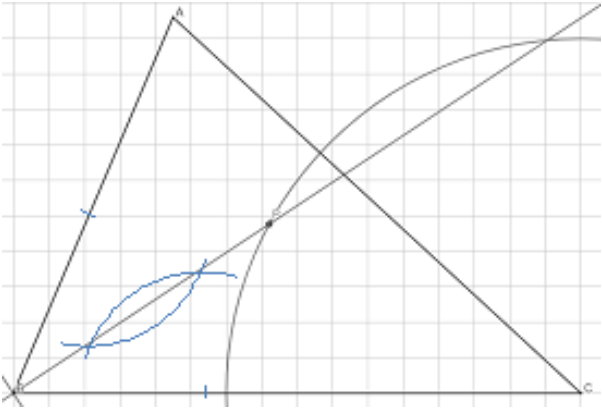
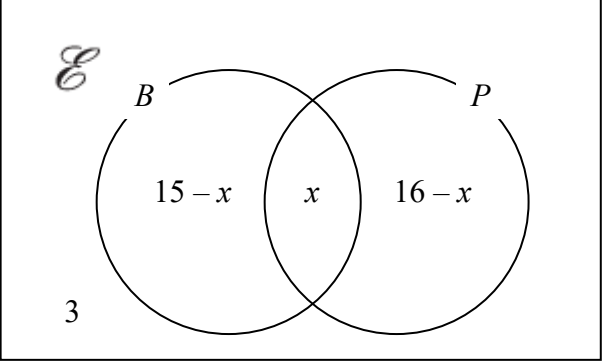


Question		Working	Answer	Mark	Notes	
17	(a)	eg $\frac{16.1}{48}$ [= 0.335] or $\frac{1610}{48}$ or $\frac{16.1}{12\cancel{25}} \text{ or } \frac{x}{16.1} = \frac{1}{48} \text{ or } \frac{x}{1610} = \frac{1}{48}$ or $\frac{x}{16.1} = \frac{25}{12}$ oe		2	M1 correct method or equation to find length in 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 $\frac{995}{V} = \frac{(a)^3}{1610^3}$	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	
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	110		A1 awrt 110	
					<i>Total 5 marks</i>	

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	<p>B2 $15 - x$, $16 - x$ and 3 in correct regions on Venn diagram</p> <p>B1 2 of $15 - x$, $16 - x$ and 3 in correct regions or all 3 values correct, one in correct region.</p> <p>Allow 11 for $15 - x$ and 12 for $16 - x$</p> <p>SC B1 x is replaced with a number $x \neq 4$ and they use this incorrect value, to find $15 - x$ and $16 - x$</p>
	(b)	$3 + "15 - x" + x + "16 - x" = 30$ oe		2	<p>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 $3 + 15 + "16 - x" = 30$</p>
		Correct answer scores full marks (unless from obvious incorrect working)	4		A1 cao
	(c)		$\frac{11}{30}$	1	<p>B1 ft follow through their answer to part (b), if $0 < \text{part(b)} < 15$ only ie $\frac{15 - "their(b)"}{30}$ with numerator a single number. Allow awrt 0.367</p>
					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				
	$\frac{2}{3}\pi \times 10^3 \left[= \frac{2000\pi}{3} = 2094.395... \right]$		5	M1 Allow for $\frac{4}{3}\pi \times 10^3 \left[= \frac{4000\pi}{3} = 4188.790... \right]$ Allow sight of 4189, awrt 4190 or awrt 2090 or exact fraction May be embedded within other working. Ignore labelling	
	$\frac{1}{3}\pi \times 10^2 x \left[= \frac{100\pi}{3} x = 104.719...x \right]$			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	
	$\frac{1}{3}\pi \times 10^2 x = \frac{3}{4} \times \left(\frac{2}{3}\pi \times 10^3 \right)$ or " $\frac{100\pi}{3}$ " x = $\frac{3}{4} \times \left(\text{"}\frac{2000\pi}{3}\text{"} \right)$ or $\frac{\frac{1}{3}\pi \times 10^2 x}{\frac{2}{3}\pi \times 10^3} = \frac{3}{4}$ 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 fit their values eg "2094" x = $\frac{3}{4} \times \text{"105"}$ NB x = 15 NB useful number $\frac{3}{4} \times \left(\frac{2}{3}\pi \times 10^3 \right) = 1570.795...$	$M2 \text{ for } \frac{\frac{1}{3}\pi 10^2 (h-10)}{\frac{2}{3}\pi \times 10^3} = \frac{3}{4}$ 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 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	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 $3^2 + ("4\sqrt{10}")^2$ $[AF^2 =]4^2 + "153"$ or $4^2 + ("3\sqrt{17}")^2$ $[AF^2 =]12^2 + "25"$ or $[AF^2 =]169$	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 $\sqrt{160} = 12.649...$ $\sqrt{153} = 12.369...$			
		<i>Working required</i>	13		A1 dependent 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 $3^2 = 160 + 13^2 - 2 \times \sqrt{160} \times 13 \cos GAF$	
	<i>Correct answer scores full marks (unless from obvious incorrect working)</i>		13.3		A1 awrt 13.3 Allow awrt 13.4	
					<i>Total 5 marks</i>	

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 $x^3 + kx^2 + gx^2 + gkx + x + k$ 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 $(k - 7)(k + 3) = 0$			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)	$[ON^2 =]19.5^2 - 18^2$ or $19.5^2 = ON^2 + 18^2$ or $39^2 - 36^2$ or $[ON =]19.5 \cos(67.3801\dots)$ or $[ON =]19.5 \sin(22.6198\dots)$ 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 $19.5 \cos(67.3801\dots) = 7.5$ or $\frac{\sqrt{39^2 - 36^2}}{2}$ oe or $19.5 \sin(22.6198\dots) = 7.5$ 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 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 $AM = \sqrt{280.25} [= 16.7406\dots]$ 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 $[AC =]\frac{8 \times 28}{("16.7406\dots" + 7.5)} + ("16.7406\dots" + 7.5)$ $\left(\frac{AC}{2}\right)^2 = 224 + 7.5^2$ or			M1 dep on previous method marks awarded. For using $AC = 2 \times$ "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 $\left(AC/2\right)^2$
		Correct answer scores full marks (unless from obvious incorrect working)	33.5		A1 awrt 33.5
					Total 6 marks

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 $1.5 \leq b \leq 2.5$ or $\frac{"1933"}{b} - 867$ oe Allow < or > or \leq or \geq 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 $1.95 \leq b < 2$ for one and $\frac{"1933"}{867 + k} = b$ or $\frac{"1933"}{b} - 867$ where $2 < b \leq 2.05$ for the other equation. Allow < or > or \leq or \geq for =
	$[k =] \frac{1933}{1.95} - 867 \left[= \frac{4847}{39} \text{ or } 124.282... \right]$ 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
		$76 \leq k \leq 124$		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⁻¹B = BC⁻¹		2	M1 for either expression implied by a fully correct expression required for the A1 (no need to see BC = CB)
			A⁻¹ABA⁻¹ = A⁻¹BAA⁻¹ or CABC = CBAC or CC⁻¹BC = CBC⁻¹C or AC⁻¹BA = ABC⁻¹A 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
					<i>Total 7 marks</i>