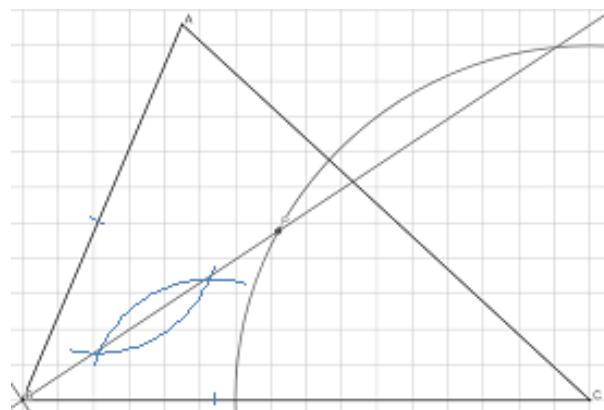


Question		Working	Answer	Mark	Notes
17	(a)	eg $\frac{16.1}{48} [= 0.335]$ or $\frac{1610}{48}$ or $\frac{16.1}{\cancel{12}\cancel{25}} \text{ or } \frac{x}{16.1} = \frac{1}{48} \text{ or } \frac{x}{1610} = \frac{1}{48}$ or $\frac{x}{16.1} = \frac{25}{12}$ oe		2	M1 correct method or equation to find length in m or cm. Implied by 0.335
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	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 $\frac{995}{V} = \frac{(a)^3}{1610^3}$
		$\frac{995}{100^3} [= 0.000995]$ or $[995 \times "110\ 592"] \div 100^3$ $0.48^3 [= 0.110\ 592]$			M1 for unit conversion by dividing by 100^3
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	110		A1 awrt 110
					Total 5 marks

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



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 $3 + 15 + "16 - x" = 30$
	<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	4		A1 cao
(c)		$\frac{11}{30}$	1	B1 ft follow through their answer to part (b), if $0 < \text{part(b)} < 15$ only ie $\frac{15 - \text{"their(b)"))}}{30}$ with numerator a single number. Allow awrt 0.367
				Total 5 marks

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			
	$\frac{2}{3}\pi \times 10^3 \left[= \frac{2000\pi}{3} = 2094.395\dots \right]$		5	M1 Allow for $\frac{4}{3}\pi \times 10^3 \left[= \frac{4000\pi}{3} = 4188.790\dots \right]$ Allow sight of 4189, awrt 4190 or awrt 2090 or exact fraction May be embedded within other working. Ignore labelling
	$\frac{1}{3}\pi \times 10^2 x \left[= \frac{100\pi}{3} x = 104.719\dots x \right]$			M1 or $\frac{1}{3}\pi 10^2 (h-10)$ Allow sight of 104, awrt 105 or exact fraction. Allow any letter for x . (Condone h for x) Ignore labelling
	$\frac{1}{3}\pi \times 10^2 x = \frac{3}{4} \times \left(\frac{2}{3}\pi \times 10^3 \right) \text{ or}$ $"\frac{100\pi}{3}" x = \frac{3}{4} \times (" \frac{2000\pi}{3} ") \text{ or}$ $\frac{\frac{1}{3}\pi \times 10^2 x}{\frac{2}{3}\pi \times 10^3} = \frac{3}{4} \text{ oe}$			M1 using $V_{\text{cone}} = \frac{3}{4} \times V_{\text{hemisphere}}$ 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 $\frac{3}{4} \times \left(\frac{2}{3}\pi \times 10^3 \right) = 1570.795\dots$
	"15"+10			M1 For using $h - 10$ anywhere OR if all 3 previous method marks awarded allow for "their x " + 10
	<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	25		A1 awrt 25
	SC $r = 10$ not substituted could get M1 M1 M0 M1 A0 1 st M1 for $\frac{\frac{1}{3}\pi r^2 x}{\frac{2}{3}\pi r^3 x} = \frac{3}{4}$ (allow sphere) 2 nd M1 $\frac{x}{2 \times r} = \frac{3}{4}$ or $\frac{x}{4 \times r} = \frac{3}{4}$ 4 th M1 for using $h - 10$ or adding 10 A0			
				Total 5 marks

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	<p>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</p> $[\angle GAB =] \tan^{-1} \left(\frac{4}{12} \right) [= 18.434\dots] \text{ and}$ $[AG =] \frac{12}{\cos "18.434\dots"} \text{ Ignore incorrect labels}$ <p>labels</p>
	$[AF^2 =] 3^2 + "160"$ or $3^2 + ("4\sqrt{10}")^2$ $[AF^2 =] 4^2 + "153"$ or $4^2 + ("3\sqrt{17}")^2$ $[AF^2 =] 12^2 + "25"$ or $[AF^2 =] 169$			<p>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</p> <p>NB $\sqrt{160} = 12.649\dots$ $\sqrt{153} = 12.369\dots$</p>
	Working required	13		A1 dependedent 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)	$\sin GAF = \frac{3}{"13"} \text{ or } \tan GAF = \frac{3}{"\sqrt{160}}"$ or $\cos GAF = \frac{"\sqrt{160}}{"13"} \text{ oe}$		2	<p>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</p> <p>Allow ($\tan AFG = \frac{\sqrt{160}}{3}$ or $\sin AFG = \frac{\sqrt{160}}{13}$ or $\cos AFG = \frac{3}{13}$) and $90 - \angle AFG$</p> <p>Allow use of cosine or sine rule eg $3^2 = 160 + 13^2 - 2 \times \sqrt{160} \times 13 \cos GAF$</p>
	Correct answer scores full marks (unless from obvious incorrect working)	13.3		A1 awrt 13.3 Allow awrt 13.4
				Total 5 marks

Question	Working	Answer	Mark	Notes
22	$(-k)^3 + 4(-k)^2 - 20(-k) - (-k) [= 0] \text{ or}$ $-k^3 + 4k^2 + 20k + k [= 0] \text{ oe}$		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 $x^3 + kx^2 + gx^2 + gkx + x + k \text{ oe}$
	$-k^3 + 4k^2 + 21k = 0 \text{ or}$ $-20 - 4k + k^2 = 1 \text{ or}$ $k + g = 4 \text{ and } 1 + kg = -20 \text{ oe}$			A1 correct simplified 3 term cubic equation or a correct quadratic equation or both correct equations from comparing x^2 and x coefficients.
	$(k)(-k^2 + 4k + 21) = 0 \text{ or}$ $k^2 - 4k - 21 = 0 \text{ oe}$			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
	$(k)(-k+7)(k+3) = 0 \text{ or}$ $(k-7)(k+3) = 0$			M1 dep 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 $(k-2)^2 \pm \dots$ An answer of 7 or -3 can imply this mark
	<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	7, -3		A1 cao (both) condone 0, 7, -3 but do not allow any other incorrect extras
				Total 5 marks

Question		Working	Answer	Mark	Notes
23	(a)	$[ON^2 =] 19.5^2 - 18^2 \text{ or } 19.5^2 = ON^2 + 18^2$ or $39^2 - 36^2 \text{ or } [ON =] 19.5 \cos(67.3801\ldots)$ or $[ON =] 19.5 \sin(22.6198\ldots) \text{ oe}$		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
		<i>Working required</i>	$\sqrt{19.5^2 - 18^2} = 7.5$		A1 allow $\sqrt{56.25} = 7.5$ or $19.5 \cos(67.3801\ldots) = 7.5$ or $\frac{\sqrt{39^2 - 36^2}}{2} \text{ oe or } 19.5 \sin(22.6198\ldots) = 7.5$ 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 $\frac{AC}{2} + 7.5$ and $\frac{AC}{2} - 7.5$ identified as AB and BC or used in a formula. Allow $x + 7.5$ and $x - 7.5$ may be implied by the 2 nd 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 $[AC] = \frac{8 \times 28}{("16.7406\ldots" + 7.5)} + ("16.7406\ldots" + 7.5)$ $\left(\frac{AC}{2}\right)^2 = 224 + 7.5^2$ 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 $\left(\frac{AC}{2}\right)^2$
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	33.5		A1 awrt 33.5
					Total 6 marks

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

Question		Working	Answer	Mark	Notes
25	(a)	$[AC =] \begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix} \begin{pmatrix} 2 & -1 \\ -5 & 3 \end{pmatrix}$ or $[CA =] \begin{pmatrix} 2 & -1 \\ -5 & 3 \end{pmatrix} \begin{pmatrix} 3 & 1 \\ 5 & 2 \end{pmatrix}$ or $3 \times 2 - 1 \times 5$ or $3 \times 2 - (-1) \times (-5)$ 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)	$AB = BA$ or $C^{-1}B = BC^{-1}$		2	M1 for either expression implied by a fully correct expression required for the A1 (no need to see $BC = CB$)
			$A^{-1}ABA^{-1} = A^{-1}BAA^{-1}$ or $CABC = CBAC$ or $CC^{-1}BC = CBC^{-1}C$ or $AC^{-1}BA = ABC^{-1}A$ 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