{CABC = CBAC}$ or $\mathbf{CC^{-1}BC = CBC^{-1}C}$ or $\mathbf{AC^{-1}BA = ABC^{-1}A}$ oe **followed by BC = CB**		A1 multiplies equation by **C or A^{-1}** both before and after (allow mixture) **AC = CA = I and/or C = A^{-1}** and/or **C^{-1} = A** leading to correct equation
					Total 7 marks

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Qu		Working		Answer	Mark	*Notes*
26	**(a)**	Method 1 for $c = d$ or $\angle SRT = \angle QPT$ oe Method 2 for $a = b$ or $\angle PQT = \angle RST$ oe Method 3 for $z = w$ or $\angle RPT = \angle SQT$ oe	**angles** in the **same segment** are equal		4	M1 For one pair of angles equated from these 6 M1 For both pairs of angles for the same method equated 
		Method 1 for $a = c$ or $\angle PQT = \angle SRT$ oe Method 2 for $b = d$ or $\angle RST = \angle QPT$ oe	**alternate** angles are equal			
		Method 3 for $y = x$ or $\angle PRT = \angle QSP$ oe	**angles** in the **same segment** are equal			
		Method 1 and Method 2 for $a = d$ or $\angle PQT = \angle QPT$	base angles of **isosceles** triangles are equal			$\angle PQT = \angle QPT$
		Method 3 for $PR = QS$	**ASA congruent**			
				$PT = QT$		A1 3 correct statements for the same method with conclusion
						B1 At least 2 relevant reasons for the method used. Need words in bold. For first reason allow **Equal chords** subtend **equal angles** at the **circumference** (Allow **on the circle**) Allow the symbol $\triangle$ for 'triangle' and $\angle$ for angle, opp, Alt
	(b)	$PT : TS = 1:2$ or $TQ : RT = 1:2$ or realising ratio of sides 1:2			4	M1 eg RT/TQ = 2 Allow any 2 sides. Implied by 2nd M
		[Area of $\triangle PTR$ or QTS =] eg $\frac{1}{2}\times 6-1[=2]$ **or** $0.5y\times 2y\times\sin\left(180-\sin^{-1}\frac{2}{y^2}\right)$ [=2] $y > 0$ [Area of trapezium $PQRS$ =] eg $\frac{1}{2}(2PQ+PQ)(MT+2MT)$ where M = midpoint of PQ **or** $\frac{2\times 1}{2}=1$ **and** $\frac{4\times 2}{2}=4$ oe				M1 for a correct method to find the area of triangle PTR or QTS or finding the area of the trapezium in terms of MT and PQ or using area of triangle for PQT and RST with both height and base in the ratio 1:2 eg Implied by the 3rd M
		eg 2 + 2 + 1 + 4 **or** $0.5\times 9\times 2$ **or** $3\times 3\times\frac{1}{2}\times\frac{2}{a}\times a$ **or** $\frac{(2+4)}{2}\times(2+1)$				M1 Full method to find area of $ABCD$. eg $\frac{1}{2}\left(\frac{2}{b}+\frac{4}{b}\right)(b+2b)$ where $b > 0$
		Correct answer scores full marks		9		A1 cao ISW
						Total 8 marks

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