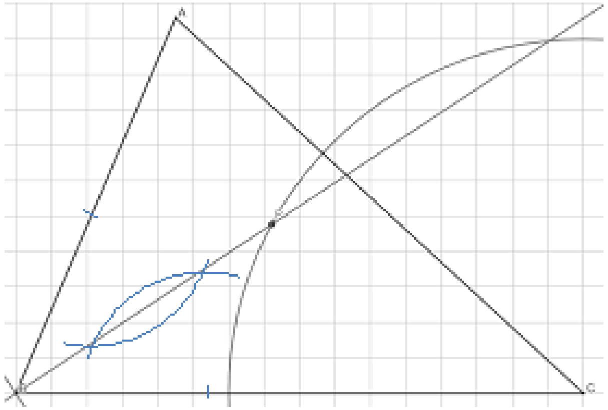
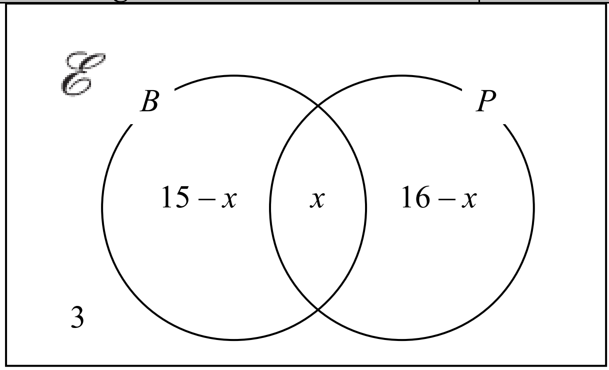
Question		Working	Answer	Mark	Notes
18			angle bisector constructed accurately	4	B2 for a line within the limits and a pair of suitable arcs. One arc centred on a point D on BC and one centred on the point E on AB such that $BE = BD$ **or** 2 arcs centred at B with the cross to find the middle. (B1 for 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 $3+15+"16-x"=30$
		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

<table>
<tr><th>Question</th><th></th><th>Working</th><th>Answer</th><th>Mark</th><th colspan="2">Notes</th></tr>
<tr><td>20</td><td colspan="6">Throughout this question condone mis-labelling. eg if they label the volume of the cone as being the hemisphere</td></tr>
<tr><td></td><td></td><td>$\frac{2}{3}\pi\times10^3\left[=\frac{2000\pi}{3}=2094.395...\right]$</td><td></td><td rowspan="5">5</td><td colspan="2">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</td></tr>
<tr><td></td><td></td><td>$\frac{1}{3}\pi\times10^2x\left[=\frac{100\pi}{3}x=104.719\ldots x\right]$</td><td></td><td colspan="2">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</td></tr>
<tr><td></td><td></td><td>$\frac{1}{3}\pi\times10^2x=\frac{3}{4}\times\left(\frac{2}{3}\pi\times10^3\right)$ 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</td><td></td><td>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
$\frac{3}{4}\times\left(\frac{2}{3}\pi\times10^3\right)=1570.795...$</td><td rowspan="2">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</td></tr>
<tr><td></td><td></td><td>"15"+10</td><td></td><td>M1 For using $h-10$ anywhere
OR if all 3 previous method marks awarded allow for "their x" + 10</td></tr>
<tr><td></td><td></td><td>Correct answer scores full marks
(unless from obvious incorrect working)</td><td>25</td><td colspan="2">A1 awrt 25</td></tr>
<tr><td></td><td></td><td colspan="5">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</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">Total 5 marks</td></tr>
</table>

Question		Working	Answer	Mark	Notes	
21	**(a)**	$\left[AG^2=\right]12^2+4^2\left(=160\right)$ or $\left[AC^2=\right]12^2+3^2\left(=153\right)$ or $\left[AE^2=\right]4^2+3^2\left(=25\right)$		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 $\left[\angle GAB=\right]\tan^{-1}\left(\frac{4}{12}\right)\left[=18.434....\right]$ **and** $\left[AG=\right]\frac{12}{\cos"18.434..."}$ Ignore incorrect labels labels	M2 for $\left[AF^2=\right]3^2+12^2+4^2$
		$\left[AF^2=\right]3^2+"160"$ or $3^2+\left("4\sqrt{10}"\right)^2$ $\left[AF^2=\right]4^2+"153"$ or $4^2+\left("3\sqrt{17}"\right)^2$ $\left[AF^2=\right]12^2+"25"$ or $\left[AF^2=\right]169$			M1 full method to find AF^2 For this mark allow values correct to 3sf. but condone truncation eg $4^2+\left(\text{awrt } 12.3\right)^2$ or $3^2+\left(\text{awrt } 12.64\right)^2$ 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 $3^2=160+13^2-2\times\sqrt{160}\times13\cos GAF$	
	Correct answer scores full marks (unless from obvious incorrect working)		13.3		A1 awrt 13.3 Allow awrt 13.4	
					Total 5 marks	

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

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 $AC = 2 \times$ "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