Mark scheme

Question			Answer/Indicative content	Marks	Guidance	
1			Answer 1500 with 3, 4 and 9000 seen	4	**B1** for at least two of the values 3, 4 and 9000 **M2** for $\frac{\textit{their}\,9000}{0.5 \times \textit{their}\,4 \times \textit{their}\,3}$ **oe** or **M1** for $\frac{1}{2} \times \textit{their}\ 4 \times \textit{their}\ 3$	For **B1** condone trailing zeros For **M2** and **M1** *their* values can be 8947, 4.04, 2.96 or other rounded relatable values
			Total	**4**		
2	a		26π **final answer**	4	**M2** for $\sqrt{12^2 + 5^2}$ **oe** or **M1** for 12^2 and 5^2 **oe** **M1dep** for 2 × π × *their r*	Accept e.g. C = 26 π **M2** implied by 13 **M1 dep** on at least **M1**
	b		24π **final answer**	4	**B2** for $x = 60$ or $\frac{60}{360}$ **oe** or $\frac{4[\pi]}{2[\pi]12}$ **oe** or **M1** for $\frac{x}{360} \times 2 \times \pi \times 12 = 4\pi$ **oe** **M1** for $\frac{\textit{their}\,60}{360} \times \pi \times 12^2$ **oe** or $\frac{x}{360} \times \pi \times 12^2$	$0 < \textit{their}\ 45 < 90$ **M1** for e.g. $\frac{4[\pi]}{2[\pi]12} \times \pi \times 12^2$
			Total	**8**		
3	a		$y \le x + 5$ **oe** and	3		Accept inequalities in either order

			$y < 12$		**B2** for $y \le x + 5$ **oe** or **B1** for $y \ldots x + 5$ **oe** but with = or an incorrect inequality symbol **B1** for $y < 12$	
	b		20 **nfww**	4	**B2** for (3, 8) and (8, 8) or (7, 12) and (12, 12) identified or for base 5 and perpendicular height 4 both identified or **B1** for (3, 8) or (8, 8) or (7, 12) or (12, 12) or for base = 5 or height = 4 AND **M1** for *their* base × *their* perpendicularheight	May be seen on diagram Must identify base and perpendicular height of parallelogram in working or on diagram Do not allow if slant height used
			Total	**7**		
4			$\sqrt{13}$ final answer	4	**B3** for answer 13 **nfww** OR **B1** for $\cos 30 = \frac{\sqrt{3}}{2}$ and **M2** for $x^2 = (4\sqrt{3})^2 + 5^2 - 2 \times 4\sqrt{3} \times 5\cos 30$	Do not accept work in decimals rounded to answers of $\sqrt{13}$ or 13 Award if seen as clear statement of fact or in use; once seen condone replacement by 0.866… or 0.87 in subsequent work Condone missing brackets Condone use of

					or better or **M1** for other correct arrangements of cosine rule where *x* or x^2 are not the subject	6.92… or 6.9 and 0.866… or 0.87 in **M2** and **M1**
			Total	**4**		
5			30.4 to 30.5 with correct working	51	**M2** for $\sqrt{(15^2+8^2)}$ or **M1** for $[\ldots]^2 = 15^2 + 8^2$ and **M2** for $\tan^{-1}\frac{10}{their\ 17}$ oe or **M1** for $\tan(BHF) = \frac{10}{their\ 17}$ oe If **0** or **1** scored, instead award **SC2** for answer 30 to	"Correct working" requires evidence of at least **M1M1** Alternative method **M2** for $\sqrt{(15^2+8^2+10^2)}$ or **M1** for $[\ldots]^2 = 15^2 + 8^2$ and **M2** for $\sin^{-1}\frac{10}{their\ \sqrt{389}}$ oe or **M1** for $\sin(BHF) = \frac{10}{their\ \sqrt{389}}$ oe Other methods **M2** for a correct expression that would give correct HF or HB or **M1** for 'one-step away' e.g. $\sin(\tan^{-1}(\frac{8}{15})) = \frac{8}{HF}$ and **M2** for correct trig inverse expression with angle BHF or **M1** for correct trig expression with angle BHF May be on diagram

					30.5 with no or insufficient working If **0** scored, instead award **SC1** for [HF =] 17 or for [HB =] $\sqrt{389}$ **oe** or 19.7 to 19.8	
			Total	**5**		
6			6.25×10^{13} with correct working	6	**B5** an answer equivalent to 6.25×10^{13} with correct working or an answer in standard form 6.2×10^{13} to 6.3×10^{13} with correct working OR **M2** for $\frac{1}{2}(\times)\frac{4}{3}(\times)\pi(\times)20^3$ or **M1** for $\frac{4}{3}(\times)\pi(\times)20^3$ or $\frac{32000\pi}{3}$ or 33510 to 33511 and **M1** for $\frac{4}{3}(\times)\pi(\times)(4\times10^{-4})^3$ **soi** **A1** for $(\frac{256\pi}{3}) \times 10^{-12}$ or $2.68\ldots \times 10^{-10}$ **oe** and **M1dep** (on **M1M1**) for $\frac{\textit{their}\text{ volume of bowl}}{\textit{their}\text{ volume of raindrop}}$ <u>Alternative method:</u> **M4** for $20^3 \div (4^3 \times 10^{-12})$ or 1.25×10^{14} **oe**	"Correct working" requires evidence of at least **M1M1** e.g. **M1** $\frac{4}{3}\pi[\times]$ *their* answer to $(4 \times 10^{-4})^3$ *Their* volumes must have come from use of correct formulas for hemisphere and sphere or for two spheres

					or **M3** for $\left[\dfrac{\frac{4}{3}\times\pi}{\frac{4}{3}\times\pi}\right]\dfrac{20^3}{\left(4\times10^{-4}\right)^3}$ **oe** and **M1dep** for 0.5 × *their* vol. scale factor If **0**, **1** or **2** scored, instead award **SC3** for answer 6.25×10^{13} with no or insufficient working If **0** or **1** scored, instead award **SC2** for a B5 answer but with no or insufficient working If **0** scored, instead award **SC1** for 16000 π/3 or 16755 to 16756 or $8.53\pi \times 10^{-11}$ or $2.68\ldots \times 10^{-10}$ with no or insufficient working	
			Total	**6**		
7			1156 or 1155 or 1155.6 to 1155.7 with correct working	6	**M2** for $\frac{1}{2} \times 56$ × *their* 47.49... × sin32 or **M1** for [AC=] 56cos 32 or 56sin58 **oe** AND **M3** for $\frac{1}{2}$ × *their*47.49 × *their*33.11... × sin35 **oe** or **M2** for [AB=] $\dfrac{\textit{their}47.49\ldots \times \sin43}{\sin102}$ **oe**	"Correct working" requires evidence of at least **M2** or **M1 M1** condone answers in range 1140 – 1170 with full correct working **M2** implied by 704.65… or 704.7 or **M1** implied by [AC=] 47.4[9…] or 47.5 AND **M3** implied by 450.97… or 451 or **M2** implied by [AB=] 33.1[1…] Accept any

					or **M1** for $\frac{AB}{\sin 43} = \frac{their\,47.49\ldots}{\sin 102}$ **oe** If **0**, **1** or **2** scored award **SC3** for answer 1156 or 1155 or 1155.6 to 1155.7 with no or insufficient working If **0** or **1** scored award **SC2** for 704.65… or 704.7 or 450.97… or 451 with no or insufficient working	correct method e.g. **M2** for area of triangle ACD = ½ × 56sin32 × 56cos32 **oe** or **M1** for [CD=]56sin32 implied by 29.6… For additional information refer to '2024 November, J560/04, Alternative, Mark Scheme Appendix' within downloadable extra resource materials.
			Total	**6**		
8			2.7 g/cm^3 or g cm^{-3}	2 1	**M1** for 37 260 ÷ 13 800	Allow clear correct conversions to other units so 0.0027, 2700 or 2 700 000 score **2** marks For **M1** condone figs 37 260 ÷ figs 13 800 Units correct or consistent with *their* answer e.g. 0.0027 kg/cm^3, 2700 kg/m^3, 2 700 000 g/m^3 or 2.7 kg/dm^3 Accept units in words including use of “per”
			Total	**3**		
9			9930 to 9931.5	4	**B2** for 25.2 or **M1** for $\frac{11.2}{4} \times 9$ **oe**	Condone answer of 9925.8… or 9926

					AND **M1** for $\pi \times 11.2^2 \times$ *their* 25.2	
			Total	**4**		
10			4577 to 4578 or 4580 with correct working	6	**M2** for cos […] = $\frac{81-65}{65}$ oe **oe** or **M1** for 81 – 65 or 16 and **M2** for $\frac{1}{2} \times 65 \times 65 \times$ sin *their* 151.49… **oe** or **M1** for $\sqrt{65^2-(their\,16)^2}$ **oe** or 63 and **M1** for $\frac{1}{2} \times their\ 126 \times their\ 16$ **oe** and **M1** for $\frac{their\ angle\ AOB}{360} \times \pi \times 65^2$ or **B1** for $\pi \times 65^2$ If **0**, **1** or **2** scored award **SC3** for the correct answer with insufficient working If **0** or **1** scored award **SC2** for 5585.81… or 7687.414... **rot** to at	"Correct working" requires evidence of at least **M2** or **M1 M1** Accept answers in the range 4575 to 4583 Accept any correct method. **M2** implied by 75.74… or 151.49… **rot** to at least an integer e.g. 75, 75.7, 75.74, 151, equivalent method includes $\cos[\ldots] = \frac{65^2+65^2-126^2}{2\times 65\times 65}$ condone with 81 instead of 126 **M2** for finding the area of the triangle OAB implied by 1008 *their* 151.49… must come from a correct attempt to find angle AOB and condone using AB = 81 for **M2** and **M1** including $\sqrt{65^2-40.5^2}$ for **M1** **M1** implied by 5585 to 5586 or **B1** implied by 4225π, 13270 to 13275 Alternative method using major sector: **M2** for angle as before implied by 208, 208.5[0]… **M2** for area of triangle as before or

					least an integer with insufficient working	**M1** for the third side e.g. 63 **M1** for $\left[\frac{\textit{their reflex angle AOB}}{360}\right] \times \pi \times 65^2$ or 7687.414…
			Total	**6**		
11			$D = \sqrt[3]{16a}$ or $D = \sqrt[3]{16a^3}$ final answer	4	**M3** for 16 [π]$\boldsymbol{a}^3$ = [π]$\boldsymbol{D}^3$ or better or **M2** for $\frac{4}{3}[\pi]a^3 = \frac{1}{3}[\pi] \times \frac{D^2}{4} \times D$ **oe** or **M1** for $\frac{1}{3}\pi \times \frac{D^2}{4} \times D$	Condone *d* for *D*throughout Answer $\sqrt[3]{16}a$ or $\sqrt[3]{16a^3}$ allow **M3** For method marks condone 3.14, 3.142 or $\frac{22}{7}$ for π For method marks ignore any units For **M3** removes fractions and simplifies terms in *D* **M3** accept e.g. 16a^3 = D^3 Must see correct expression in *D* for **M1**
			Total	**4**		
12			$14\sqrt{2} + 21\pi$final answer with correct working	7	**M1** for angle of major sector = 270° or $\frac{270}{360}$**oe soi** **M1** for $\frac{\textit{their}\,270}{360} \times 2 \times \pi \times 14$ **A1** for 21π AND **M2** for [2 ×] 14 cos45° **oe** or **M1** for $\frac{x}{14} = \cos 45$**oe**	Correct working requires evidence of at least **M1M1M2** For **M1** accept e.g. $\frac{3}{4}$ **soi** 270 may be on diagram For **M1** 90 ≤ *their* 270 ≤ 315 but not 180 28 π ÷ 4 × 3 **oe** e.g. done in stages implies **M1M1** **M2 oe** accept e.g. [AB^2 =] 14^2 + 14^2 [– 2.14.14.cos 90]

					B1 for $\cos 45 = \frac{1}{\sqrt{2}}$ **soi** **A1** for $14\sqrt{2}$ OR **M2** for $\sqrt{14^2 + 14^2}$ or $\sqrt{392}$ or **M1** for $14^2 + 14^2$	or $\frac{14[\sin 90]}{\sin 45}$, $[2\times]\sqrt{14^2 - (14\sin 45)^2}$ **oe** where *x* is ½ AB **M1** for any correct implicit method for finding AB or ½ AB In this method and other methods used, B1 is awarded for the correct trig value[s] associated with *their* method for find [½]AB, even if *their* method is incorrect, not just seen in a table of trig values unless selected Award maximum of **6** marks if answer incorrect Refer to 'Additional Guidance Qn20, 2024 June, Alternative J560/05, Mark Scheme Appendix' within downloadable resource materials.
			Total	**7**		
13			1500 final answer and 500 and 3 shown	3	**M2** for 500 × 3 or **M1** for *their* 500 × *their* 3 or **B1** for 500 and 3 seen	For **M1** e.g. uses 497 and 2.7 or uses incorrectly rounded values
			Total	**3**		
14	a		$\frac{30}{360} \times \pi \times 10^2$ **oe** 26.179 to 26.183	M2 A1	**M1** for $\pi \times 10^2$ implied by 100π or 314.1 to 314.2 **A0** for just 26.2	**M2 oe** e.g. $\frac{360}{30} = 10$ and $\frac{\pi \times 10^2}{10}$ Condone 3.14 or $\frac{22}{7}$ for π in **M** marks **M0**

						for 10π without working
	b		70.85 to 70.95 **nfww**	4	<u>With area of parallelogram as 90 or from an attempt at 18 × 5:</u> **M3** for $\frac{their(18\times5)-26.2}{their(18\times5)}$ [× 100] **oe** or **M2** for their (18 × 5) − 26.2 implied by 63.8 or for $\frac{26.2}{their(18\times5)}$ [× 100] implied by 29.1 to 29.2 or **M1** for 18 × 5 implied by 90 <u>If correct method for area of parallelogram is not shown or an incorrect value is used:</u> If *A* > 26.2 **SC2** for $\frac{A-26.2}{A}$ [× 100] **oe** or **SC1** for $\frac{26.2}{A}$ [× 100]	If 90 not used, *their* (18 × 5) must come from attempt at 18 × 5 Note there are other methods for finding area of a parallelogram 26.2 may be *their* more accurate 26.179 to 26.183 from **(a)** **M3 oe** e.g. $100-\frac{26.2\times100}{their(18\times5)}$ e.g. **SC2** for $\frac{180-26.2}{180}$ [× 100] **oe** For **SC** marks method must be shown; do not imply from an answer only
			Total	**7**		
15			7.8 to 7.9 with correct working	6	**M2** for $AC=\frac{5\sin60}{\sin25}$ or **M1** for $\frac{AC}{\sin60}=\frac{5}{\sin25}$ **oe** **A1** for 10.2 to 10.3 AND **M2** for	'Correct working' requires evidence of at least **M1M1** **A1** implies **M2** after **M1** seen

					$\sqrt{their\,10.2^2 + 6^2 - 2 \times their\,10.2 \times 6 \times \cos 50}$ or **M1** for *their* $10.2^2 + 6^2 - 2 \times$ *their* $10.2 \times 6 \times \cos 50$ If **0, 1** or **2** scored, instead award **SC3** for 7.8 to 7.9 with no working or insufficient working If **0** or **1** scored, instead award **SC2** for 61.4 to 62.6 with no working or insufficient working If **0** scored, instead award **SC1** for 10.2 to 10.3 with no working or insufficient working	*Their* 10.2 or 10 from use of trig May be performed in stages
			Total	**6**		
16			12.5 and 3.5 with correct working	5	**M2** for [h^2 =] $7.5^2 - 6^2$ or better or **M1** for $6^2 + h^2 = 7.5^2$ or better **B1** for $h = 4.5$ AND **M1** for 8 + *their* 4.5 **soi** by 12.5 or 8 – *their* 4.5 **soi** by 3.5 If **0**, **1** or **2** scored, instead award **SC3** for both 12.5 and 3.5 as answers with no or insufficient working If **0** or **1** scored, instead award **SC2** for either 12.5 or 3.5 as answer with no working or insufficient working	‘Correct working’ requires evidence of Pythagoras or quadratic Accept $\frac{25}{2}$ and $\frac{7}{2}$ Allow other letters or $t - 8$ for h and allocate marks as per main method Accept -4.5 or ±4.5 *Their* 4.5 from use of Pythagoras <u>Alternative method 1:</u> **M3** for $t^2 - 16t + 43.75 = 0$ or

					M2 for $36 + t^2 - 16t + 64 = 56.25$ or **M1** for $6^2 + (t - 8)^2 = 7.5^2$ AND **M1** for correct method to solve *their* 3-term quadratic
			Total	**5**	
17			$\sqrt{31}$ final answer	4	**B3** for answer 31 nfww — Do not accept work in decimals rounded to answers of $\sqrt{31}$ or 31 OR **B1** for $\cos 30 = \frac{\sqrt{3}}{2}$ — Award if seen as clear statement of fact or in use; once seen condone replacement by 0.866... or 0.87 in subsequent work and **M2** for $x^2 = (6\sqrt{3})^2 + 7^2 - 2 \times 6\sqrt{3} \times 7\cos 30$ or better — Condone missing brackets or **M1** for other correct arrangements of cosine rule where x or x^2 are not the subject — Condone use of 10.39... or 10.4 and 0.866... or 0.87 in **M2** and **M1** **<u>Examiner's Comments</u>** Many candidates used trigonometry or Pythagoras in a right-angled triangle, scoring zero or B1 if the exact form of cos 30 was seen. Correct substitution into the cosine rule, with x or x^2 as the subject, scored M2. Many of these cosine expressions were written accurately but not evaluated properly with

					answers to $((6\sqrt{3})^2 + 7^2 - 2 \times 6\sqrt{3} \times 7)$ cos 30 or similar being very common. Other candidates used decimal approximations such as 0.866 for cos 30 and 10.39 for $6\sqrt{3}$ when the question asks for the exact value. **Assessment for learning** When presented with geometric diagrams, right angles will normally be indicated by notation and may also be referred to in the text, unless their identification is part of the assessment (e.g. angle in a semicircle). Mistakes were made and marks lost by finding $b^2 + c^2 - 2bc$, an unnecessary and incorrect step in the evaluation. Instead, candidates should type the whole expression for a 2 into their calculator, write down that answer, and then show the square root step.
			Total	**4**	
18			30.9 to 31 with correct working	5	**M2** for $\sqrt{(24^2 + 7^2)}$ or **M1** for $[...]^2 = 24^2 + 7^2$ and **M2** for $\tan^{-1} \frac{15}{their\ 25}$ oe or **M1** for tan(BHF) = $\frac{15}{their\ 25}$ oe Correct working requires evidence of at least **M1M1** <u>Alternative method:</u> **M2** for $\sqrt{(24^2 + 7^2 + 15^2)}$ or **M1** for $[...]^2 = 24^2 + 7^2 + 15^2$ and **M2** for $\sin^{-1} \frac{15}{their\ \sqrt{850}}$ oe or **M1** for sin(BHF) = $\frac{15}{their\ \sqrt{850}}$ oe <u>Other methods:</u> **M2** for a correct

					expression that would give correct HF or HB or **M1** for "one-step away" eg sin $(\tan^{-1}(\frac{7}{24})) = \frac{7}{HF}$ and **M2** for correct trig inverse expression with angle BHF or **M1** for correct trig expression with angle BHF
					If **0** or **1** scored, instead award **SC2** for answer 30.9 to 31 with no or insufficient working If **0** scored, instead award **SC1** for [HF =] 25 or for [HB =] $\sqrt{850}$ oe or 29.1 to 29.2 May be on diagram **Examiner's Comments** About half of the candidates scored zero, but about a third scored full marks. Among the latter candidates, length BH was often found and used in a sin ratio in preference to using the more accessible FH in a tan ratio. Candidates who used Pythagoras to find either BH or FH correctly scored 2 marks.
			Total	**5**	
19			6.25×10^{13} with correct working	6	**B5** an answer equivalent to 6.25×10^{13} with correct working or an answer in standard form 6.2 × Correct working requires evidence of at least **M1M1**

					10^{13} to 6.3×10^{13} with correct working OR **M2** for $\frac{1}{2}$ (×) $\frac{4}{3}$ (×) π (×) 15^3 or **M1** for $\frac{4}{3}$ (×) π (×) 15^3 or 4500π or 14137 to 14139 and	
					M1 for $\frac{4}{3}$ (×) π (×) $(3 \times 10^{-4})^3$ soi	*their* answer to $(3\times 10^{-4})^3$
					A1 for $3.6\pi \times 10^{-11}$ or $1.13... \times 10^{-10}$ oe and	
					M1dep (on M1M1) for $\frac{\textit{their}\text{ volume of bowl}}{\textit{their}\text{ volume of raindrop}}$	*Their* volumes must have come from use of correct formulas for hemisphere and sphere or for two spheres
					Alternative method: **M4** for $15^3 \div (3^3 \times 10^{-12})$ or 1.25×10^{14} oe or **M3** for $\left[\frac{4/3 \times \pi}{4/3 \times \pi}\right] \frac{15^3}{(3 \times 10^{-4})^3}$ oe and **M1dep** for 0.5 × *their* vol. scale factor If **0**, **1** or **2** scored, instead award **SC3** for answer 6.25×10^{13} with no or insufficient working If **0** or **1** scored, instead award **SC2** for a B5 answer but with no or insufficient	

					working If **0** scored, instead award **SC1** for 2250π or 7068 to 7070 or 3.6π × 10^{-11} or 1.13… × 10^{-10} with no or insufficient working **<u>Examiner's Comments</u>** This question provided good differentiation between candidates. Many candidates scored at least 1 mark, and there was a good spread of candidates scoring 3 or more marks. Candidates needed to find the volume of the hemispherical bowl (2 marks), the volume of a raindrop (2 marks), and perform the division giving the exact answer in standard form (2 marks). Candidates scoring 1 mark usually found the volume of a spherical bowl and stopped. Candidates who completed the demand using this incorrect volume could score up to 4 marks out of 6. A few candidates changed the given formula from r^3 to r^2 and so scored zero. A very common error was to use the radius of the raindrop instead of finding its volume. Such candidates avoided the use of standard form in a calculation and were limited to the 1 or 2 marks available for the volume of the bowl. If candidates worked to full accuracy, they should have reached the answer 6.25 × 10^{13}. A few candidates rounded interim values, but usually scored 5 marks. The mark scheme shows an anticipated alternative, more efficient, method that avoids the need to calculate the two volumes. However, with such a small entry, this method was not seen.	
			Total	**6**		
20			Answer 800 with 2, 5 and 4000 seen	4	**B1** for at least two of the values 5, 2 and 4000	For B1 condone trailing zeros For M2 and M1

					M2 for $\frac{their\ 4000}{0.5 \times their\ 5 \times their\ 2}$ oe or **M1** for $\frac{1}{2} \times their\ 5 \times their\ 2$ *their* values can be 3951, 5.03, 1.96 or other rounded relatable values **Examiner's Comments** A number of candidates answered this correctly using values rounded to one significant figure. In questions that ask for an estimation in the demand, candidates should round the given values to one significant figure before attempting any calculation. A number of candidates worked with the given values in the question making the calculation much more difficult and not answering the demand. Other made errors in calculating the triangular area and did base × height rather than base × height ÷ 2. A few converted units from km to metres which was unnecessary and led to errors.
			Total	**4**	
21	a		20π final answer	4	**M2** for $\sqrt{8^2+6^2}$ oe or **M1** for 6^2 and 8^2 oe **M1dep** for 2 × π × their *r* Accept e.g. C = 20π M2 implied by 10 M1 dep on at least M1 **Examiner's Comments** A few candidates answered this part well, finding the radius first using Pythagoras' and then calculating the circumference in terms of π. A small number attempted an evaluation using a value of π which was not required in the demand. A few candidates did not attempt to find the radius and attempted area calculations with 6cm and 8cm. There were some candidates that omitted this part.
	b		8π final answer	4	

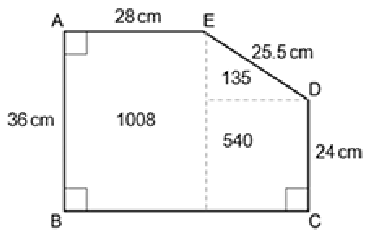
					B2 for $x = 45$ or $\frac{45}{360}$ oe or $\frac{2[\pi]}{2[\pi]8}$ oe or **M1** for $\frac{x}{360} \times 2 \times \pi \times 8 = 2\pi$ oe **M1** for $\frac{their\ 45}{360} \times \pi \times 8^2$ oe or $\frac{x}{360} \times \pi \times 8^2$ 0 < *their* 45 < 90 M1 for e.g. $\frac{2[\pi]}{2[\pi]8} \times \pi \times 8^2$ **Examiner's Comments** A small number of candidates were successful and gave a correct response. Most candidates found this part more challenging than part (a) and many struggled to find the fraction of the circle represented by the sector or the angle x. Some showed understanding however of how to find the area of the sector for their angle x.
			Total	8	
22	a		$y \le x + 4$ oe and $y < 9$	3	**B2** for $y \le x + 4$ oe or **B1** for $y \ldots x + 4$ oe but with = or an incorrect inequality symbol **B1** for $y < 9$ Accept inequalities in either order **Examiner's Comments** A small number of candidates fully answered this part correctly. Some candidates found the equations for both boundary lines but were unable to write the correct inequality to describe the region. Candidates were more successful in giving $y < 9$ than $y \le x + 4$. Many struggled to find the equation of the boundary line $y = x + 4$ using the parallel line property with $y = x$ and having y – intercept 4.
	b		12 nfww	4	**B2** for (2, 6) and (6, 6) or (5, 9) and (9, 9) identified or for base 4 and perpendicular height 3 May be seen on diagram Must identify base

					both identified or **B1** for (2, 6) or (6, 6) or (5, 9) or (9, 9) or for base = 4 or height = 3 AND **M1** for *their* base × *their* perpendicular height **Examiner's Comments** This part was omitted by many candidates. A small number attempting this were successful and others earned method marks by annotating the diagram with correct values for the length and/or the perpendicular height of the parallelogram. Some wrote coordinates of vertices and received partial credit. A misconception for some was to write 3 as the slant height of the parallelogram.	and perpendicular height of parallelogram in working or on diagram Do not allow if slant height used
			Total	**7**		
23			1763 or 1763.4 to 1763.5 with correct working	6	**M2** for $\frac{1}{2}$× 72 × *their* 65.25… × sin 25 or **M1** for [AC=] 72cos 25 or 72sin 65 oe **M3** for $\frac{1}{2}$× *their* 65.254 × *their* 42.24…× sin34 oe or **M2** for [AB=] $\frac{their 65.25\ldots \times sin38}{sin108}$ oe or **M1** for $\frac{AB}{\sin 38} = \frac{their 65.25\ldots}{\sin 108}$ oe If **0**, **1** or **2** scored award **SC3** for answer 1763 or 1763.4 to 1763.5 with no or insufficient working If **0** or **1** scored award **SC2** for 992.79… or	"Correct working" requires evidence of at least **M2** or **M1 M1** condone answers in range 1750 – 1780 with full correct working **M2** implied by 992.79… or 992.8 or maybe by 985 – 999[…] nfww or **M1** implied by [AC=] 65.2[5…] or 65.3 **M3** implied by 770.69… or 770.7 or maybe by 760 – 783 nfww **M2** implied by [AB=] 42.2[4…]accept any correct

					992.8 or 770.69… or 770.7 with no or insufficient working	method e.g. **M2** for area of triangle ACD = ½ × 72sin25 × 72cos25 oe or **M1** for [CD=]72sin25 implied by 30.4… For additional information refer to '2024 November, J560/04, Mark Scheme Appendix: item 3' within downloadable extra resource materials.
					<u>Examiner's Comments</u> Triangle ACD has a right angle so the use of sine or cosine is expected, and many candidates did do this. However, triangle ABC does not have a right angle, therefore, to solve this triangle they need to use either the sine rule, which was best choice here, or the cosine rule. The usual trigonometric functions are not valid in this triangle. Also, the length of side AC has to be calculated from triangle ACD and it must be used with sufficient accuracy in triangle ABC otherwise the answer calculated will be significantly different from the required accurate answer.	
			Total	**6**		
24			2.6 g/cm^3 or g cm^{-3}	2 1	**M1** for 36 920 ÷ 14 200	Allow clear correct conversions to other units so 0.0026, 2600 or 2 600 000 score **2** marks for **M1** condone figs 36 920 ÷ figs14 200 Units correct or consistent with *their* answer e.g. 0.0026 kg/cm^3,

					2600 kg/m^3, 2 600 000 g/m^3 or 2.6 kg/dm^3 Accept units in words including use of "per". **Examiner's Comments** Many correctly divided 36 920 by 14 200 to get 2.6 but not all of them were able to give the units correctly, some giving g^2. Some candidates attempted to change the units to kilometres and kilograms, neither was requested and it was unnecessary work that made the question more difficult.
			Total	**3**	
25			4 655 to 4 655.7 or 4 656	4	**B2** for 21 or **M1** for $\frac{8.4}{2} \times 5$ oe and **M1** for $\Pi \times 8.4^2 \times$ *their* 21 Condone answer of 4652.7… or 4653 or 4656.9… or 4657 **Examiner's Comments** Many were able to find the height of 21 cm, but they could not use the correct formula for the volume of the cylinder.
			Total	**4**	
26			7.728 to 7.731 **nfww**	4	**B2** for 461.8[1…], 462 or 147π or **M1** for $\frac{1}{3}\pi \times 7^2 \times 9$ AND **M1** for $\sqrt[3]{their\left(\frac{1}{3}\pi \times 7^2 \times 9\right)}$ oe Accept answer 7.7 after **B2** seen *Their* value must come from correct substitution into given formula
			Total	**4**	
27			9.40 or 9.397 to 9.398	4	

					B1 for [ABC =] 85 **soi** AND **M2** for [AC =] $\frac{8 \times \sin(85 \text{ or } \textit{their} \text{ ABC})}{\sin 58}$ or **M1** for $\frac{\text{AC}}{\sin(85 \text{ or } \textit{their} \text{ ABC})} = \frac{8}{\sin 58}$ **oe**	Accept 9.4 with working May be seen on diagram or within **M2/M1** expressions
			Total	**4**		
28	a		BF = DE or BF = 4*t* and [opposite sides of a] rectangle [are equal] AB = BF [= 4*t*] and radii [of a sector/circle]	1 1	For **2 marks**, 4*t* must be seen in at least one statement as BF or on the diagram as BF	
	b		ABF = 65 and BC = 2*t* $\frac{\textit{their } 65}{360} \times 2\pi \times \textit{their } 4t$ $\frac{25}{360} \times 2\pi \times 2t$ $4t + 2t + 4t + 2t$ $\frac{25}{360} \times 2\pi \times 2t + \frac{65}{360} \times 2\pi \times 4t$ $+4t + 2t + 4t + 2t$ $\frac{31}{18}\pi t + 12t$	B1 M1 M1 M1 A1		Stated or seen on diagram All **M** marks may be seen within a summarising expression Condone 8*t* + 4*t*, 6*t* + 6*t* etc but not 12*t*
			Total	**7**		
29			1683 with correct working	6	**M2** for $\sqrt{25.5^2 - 12^2}$ or **M1** for $[\ldots]^2 + 12^2 = 25.5^2$ or **B1** for 12	"Correct working" requires evidence of either **M2** or **M1 M1** **M2** implied by 22.5

					Accept any correct method for the area e.g. **M1** for (28 + *their* 22.5) × 36 or 1818 **M1** for $\frac{1}{2}$× *their* 22 5 × 12 or 135 **M1** for *their* 1818 – *their* 135 If **0**, **1** or **2** marks scored, instead award **SC3** for answer 1683 with no or insufficient working If **0** or **M1** scored, instead award **SC2** for 22.5 with no or insufficient working	Alternative method **M1** for 28 × 36 implied by 1008 **M1** for $\frac{1}{2}$× (36 + 24) *their* 22 5 implied by 675 **M1** for *their* 1008 + *their* 675 OR **M1** for 28 × 36 implied by 1008 **M1** for 24 × *their* 22 5 + $\frac{1}{2}$× *their* 22 5 × 12 implied by 540 + 135 **M1** for *their* 1008 + *their* 540 + *their* 135 i.e. adding all *their* areas together Note: **M1 M1 M1** for the area requires a correct method
					 	
			Total	**6**		
30	a		[AC =] $\frac{3}{\cos 30}$ oe [AC =] $\frac{6}{\sqrt{3}}$ or better $\frac{40}{360}\times\pi\times\left(their\ \frac{6}{\sqrt{3}}\right)^2$ $\frac{40}{360}\times\pi\times\frac{36}{3}$ or better or $\frac{1}{9}\times\pi\times\frac{6}{\sqrt{3}}\times\frac{6}{\sqrt{3}}$ $=\frac{4}{3}\pi$	M2 A2 M1 A1	**M1** for $\frac{3}{AC}$= cos 30 **oe** or for $\frac{\sin 60}{3}=\frac{\sin 90}{AC}$ oe **B1** for cos 30 = $\frac{\sqrt{3}}{2}$ **oe** With no errors seen	Accept any variable for AC provided not incorrect length Accept longer methods using 3 tan30 to find BC then Pythagoras' or sine rule **M2** for AC explicit **oe** for **B1** e.g. sin 60 = $\frac{\sqrt{3}}{2}$ **Dep** on at least **M1**

						Accept $\frac{1}{9}\times\pi\times\frac{6^2}{3}$
	b		$\frac{3\sqrt{3}}{2}+\frac{4}{3}\pi$	3	**M1** for $\frac{1}{2}\times 3\times\frac{6}{\sqrt{3}}\times$ sin 30 **FT** *their* AC from **(a)** or for $\frac{1}{2}\times 3\times 3\times$ tan 30 **B1** for sin 30 = $\frac{1}{2}$ **oe** or for tan 30 = $\frac{\sqrt{3}}{3}$ **oe**	Accept e.g. $\frac{18\sqrt{3}}{12}+\frac{4}{3}\pi$ for **3** marks
			Total	**9**		
31			17.5 to 17.6 with correct working	6	**M2** for $AC=\frac{8\sin 60}{\sin 20}$ or **M1** for $\frac{AC}{\sin 60}=\frac{8}{\sin 20}$ oe **A1** for 20.2 to 20.3 AND **M2** for $\sqrt{their20.3^2+6^2-2\times their20.3\times 6\times\cos 55}$ or **M1** for *their*$20.3^2+6^2-2\times$ *their*$20.3\times 6\times\cos 55$ If **0**, **1** or **2** scored, instead award **SC3** for 17.5 to 17.6 with no working or insufficient working If **0** or **1** scored, instead award **SC2** for 306.6 to 308.4 with no working or insufficient working If **0** scored, instead award **SC1** for 20.2 to 20.3 with no	'Correct working' requires evidence of at least **M1M1** **A1** implies **M2** after **M1** seen *Their* 20.3 or 20 from use of trig May be performed in stages

					working or insufficient working

Examiner's Comments

Over 30% of candidates scored 6 marks and a further 20% scored 3, 4 or 5 marks. The remainder generally scored 0 marks due to incorrect assumptions, such as that BAC is a right angle, or ABCD is a cyclic quadrilateral, or AD and BC are parallel.

Successful candidates often recognised that two stages would be necessary and also that the first step required use of the sine rule. As a result, there were many solutions that quickly and correctly found AC to be 20.25…. Some were less efficient in their method (for example, first finding BC by the sine rule and then AC by the cosine rule), but they usually reached the correct value for AC in the end.

The next step caused greater difficulty. Some assumed ADC was a right angle and used Pythagoras' theorem or right-angled trigonometry. Those that realised they needed to use the cosine rule usually substituted accurately into the formula, but there were the usual occurrences of incorrect processing in separating cos55 from 2*bc*. Premature rounding of the value of AC resulted in a few candidates losing the final accuracy mark.

Assessment for learning

When presented with geometric diagrams, right angles will normally be indicated by notation and may also be referred to in the text, unless their identification is part of the assessment, (e.g. angle in a semicircle).

Similarly, parallel lines will normally have arrow notation on the diagram and may be referred to as parallel in the text (or implied, for example from a quadrilateral being described as a parallelogram).

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2">Assessment for learning

Many candidates struggled to evaluate the cosine rule correctly. While the cosine rule was given on the formulae sheet this series, there are still generally 3 marks available for its use; one for correct substitution, one for reaching an acceptable response for a^2 and one for reaching an acceptable response for a (it is unlikely there would be extra evaluation marks). Mistakes were made and marks lost by finding $b^2 + c^2 - 2bc$, an unnecessary and an incorrect step in the evaluation.

Candidates are advised to write down the whole expression for a^2, then enter that into their calculator, write down the answer and then finally show the square root step.

Some candidates wrote ‘ANS’ in their calculations. While this was condoned if the correct answer followed, it is not best practice. In a question like this, the value of ‘ANS’ actually changes several times. It is good practice to use the ‘ANS’ function on the calculator to preserve accuracy, but in written working it is better to write the actual values (for example, ‘20.25…’).</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td colspan="2"></td></tr>
<tr><td>32</td><td></td><td></td><td>13.5 and 6.5 with correct working</td><td>5</td><td>M2 for [h^2 =] $12.5^2 - 12^2$ or better
or M1 for $12^2 + h^2 = 12.5^2$ or better

B1 for $h = 3.5$

AND

M1 for 10 + their 3.5 soi by 13.5 or 10 – their 3.5 soi by 6.5</td><td>‘Correct working’ requires evidence of Pythagoras or quadratic

Accept $\frac{27}{2}$ and $\frac{13}{2}$

Allow other letters or $t - 10$ for h and allocate marks as per main method

Accept -3.5 or ±3.5

Their 3.5 from use of Pythagoras</td></tr>
</table>

					If **0**, **1** or **2** scored, instead award **SC3** for both 13.5 and 6.5 as answers with no or insufficient working If **0** or **1** scored, instead award **SC2** for either 13.5 or 6.5 as answer with no working or insufficient working	<u>Alternative method 1:</u> **M3** for $t^2 - 20t + 87.75 = 0$ or **M2** for $144 + t^2 - 20t + 100 = 156.25$ or **M1** for $12^2 + (t - 10)^2 = 12.5^2$ AND **M1** for correct method to solve *their* 3-term quadratic
					<u>Examiner's Comments</u> 20% of candidates omitted this question. The key to success was realising that because it involved the distance between two points, Pythagoras' theorem would be needed. Candidates who marked a point for (12, *t*) and drew a line to (0, 10) often proceeded to full marks (with the exception of those who marked (12, 0)). Successful candidates usually set-up an equation such as $12^2 + h^2 = 12.5^2$ or $12^2 + (t - 10)^2 = 12.5^2$, rearranged and solved to find $h = 3.5$ or $t - 10 = \pm 3.5$ and hence the answers. Candidates who stopped at $h = 3.5$ scored M2B1 if working was shown. Incorrect uses of Pythagoras' theorem came from using (12, 0) or (*h*, 12). Methods equating the given distance of 12.5 to a gradient formula $(\frac{y-y_1}{x-x_1})$ or using it within $y = 12.5x + c$ were very common and unproductive. Others used 12.5 – 12 = 0.5 to get answers of 9.5 and 10.5. There are alternative longer methods involving trigonometry, but they were rarely seen and few attempts were free of error.	
			Total	**5**		
33			980	2	**M1** for 1.4 × 700	

			Total	**2**	
34	a		$\frac{30}{360} \times \pi \times 12^2$ oe 37.69 to 37.704	M2 A1	**M1** for $\pi \times 12^2$ implied by 144π or 452.3 to 452.45 **A0** for just 37.7 **M2** oe e.g. $\frac{360}{30} = 12$ and $\frac{\pi \times 12^2}{12}$ Condone 3.14 or $\frac{22}{7}$ for π in **M** marks **M0** for 12π without working **<u>Examiner's Comments</u>** This was answered well, with most candidates substituting directly into the formula for the area of a sector. This was a 'Show that…' question, so sufficient working needed to be seen for the full 3 marks. For example, $\frac{30}{360}$(or the interim step $\frac{360}{30} = 12$ rather than just 12) needed to be seen. Jumping straight from 12π to the given 37.7 also did not satisfy the demand, as a more accurate response such as 37.69… should be shown. Those candidates that didn't score often tried methods such as splitting the sector into a triangle and another area then applying trigonometry or Pythagoras' theorem, or trying to include the parallelogram within their calculations.
	b		68.5 to 68.6 nfww	4	<u>With area of parallelogram as 120 or from an attempt at 20 × 6:</u> **M3** for $\frac{their(20 \times 6) - 37.7}{their(20 \times 6)}$[× 100] oe or **M2** for *their* (20 × 6) – 37.7 implied by 82.3 or for $\frac{37.7}{their(20 \times 6)}$[× 100] implied by 31.4 to 31.5 or **M1** for 20 × 6 implied by 120 If 120 not used, *their* (20 × 6) must come from attempt at 20 × 6 Note there are other methods for finding area of a parallelogram 37.7 may be *their* more accurate 37.69 to 37.704 from **(a)** **M3** oe e.g. 100 – $\frac{37.7 \times 100}{their(20 \times 6)}$

					<u>If correct method for area of parallelogram is not shown or an incorrect value is used:</u> If A > 37.7 **SC2** for $\frac{A-37.7}{A}$[× 100] oe or **SC1** for $\frac{37.7}{A}$[× 100]	e.g **SC2** for $\frac{240-37.7}{240}$[× 100] oe For **SC** marks method must be shown; do not imply from an answer only
					<u>Examiner's Comments</u> The question had a relatively high omission rate, with a large number of candidates seemingly not knowing how to find the area of a parallelogram even when given the perpendicular height. For the parallelogram's area, base length × slant length (20 × 12, leading to 240 cm^2) was very commonly used. Many lengthy methods that involved partitioning the parallelogram into smaller areas were seen, sometimes two triangles and a rectangle, but also more awkward shapes as a result of using sectors. Very occasionally these complex methods did reach exactly 120 cm^2, but more often than not they were inaccurate or completely wrong. Most candidates that reached an area for the parallelogram (even if incorrect) were able to find the unshaded area as a percentage of the whole and so were able to earn the 2 marks allocated to the percentage stage.	
			Total	**7**		
35			$12\sqrt{3}$ + 16 π final answer with correct working	7	**M1** for angle of major sector = 240° or $\frac{240}{360}$ oe soi **M1** for $\frac{their\ 240}{360}$ × 2 × π × 12 **A1** for 16 π AND	Correct working requires evidence of at least M1M1M2 For M1 accept e.g. $\frac{2}{3}$ soi 240 may be on diagram For M1 120 ≤ *their* 240 ≤ 300 but not 180

						$24\pi \div 3 \times 2$ oe eg done in stages implies M1M1
					M2 for [2 ×] 12 cos30° oe	M2 oe accept e.g. [AB^2 =] $12^2 + 12^2 - 2.12.12.\cos 120$ or $\frac{12\sin 120}{\sin 30}$, [2×] $\sqrt{12^2 - (12\sin 30)^2}$ oe
					or **M1** for $\frac{x}{12}\cos 30$ oe	where x is ½ AB M1 for any correct implicit method for finding AB or ½ AB
					B1 for cos 30 = $\frac{\sqrt{3}}{2}$ soi **A1** for $12\sqrt{3}$ If 0, 1 or 2, scored instead award **SC3** for answer $12\sqrt{3}$ + 16 π If 0 or 1 scored, instead award **SC2** for $12\sqrt{3}$or 16π in answer	In this method and other methods used, B1 is awarded for the correct trig value[s] associated with their method for find [½]AB, even if their method is incorrect, not just seen in a table of trig values unless selected Award maximum of 6 marks if answer incorrect SEE AG
					The length AB or $\frac{1}{2}$AB ($12\sqrt{3}$ oe or $6\sqrt{3}$oe may be seen unsimplified e.g. $2\sqrt{108}$or $\sqrt{108}$) can be obtained by a number of different methods. M2 is for the explicit method leading to AB or $\frac{1}{2}$AB and examples of this are in the guidance column of the scheme M1 is for a correct **implicit** method The B mark is awarded for a correct trig value[s] for their chosen method Implicit methods may include $AB^2 + (12\sin 30)^2 = 12^2$ oe or better Award B1 for sin 30 = $\frac{1}{2}$soi	

					$\cos 120 = \frac{12^2+12^2-AB^2}{2\times12\times12}$ oe or better Award B1 for $\cos 120 = -\frac{1}{2}$ soi $\frac{\sin 120}{AB} = \frac{\sin 30}{12}$ oe or better Award B1 for $\sin 120 = \frac{\sqrt{3}}{2}$ **and** $\sin 30 = \frac{1}{2}$ soi **<u>Examiner's Comments</u>** This proved to be a challenge for many candidates. Those who annotated the diagram tended to be more successful. For the major arc length, a number did not identify 240° as the angle for the sector. Errors included finding the full circumference, using the minor sector angle 120° or using the area formula for the sector. More successful responses were methodical and showed clear working leading to the correct arc length 16π. Most candidates attempted to calculate the length of AB and there were a number of methods seen. The most concise method was using 12cos30 to get $6\sqrt{3}$ and then multiplying by 2, which gave an answer presented as a simplified surd. Some found the height of triangle OAB first by using sin30 to get 6 cm, then used Pythagoras' theorem to find $\frac{1}{2}AB$ before multiplying by 2. Those that used the sine rule to find the length of the chord AB did not always know the value of sin120 and hence struggled to complete the calculation. Similarly, the candidates who used the cosine rule did not always know the value of cos120, or incorrectly used cos30 or 2cos60 instead of cos120. For many attempting the length AB, there was working all over the page showing multiple attempts without any selection of a final method, which led to the inability to award method marks.
			Total	**7**	
36			$R = \sqrt[3]{2}x$ or $R = \sqrt[3]{2x^3}$ final answer	4	Condone r for R throughout Answer $\sqrt[3]{2}x$ or $\sqrt[3]{2x^3}$

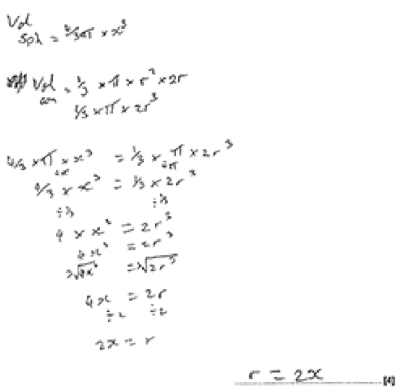
	allow M3 For method marks condone 3.14, 3.142 or $\frac{22}{7}$ for π For method marks ignore any units
M3 for $12[\pi]x^3$ or $6[\pi]R^3$ or better Or **M2** for $\frac{4}{3}[\pi]x^3 = \frac{1}{3}[\pi] \times R^2 \times 2R$ oe	For M3 removes fractions and simplifies terms in R M3 accept e.g. $2x^3 = R^3$
or **M1** for $\frac{1}{3}\pi \times R^2 \times 2R$	Must see correct expression in R for M1

<u>Examiner's Comments</u>

Many candidates were able to score some marks on the question, but only a few gave a fully correct response. Candidates often scored 2 marks by correctly substituting R and $2R$ into the cone formula and x into the sphere formula and then equating them, but they generally struggled to simplify further. A common error was not simplifying $R^2 \times 2R$ within the formula for the volume of the cone. Many were also unable to simplify the fractions and so struggled to reach $2x^3 = R^3$.

Those that did reach $2x^3 = R^3$ were sometimes unable to deal with the cube root correctly and gave final a response of $2x = R$.

Exemplar 2



					In this example the candidate shows a correct method as far as $4x^3 = 2R^3$, which earns 3 method marks. Following this they attempt to cube root but do it incorrectly. The mistake seen here was one made by a number of candidates.
			Total	**4**	
37			1800 final answer and 200 and 9 shown	3	**M2** for 200 × 9 or **M1** for *their* 200 × *their* 9 or **B1** for 200 and 9 seen For M1 e.g. uses 198 and 8.9 or uses incorrectly rounded values **<u>Examiner's Comments</u>** This question was very well answered. Some incorrectly rounded 8.9 to 10, leading to a final answer of 2000. Others divided rather than multiplied. Partial credit was given for rounding correctly to 200 and 9, as well as for multiplying their rounded or unrounded values.
			Total	**3**	
38			2219.9… or 2220 with correct working	6	**M2** for cos […] = $\frac{72-52}{52}$ oe or **M1** for 72 – 52 or 20 and **M2** for $\frac{1}{2}$× 52 × 52 × sin *their* 134.76… oe or **M1** for $\sqrt{52^2-(their 20)^2}$ oe or 48 and **M1** for $\frac{1}{2}$ ×*their*96 × *their*20 oe and **M1** for $\frac{their\ angle\ AOB}{360} \times \pi \times 52^2$ "Correct working" requires evidence of at least **M2** or **M1 M1** Accept answers in the range 2217 to 2226. Accept any correct method. **M2** implied by 67.38… or 134.76… rot to at least an integer e.g. 67, 67.3, 67.4, 67.38, 134, equivalent method includes cos[…] = $\frac{52^2+52^2-96^2}{2\times52\times52}$ condone with 72 instead of 96

					or **B1** for $\pi \times 52^2$ If **0**, **1** or **2** scored award **SC3** for the correct answer with insufficient working If **0** or **1** scored award **SC2** for 3179.918… or 5314.718.. rot to at least an integer with insufficient working **M2** for finding the area of the triangle OAB implied by 960 *their* 134.76… must come from a correct attempt to find angle AOB and condone using AB = 72 for **M2** and **M1** including $\sqrt{52^2 - 36^2}$ for **M1** **M1** implied by 3176 to 3186 or **B1** implied by 2704π, 8490 to 8496 alternative method using major sector: **M2** for angle as before implied by 225, 225.2, 225.23 or 225.24 **M2** for area of triangle as before or **M1** for the third side e.g. 48 **M1** for $\left[\frac{\textit{their reflex angle AOB}}{360}\right] \times \pi \times 52^2$ or 5314.718.. **<u>Examiner's Comments</u>** The key to solving this problem was to realise that the area of the triangle OAB was required and hence the perpendicular height of this triangle was also required. The most common error was to attempt to find the shaded area by either treating it as a triangle with base AB and height 32 cm, or as a semicircle (usually with a radius of 32 cm). Many were unable to find the angle AOB and did not realise the triangle was isosceles, so it could be divided into two identical right-angled triangles that would make the calculations easier.
			Total	6	

39			Accept answers that round to 15.5 with correct working	6	**M2** for $\frac{8 \times \sin 30}{\sin 13}$ oe or **M1** for $\frac{8}{\sin 13} = \frac{[\ldots]}{\sin 30}$ oe AND **M3** for correct cos rule with cos as the subject $\frac{12^2 + (their\ 17.781\ldots)^2 - 7^2}{2 \times 12 \times (their\ 17.781\ldots)}$ oe or **M2** for the above **(M3)** with one error or wrong angle selected or for $7^2 = 12^2 + (their$ $17.781\ldots)^2 - 2 \times 12 \times (their$ $17.781\ldots) \times \cos[\ldots]$ or **M1** for the above **(M2)** with one error or wrong angle selected If **0** or **1** or **2** scored, instead award **SC3** for 15.5 (or an answer rounding to 15.5) with no working or insufficient working If **0** or **1** scored, instead award **SC2** for 0.961 to 0.965 with no working or insufficient working If **0** scored, instead award **SC1** for [QS =] 17.7 to 17.8 with no working	"Correct working" requires evidence of at least **M1** AND **M2** (17.781…) (0.963…) e.g. for $\frac{7^2 + (their\ 17.781\ldots)^2 - 12^2}{2 \times 7 \times (their\ 17.781\ldots)}$ e.g. for $12^2 = 7^2 + (their$ $17.781\ldots)^2 - 2 \times 7 \times (their$ $17.781\ldots) \times \cos[\ldots]$
			Total	**6**		

40			$20\sqrt{3}$ final answer	3	**M1** for ½ × 10 × 8 × sin 60 oe **B1** for sin 60 = $\frac{\sqrt{3}}{2}$	
			Total	**3**		
41			$9^2 + 3^2 + 5^2$ oe or better 115 oe or better Does not fit and $11^2 = 121$ or $\sqrt{115}$ lies between 10 and 11 oe	M2 A1 A1	**M1** for $9^2 + 5^2$ or $5^2 + 3^2$ or $9^2 + 3^2$ all oe or better Dep on M2A1	M1 implied by 106, 34, or 90 e.g., $\sqrt{115}$ Accept No and $\sqrt{115}$ is less than 11 or No and $\sqrt{115}$ = 10. […]
			Total	**4**		
42			9 with correct working	6	**B2** for $\frac{83}{90}$ oe or $\frac{7}{90}$ oe or **M1** for $\frac{2}{9} + \frac{7}{10}$ oe soi **M2** dep on M1 for [distance in m =] 700 $\div \left(1 - their\ \frac{83}{90}\right)$ oe or **M1** dep on M1 for 700 = 1 – *their* $\frac{83}{90}$ **M1** for *their* distance ÷ 1000 soi with no further incorrect conversion If 0, 1 or 2 scored then instead award **SC3** for answer 9 If 0 or 1 scored then instead award **SC2** for answer 9000	''Correct working" requires evidence of at least M1M2 or convincing pictorial/alternate convincing approach $0.9\dot{2}$ or $92.\dot{2}\%$ or $0.0\dot{7}$ or $7.\dot{7}\%$. Accept conversion to 3 figs rot $0.\dot{2}$ + 0.7 or $22.\dot{2}\%$ + 70% e.g. 700 ÷ 7 = 100 and 100 × 90 = 9000 allow M1 for 700 ÷ 1000 with no further incorrect conversion seen Must see written distance to convert
			Total	**6**		
43			8.9 with correct working	6		

					M5 for $\sqrt{6.8^2+(4.5\times\tan52)^2}$ OR **M2** for 4.5 × tan 52 oe Or **M1** for tan52 = $\frac{opp}{4.5}$ oe **A1** for 5.7[5…] or 5.8 AND **M2** for $\sqrt{6.8^2+(\textit{their}\ 5.7[5...])^2}$ Or **M1** for 6.8^2 + (*their* 5.7 [5…])^2 If **0**, **1** or **2** scored, instead award **SC3** for answer 8.9 with no or insufficient working If **0** or **1** scored, instead award **SC2** for answer 8.911 or 8.9[1] with no or insufficient working If **0** scored, instead award **SC1** for 5.7[5…] or 5.8 with no or insufficient working	"Correct working" requires evidence of at least **M1M1** or **M2** and also accept 2sf numbers 5.7[5…] or 5.8 can imply **M2** if **M1** given <u>Alternative method (sine rule)</u> **M2** for $\frac{4.5\times\sin52}{\sin(\textit{their}\ 38)}$ oe Or **M1** for $\frac{x}{\sin52}=\frac{5.4}{\sin(\textit{their}\ 38)}$ oe 8.911… or 8.9[1] can imply **M2** if **M1** awarded Allow full and correct equivalent trig. methods to score **M2** in both triangles e.g. using the other angle in the first triangle, i.e. *their* 38
			Total	**6**		
44			12.5 or 12.48 to 12.49 with correct working	6	**M4** for $\frac{4}{3}\times\pi\times6^3=\frac{1}{3}\times\pi\times\left(\frac{2}{3}d\right)^2\times d$ oe **M1** for rearranging *their* equation OR	"Correct working" requires evidence of at least **M2** or **M1M1** **M1** implied by 288π Note they can use

					M1 for $\frac{4}{3} \times \pi \times 6^3$ implied by 905 or 904.[77…] **B1** for [radius of water =] $\frac{2}{3}d$ **M2** for $\frac{1}{3} \times \pi \times \left(\frac{2}{3}d\right)^2 \times d$ = *their* 904.77 Or **M1** for $\frac{1}{3} \times \pi \times \left(\frac{2}{3}d\right)^2 \times d$, condone one error **M1** for rearranging *their* equation e.g. $d^3 = \frac{\text{their } 904.77... \times 27}{\pi \times 4}$ implied by [d^3 =] 1944 or 1943 <u>Alternative method</u> **M4** for $\frac{228\pi}{\frac{1}{3}\pi \times 20^2 \times 30} = \left(\frac{d}{30}\right)^3$ oe **M1** for rearranging *their* equation OR **M1** for $\frac{4}{3} \times \pi \times 6^3$ implied by 904.[77], 904.8 or 288π **M1** for $\frac{1}{3}\pi \times 20^2 \times 30$ implied by 4000π or 12 566[.37…] or 12 566 or 12 566.4 **M2** for $[\text{sf} =] \sqrt[3]{\frac{288\pi}{\frac{1}{3}\pi \times 20^2 \times 30}}$ oe or 0.41601… rot Or **M1** for $\frac{288\pi}{\frac{1}{3}\pi \times 20^2 \times 30}$ oe or 0.072… **M1** for *their* sf × 30 If **0** or **1** scored, instead award **SC3** for answer 12.5 or 12.48 to 12.49	$d = \frac{3}{2}r$ so apply the scheme accordingly, 1944 will become 576 Complete method with trials giving the correct answer can score **6** marks **M1** for each correct trial up to a maximum of **M3**

					with no or insufficient working	
			Total	**6**		
45	a		39.2	2	**M1** for 2 × 5 × 7 oe	
	b		A and 110 000 or [0].098 or A and 1100 **and** 980	2	**M1** for correct use of $(10^3)^2$ oe or correct use of $(10^2)^2$ or $(10^1)^2$ if converted to cm^2	For **M1** ignore units and can be implied by one correct result e.g. 1100 or 980
			Total	**4**		
46			$192\sqrt{73}$ or 1639 to 1641 with correct working	5	**M3** for $\sqrt{19^2-12^2-12^2}$ **oe** or **M2** for $19^2 - 12^2 - 12^2$ **oe** or **M1** for $19^2 = 12^2 + 12^2 + h^2$ or for $12^2 + 12^2$ **oe** implied by 288 or for $\sqrt{12^2+12^2}$ **oe** implied by 16.9…or $12\sqrt{2}$ or for $24^2 + 24^2$ **oe** implied by 1152 or for $\sqrt{24^2+24^2}$ **oe** implied by 33.9[4..], 33.9 …or $24\sqrt{2}$ AND **M1** for $\frac{1}{3}$ × 24 × 24 × *their* 8.5 [4...] or for $\frac{1}{3}$ × 576 × *their* 8.5 [4...] If **0** or **1** scored, instead award **SC2** for $192\sqrt{73}$ or 1639 to 1641 with no or insufficient working	'Correct working' requires evidence of at least three **M** marks Working may be on diagram May be seen in stages Method must be seen for **M3** (8.5[4…] or $\sqrt{73}$) May be seen in stages For **M3** and **M2** condone $12\sqrt{2^2}$ for $(12\sqrt{2})^2$ which may lead to wrong answer for **M2** of 337 or for **M3** of 18.35… *Their* 8.5[4…] must be in the range 8.5[0] to 8.55 and must come from an attempt at 3D trig or 3D Pythagoras

					If **0** scored, **SC1** for $\sqrt{73}$ or 8.5[0] to 8.55 with no or insufficient working	
			Total	**5**		
47	a		[cos BAC =] $\frac{11.6^2+13.1^2-9.2^2}{2\times11.6\times13.1}$ **oe** or better 43.20…	M2 A1	**M1** for $9.2^2 = 11.6^2 + 13.1^2 - 2 \times 11.6 \times 13.1 \times \cos[.]$ **oe** and **M1dep** for 0.7289… or 303.92 cos[.] = 221.53 Dep on at least **M1** scored If **0** scored award **SC1** for 43.20…	Do not reward work from use of 43.2°. **M2** implied by $\frac{221.53}{303.92}$ **oe** and accept 84.64 for 9.2^2 etc **Dep** on previous **M1** For **M2** and **M1** accept alternative methods which must be correct and complete.
	b		52.01 to 52.02 or 52[.0]	2	**M1** for $\frac{1}{2}\times 11.6 \times 13.1 \times \sin 43.2$ …	For **M1** accept alternative methods which must be correct and complete e.g. using a different angle
			Total	**5**		
48	a		16, 29 and 35 in any order with correct working	5	**M1** for $x + 6 + 2x + 9 + 4x - 5 = 80$ may be implied by a subsequent correct equation **M1** for simplifying *their* equation to $ax + b = c$ implied by $7x + 10 = 80$ **M1** for the first correct step in solving *their* $ax + b = c$ e.g. $7x = 80 - 10$	"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 – 6 – 9 + 5

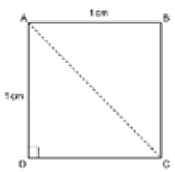
					M1 for substituting *their* 10 into $x + 6$, $4x – 5$ and $2x + 9$ <u>Alternative method using trials</u> **M2** for at least one complete correct evaluation of $x + 6 + 2x + 9 + 4x – 5$ If **0** or **1** scored, instead award **SC2** for 16, 29, 35 in any order with no or insufficient working If **0** scored **SC1** for $x = 10$ with no or insufficient working	**oe** or 70 or **M1** for 6 + 9 – 5 or 10 **M1** for *their* 70 ÷ *their* 7 implied by 10 **M1** for substituting *their* 10 into $x + 6$, $4x – 5$ and $2x + 9$
	b		*Their* fully correct conclusion after **M2** scored	3	**M2** for $\sqrt{(their\ 16)^2 + (their\ 29)^2}$ correctly evaluated or for (*their* 16)^2 + (*their* 29)^2 and (*their* 35)^2 both correctly evaluated OR **M1** for $\sqrt{(their\ 16)^2 + (their\ 29)^2}$ either not evaluated or incorrectly evaluated or for (*their* 16)^2 + (*their* 29)^2 and (*their* 35)^2 either not evaluated or incorrectly evaluated or for (*their* 16)^2 + (*their* 29)^2 correctly evaluated <u>Alternative methods</u> Cosine rule : [cos … =] $\frac{16^2+29^2-35^2}{2\times16\times29}$ = 0.13… or 0.14v hence angle … ≠ 90 [97.928…°] **M1** for correct cos rule statement for angle, **M1** for ≠ 0 OR cos^{-1} or arc cos with 98 and **A1** for	e.g. **3** marks for No, $\sqrt{16^2+29^2} \neq 35$ No, $16^2 + 29^2 = 1097$ and $35^2 = 1225$ or e.g. after 16, 30, 34 Yes, $16^2 + 30^2 = 1156$ and $34^2 = 1156$ Adapt the scheme for equivalent correct methods e.g. Pythagoras using hypotenuse and subtraction

					“No” (**A1 dep** on **M2**) Algebra : **M1** for both $(x + 6)^2 + (2x + 9)^2 = x^2 + 12x + 36x + 4x^2 + 36x + 81 = 5x^2 + 48x + 117$ and $(4x - 5)^2 = 16x^2 - 40x + 25$ [leading to $11x^2 - 88 - 92 = 0$ {which has roots of 8.935… and −0.935…}] and **M1** for substituting $x = 10$ into $5x^2 + 48x + 117$ and $16x^2 + 40x + 25$ and getting 1037 and 1225 for correct reason “No”	
			Total	**8**		
49			[Vol of block ≈ 5 × 2 × 3 =] 30 or [4.8 × 2 × 3 =] 28[.8] or 29 or [5 × 2.1 × 3 =] 31[.5] or 32 or [5 × 2 × 3.2 =] 32 *their* 30 × *their* 9 or 2700 ÷ *their* 30 or 2700 ÷ *their* 9 270 or 90 or 300 Not reasonable **oe** and 2700 g or 0.27[0] kg shown **oe** or Not reasonable **oe** and 90 or 0.09 kg/cm^3 shown or Not reasonable **oe** and 300 and 30 shown	M2 M1 A1 A1	**M1** for 4.8 × 1.1 × 3.2 or with one rounded value[s] **Dep** on at least **M1** **or** for 2700 and *their* 9 used If **M0M0**, **SC1** for two of 5, 2, 3 and 9 used **Dep on M2M1A1**	Throughout question if the candidate attempts to convert to different units this must be done correctly for method marks *Their* 9 is 8.89, 8.9 or 9 Accept 2.7 ÷ *their* 30 *Their* 9 is 8.89, 8.9 or 9 If these calculations are not shown they may be implied by correct figures for the answers Accept e.g. 0.27 kg Accept e.g. 0.09 kg/cm^3 Allow e.g. wrong/not correct for not reasonable Accept implicit comparison with 2.7 kg if 2700 g or 0.27 kg not shown e.g. it should be 10 times heavier
			Total	**5**		
50	a		9	3		

					M1 for sin 30 = $\frac{BD}{18}$ **oe** **B1** for sin 30 = 0.5 **oe soi**	Accept e.g. sin 30 = $\frac{\sqrt{1}}{2}$ Do not allow **B1** if contradicted
	b		$9\sqrt{2}$ or $\frac{18}{\sqrt{2}}$	3	**B2** for $\sqrt{162}$ **or better** **OR** **M1** for $\frac{their\,(a)}{sin45}$ = [*AB*] **oe** or 2(*their* (*a*))^2 **oe** or $\frac{18 \times sin30}{sin45}$[= *AB*] **B1** for sin 45 = $\frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ **oe soi**	For **M1**, accept $\frac{their\,(a)}{cos45}$[= *AB*] oe For **M1**, accept e.g. $\frac{their\,(a) \times sin90}{sin45}$[= *AB*] **M1** implied by e.g. 162 For **B1** accept cos 45 = $\frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ **oe** Do not allow **B1** if contradicted
			Total	**6**		
51			2.91 to 2.93 with correct working	6	First M1 may be on diagram or within other M marks **M1** for BAC = 180 – (37 + 48) or 53 + 42 or 95 AND **M2** for AC = $\frac{6.5 \times \sin 37}{\sin(their\ 95)}$ or **M1** for $\frac{AC}{\sin 37} = \frac{6.5}{\sin(their\ 95)}$ oe AND **A1** for AC = 3.92[6…] or 3.93 (M1A1 implies M2A1)	All methods: “correct working” requires at least **M1**AND**M1**AND**M1** First M1 may be on diagram or within other M marks **M1** for BAC = 180 – (37 + 48) or 53 + 42 or 95 AND **M2** for AB = $\frac{6.5 \times \sin 48}{\sin(their\ 95)}$ or **M1** $\frac{AB}{\sin 48} = \frac{6.5}{\sin(their\ 95)}$ oe AND **A1** for AB = 4.84[8…] or 4.85 (M1A1 implies M2A1)

					AND **M1** for $\frac{AX}{their\ 3.93}$ = sin48 or *their* 3.92 × sin48 oe If 0, 1 or 2 scored, instead award **SC3** for 2.91 to 2.93 with no or insufficient working. If 0 or 1 scored, instead award **SC2** for 3.92[6...] or 3.93 with no or insufficient working. <u>Alternative Method splitting BC:</u> First M1 may be on diagram or within other M marks. Accept other terms for *d*. Do not accept numerical partition of BC. **M1** for BX = *d* and XC = 6.5 – *d* AND **M2** for *d* = $\frac{6.5\tan48}{\tan37+\tan48}$ oe or **M1** for *d*tan37 = (6.5 – *d*) tan48 oe AND **A1** for *d* =3.87 to 3.88 (M1A1 implies M2A1) AND **M1** for $\frac{AX}{their\ 3.87}$ = tan37 or *their* 3.87 × tan37	AND **M1** for $\frac{AX}{their\ 4.85}$ = sin37 or *their* 4.85 × sin37 oe If 0, 1 or 2 scored, instead award **SC3** for 2.91 to 2.93 with no or insufficient working. If 0 or 1 scored, instead award **SC2** for 4.84[8…] or 4.85 with no or insufficient working. First M1 may be on diagram or within other M marks. Accept other terms for *d*. Do not accept numerical partition of BC. **M1** BX = 6.5 – *d* and XC = *d* AND **M2** for *d* = $\frac{6.5\tan37}{\tan48+\tan37}$ oe or **M1** for *d*tan48 = (6.5 – d)tan37 oe AND **A1** for *d* = 2.62 to 2.63 (M1A1 implies M2A1) AND **M1** for $\frac{AX}{their\ 2.63}$= tan48 or *their* 2.63× tan48

					or for $\frac{AX}{(6.5 - their\ 3.87)}$ = tan48 or (6.5 – *their* 3.87) × tan48 If 0, 1 or 2 scored, instead award **SC3** for 2.91 to 2.93 with no or insufficient working. If 0 or 1 scored, instead award **SC2** for 3.87 to 3.88 with no or insufficient working. <u>Alternative Method using Areas</u> The main scheme still applies. The first four marks will be identical and the area method eventually simplifies to the final M1 expression. This is just a much more complex method.	or $\frac{AX}{(6.5 - their\ 2.63)}$tan37 or (6.5 – *their* 2.63) × tan37 If 0, 1 or 2 scored, instead award **SC3** for 2.91 to 2.93 with no or insufficient working. If 0 or 1 scored, instead award **SC2** for 2.62 to 2.63 with no or insufficient working.
			Total	**6**		
52			81.48[…] with correct working	4	**M3** for π × $\left(\frac{32}{2\pi}\right)^2$ OR **M1** for 32 ÷ 2π or 32 = 2π*r* or 32 =π*d* **A1** for 5.09[…] **M1** for π × (*their* 5.09)^2 If 0 or 1 scored, instead award **SC2** for	Correct working requires evidence of at least **M1** Do not accept starting with 81.5 and working backwards Candidates should use the π button or 3.142. Accept 3.14 and 22/7 for max of **M3** **M1** may be in two steps or seen as diameter here and diameter/2 in the area calculation *their* 5.09 must come from a calculation involving π

					81.48[…] with no or insufficient working If 0 scored, instead award **SC1** for 5.09[…], 81.39[…], 81.42[…], 81.52[…] or 325[…] or 326 with no or insufficient working	
			Total	**4**		
53			82 min 30 sec	4	**B3** for 82.5 or $82\frac{1}{2}$ or $82\frac{30}{60}$ or for answer 82m 5s or 82m 50s OR **M1** for $3.3 \times 10^{-6} \times 1.5 \times 10^{9}$ oe soi by figs 495 and **M1FT** for (*their* 4950 ÷ 60)	e.g. $\frac{1.5 \times 10^{9}}{303030[.3\ldots]}$ *their* 4950 from attempt at a correct M1 expression
			Total	**4**		
54			Correctly shows cos 45° = $\frac{1}{\sqrt{2}}$ with supporting working 	4	Using triangle ACD (mark similarly for use of triangle ABC): **B1** for ACD = 45° or CAD = 45° **M2** for [AC =] $\sqrt{1^{[2]} + 1^{[2]}}$ [= $\sqrt{2}$] or for [AC^2 =] $1^{[2]} + 1^{[2]}$ oe and $\sqrt{2}$ or **M1** for [AC^2 =] $1^{[2]} + 1^{[2]}$ OR **B1** for ACD = 45° or CAD = 45° soi by use in cos rule **M2** for $\sqrt{1^{[2]} + 1^{[2]} - 2 \times 1 \times 1 \times \cos 90}$ **and** cos 90 = 0 soi [=	May be on diagram

					$[=\sqrt{2}\,]]$ or **M1** for $1^{[2]} + 1^{[2]} - 2 \times 2 \times 1 \times \cos 90$ OR **B1** for ACD = 45° or CAD = 45° soi by use in sine ratio or sine rule **M2** for [x =] $\frac{1}{\sin 45}$ oe **and** $\sin 45 = \frac{1}{\sqrt{2}}$ soi $[=\sqrt{2}\,]$ or **M1** for $\frac{\sin 90}{x} = \frac{\sin 45}{1}$ oe **AND** **A1dep** for ACD = 45° or CAD = 45° stated/on diagram and cos 45° = $\frac{1}{\sqrt{2}}$ and with no errors seen leading to the answer	**Dep** on **B1M2** A0 for cos = $\frac{1}{\sqrt{2}}$ (without the 45)
			Total	**4**		
55			$\frac{7\pi r}{12}$ with correct working	5	**B4** for correct unsimplified answer with correct working OR **M1** for $\frac{45}{360} \times [2 \times]\pi k$ oe **A1** for $\frac{45}{360} \times 2\pi r$ oe or better isw incorrect cancelling/simplification AND **M1** for $\frac{45}{360} \times [2 \times]\ \pi\frac{4k}{3}$ **A1** for $\frac{45}{360} \times \pi\frac{8}{3}r$ oe or better isw incorrect cancelling/simplification	Condone '×' sign oe in simplified answer if otherwise correct e.g. $\frac{7}{12} \times \pi r$ "correct working" requires **M1A1M1A1** Condone R for r throughout For method marks, allow use of 3.14, 3.142, 22/7 for π Where k is numeric or algebraic **but does not** come from squaring Allow e.g. $k = 3$, r, d, $\frac{3}{7}$, $\frac{3}{7}x$ For A1 accept e.g. 0.25 πr Correct expression

					If 0 or 1 scored, instead award **SC2** for final answer $\frac{7\pi r}{12}$ oe simplified answer with no or insufficient working	implies M1A1 For M1 must use *their* previous *k* e.g. uses *k* = 6 for first M1 then uses 8 here for $\frac{4k}{3}$ gets 2nd M1 **unless** the expression is correctly stated as $\frac{45}{360} \times \pi \frac{8}{3} r$ oe which gets M1A1 Correct expression implies M1A1
			Total	**5**		
56			Answer in range 36 to 42	4dep	**Dep on B1B1** **B1** for bearing of 078° **B1** for bearing of 114° **M1dep** for 5 × *their* RL ±0.1cm soi	Bearings can be short lines. If no lines then L labelled can imply the bearings **Dep** on L marked oe e.g. with cross etc or on 2 intersecting lines Use ruler to measure RL (Do not allow RS measured if no L)
			Total	**4**		
57			2 with correct working	5	**M3** for method for three areas correct or for 3000 **or** 900 and 1500 and 600 nfww	"correct working" requires at least M3 Treat as three separate areas, so trapezium from 0 to 1500 is three areas, trapezium from 0 to 1100 is 2 areas, trapezium from

					or **M2** for method for two areas correct (method towards two from 900, 1500, 600) or **M1** for method for one area correct (method towards 900 or 1500 or 600) or for 1500 seen AND **M1dep** for *their* 3000 ÷ 1500, dep on at least M2 If 0 or 1 scored instead award **SC2** for 2 with no or insufficient working but not from wrong working	600 to 1500 is 2 areas. For M marks, mark method not accuracy, so M1 for $\frac{600 \times 3}{2}$ even if not evaluated as 900.
			Total	**5**		
58			18.5 to 18.6 with correct working	5	**M2** for $\sqrt{2.6^2 + 5.3^2}$ or **M1** for $2.6^2 + 5.3^2$ and **M2** for π × *their* 5.90… oe or **M1** for 2 × π × *their* 5.90… or π × *their* 5.90… × $\frac{1}{2}$ If **0** or **1** scored award **SC2** for answer 18.5 to	"correct working" requires at least **M1** and **M1** or **M2** from use of Pythagoras' theorem or full and correct method using trigonometry **M2** implied by 5.90… *their* 5.90 includes 34.85 or $\frac{697}{20}$

					18.6 with no working or insufficient working	
			Total	**5**		
59	a		6 **nfww**	4	**B3** for 144 min and 150 min or for 0.1h Or **B2** for 144 min or 150 min or for A: 2.4h and B: 2.5h Or **M1** for evidence of time = distance/speed	For **B3** and **B2** accept 2h 24 min and 2h 30 min
	b		3600x/1000 **oe isw**	2	**B1** for 3600x [m/h] or x/1000 [km/s] or x3600/1000 **oe**	For **2** marks, final answer must not have any units within the expression **isw** wrong simplification after correct answer Accept 3.6x For **B1** allow x × 3600 or x ÷ 1000 or these clearly implied in a longer calculation
			Total	**6**		
60			Answer with at least 4 sf rounding to 44.3 with correct working	6	**M1** for [vol =] 240 ÷ 8.66 [= 27.7…] AND **M2** for $\frac{their\,27.7\ldots \times 3}{4 \times \pi}$ **oe** [= 6.6…] Or **M1** for *their* 27.7 = $\frac{4}{3}\pi r^3$ **A1** for r = 1.88 or 1.877[3…] AND **M1** for [SA =] 4 × π × *their* 1.88^2	'Correct working' requires evidence of at least **M1** AND **M1** AND **M1** i.e. using formulas for density, volume and surface area After *their* 27.7 = $\frac{4}{3}\pi r^3$, r = 1.88 or 1.877[3…] scores **M2A1** Condone working in

					If **0** scored, **SC1** for [r =] 1.88 or 1.877[3…] with no working	reverse for a maximum of **2** marks: **M1** for 44.4 = $4\pi r^2$ **A1** for r = 1.88 or 1.879[6…]
			Total	**6**		
61			77 to 78 with correct working	5	Check diagram for incorrect triangle <u>Correct triangle or no triangle indicated</u> **M2** for $\sqrt{3.6^2+2.7^2}$ [= 4.5] or for full alternative method Or **M1** for $3.6^2 + 2.7^2$ [= 12.96 + 7.29] AND **M2** for $5.4\times5.4+4\times\frac{1}{2}\times5.4\times their\,4.5$ Or **M1** for $\frac{1}{2}\times5.4\times their\,4.5$ <u>Incorrect triangle indicated</u> **M1** for complete Pythagoras to find hypotenuse with a maximum of one incorrect dimension If **0** or **M1** scored, instead award **SC2** for answer 77 to 78 with no or insufficient working If **0** scored, **SC1** for 4.5 either	'Correct working' requires evidence of at least **M2** AND **M1** i.e. correct triangle with Pythagoras and area of a triangle e.g. Finding AC, AO, AE then the height (AC = 7.63 to 7.64, AE = 5.24 to 5.25) e.g. EB found as $\sqrt{3.6^2+2.7^2}$ using an incorrect dimension for OB

					correctly placed on diagram or with no working	
			Total	**5**		
62			16 + 6 π final answer with correct working	6	**B3** for [angle at centre] = 135 with correct working or $\frac{3}{8}$[of circle] **oe** Or **M2** for $\frac{[360 \times]24\pi}{\pi \times 8^2}$ oe Or **M1** for $\frac{\theta}{360} \times \pi \times 8^2$ **oe** AND **M2** for answer 16 + k π where $k = \frac{8 \times their\,\theta}{180}$ Or **M1** for $\frac{their\,\theta}{360} \times 2 \times \pi \times 8$ **oe** or answer 16 + k π If **0** scored, **SC2** for answer 16 + 6 π	For full marks 'correct working' requires evidence of at least **M1** AND **M1** i.e. use of formulas for sector area and arc length or alternate convincing approach For **B3** 'correct working' requires at least **M1** for use of formula for sector area **M2** method for finding fraction of circle **M1** Implied by 6 π For **M1** $k \neq 0$ May be on diagram
			Total	**6**		
63			50	4	**M2** for correct method to find area of L-shaped face e.g. 7 × 4 – 6 × 3 Or **M1** for finding one	**M1** could be on diagram

					of the relevant partial lengths of 3 or 6 **M1** for *their* area × 5 OR **M1** for 4 × 5 × 1 **M1** for 6 × 5 × 1 **A1** for 20 or 30 OR **M1** for 7 × 4 × 5 **M1** for 3 × 6 × 5 **A1** for 140 or 90	Treat extra volumes as choice **A1** Implies **M1** Mark as oe for other correct products if split into two different cuboids that make the solid Not 7 × 4 × 5 × 1 × 1 Treat extra volumes as choice **A1** implies **M1** unless 140 comes from 7 × 4 × 5 × 1 × 1
			Total	**4**		
64			10 with correct working	7	**M1** for $\frac{BD}{12}$= sin 30 **oe** **B1** for sin 30 = 0.5 **soi** **A1** for [BD =] 6 **M1** for *their* BD × $\frac{4}{3}$**oe** **A1** for CD = 8 **M1** for (*their* BD)^2 + (*their* CD)^2 [= BC^2] **oe** If **0** scored **SC3** for answer 10 with no working Or **SC2** for CD = 8 with no working	'Correct working' requires evidence of at least **M1** or **B1** and **M1M1** or alternate convincing approach Answer 8 gets **A0** unless CD = 8 shown in working or on diagram **SCs** may be seen on the diagram

					Or **SC1** for BD = 6 with no working	
			Total	**7**		
65			92 or 91.87 to 91.88	6	**M2** for $\frac{45 \times \sin 58}{78}$ **oe** implied by 29.29… Or **M1** for $\frac{\sin 58}{78} = \frac{\sin C}{45}$ **oe** **M1** for [B =] 180 – 58 – *their* 29.292… or 92.7[08…] **M2** for $\frac{78 \times \sin \textit{their}\ B}{\sin 58}$ **oe** Or **M1** for $\frac{[AC]}{\sin \textit{their}\ B} = \frac{78}{\sin 58}$ **oe** Alternative method cosine rule (AC = x) **M3** for quadratic with coefficients evaluated Or **M2** for $x^2 + (-2 \times x \times 45 \times \cos 58) + (45^2 - 78^2)[= 0]$ **oe** Or **M1** for $78^2 = x^2 + 45^2 - 2 \times x \times 45 \times \cos 58$ AND **M2** for correct use of quadratic formula Or **M1** for quadratic formula with at most one error If **0** scored **SC2** for 92 or 91.87 to 91.88 with no working Or **SC1** for 29.3 or 29.29[…] with no working	'Correct working' requires evidence of at least **M2** or **M1M1** i.e. $x^2 - 47.69x - 4059$ [= 0] **oe**
			Total	**6**		
66			Complete correct argument e.g. Angle ABC = 20° [BO =] e.g. $\frac{5}{\sin 10}$	B1 M2 A1dep		Accept any correct method not using 28.79 Could be on diagram and also accept

			28.793…… or 28.794		**M1** for e.g. $\sin 10 = \frac{5}{[BO]}$ Dep on at least **M1**	ABO = 10°, BO'T' = 80° i.e. BO as subject for **M2** and condone sine rule with sin 90° for **M2**
			Total	**4**		
67			81.7	2	**M1** for $\frac{1}{2}$× (7.4 + 11.6) × 8.6 **oe**	
			Total	**2**		
68			201 or 201.2 to 201.5 with correct working	5	Accept any correct method e.g. **M1** for [height =] 28.79 + 5 or 33.79 **M2** for [half base =] $\frac{5}{\tan 40}$ or $\frac{33.79}{\tan 80}$ Or **M1** for tan40 = $\frac{5}{\text{half base}}$ or tan80 = $\frac{33.79}{\text{half base}}$ **M1** for $\frac{1}{2}$× *their* base × *their* height **oe** If **0** scored **SC2** for 201 or 201.2 to 201.5 with no working Or **SC1** for 5.95 to 5.96 or 11.9 to 12 with no working	'Correct working' requires evidence of at least **M2** or **M1M1** Condone use of 6 leading to an answer of 202.7… **M2** implied by e.g. 5.95 to 5.96 or 11.9 to 12.0 e.g. $\frac{1}{2}$× (2 × 5.958…) × 33.793
			Total	**5**		
69			600 ml with three correct comparisons	3	Allow any correct comparison e.g. (converting all to 600 ml)	11.3[3…], 10.8[3…], 10.9p per 100 ml Or 34, 32.5, 32.7p per 300 ml Or 68, 65, 65.4p per

					B2 for three correct figures to compare Or **B1** for two correct figures OR **M1** for one correct appropriate calculation e.g. 2.18 × $\frac{3}{20}$ or 34 × 20 ÷ 3 **oe** — 600 ml Or 226[.6…], 216[.6…], 218p per 2 litres e.g. 32.5[p] is sufficient for **B1** as it compares to 34[p]
			Total	**3**	
70			6.67 or 6.670 to 6.671	4	**B1** for [BAC =] 45 soi AND **M2** for [BC=] $\frac{8 \times \sin(45 \text{ or } their \text{ BAC})}{\sin 58}$ or **M1** for $\frac{BC}{\sin(45 \text{ or } their \text{ BAC})} = \frac{8}{\sin 58}$ oe — Accept 6.7 with working May be seen on diagram or within **M2**/**M1** expressions **<u>Examiner's Comments</u>** Lower performing candidates did not make worthwhile progress, as knowledge of circle theorems and the sine rule needed to be combined to answer the question. Angle CAB is 45° from the alternate segment theorem, although the reason was not required for the award of the mark. However, it was common to misuse the theorem and give the angle as 77°. A few candidates assumed this was an isosceles triangle and therefore worked out the angle as 64°.

					The sine rule work was performed very well by those attempting to finish the question. Many of those candidates who had an incorrect value for angle CAB were still able to use it correctly in the sine rule and so gained two marks out of four.
			Total	**4**	
71	a		BD = EF or BD = 2*t* and [opposite sides of a] rectangle [are equal] BC = BD [= 2*t*] and radii [of a sector/circle]	1 1	For two marks, 2*t* must be seen in at least one statement as BD or on the diagram as BD **<u>Examiner's Comments</u>** Candidates needed to make clear use of BD as the connection between FE and BC alongside supporting reasons. For example, 'BD = FE because they are opposite sides of a rectangle and so BD = 2*t* and then BC = BD because they are both radii of the same sector/circle'.
	b		ABF = 55 and AB = 5*t* $\frac{their 55}{360} \times 2\pi \times$ *their* 5t $\frac{35}{360} \times 2\pi \times 2t$ $5t + 2t + 5t + 2t$ $\frac{35}{360} \times 2\pi \times 2t + \frac{55}{360} \times 2\pi \times 5t$ $+5t + 2t + 5t + 2t$ $\frac{23}{12}\pi t + 14t$	B1 M1 M1 M1 A1	Stated or seen on diagram All **M** marks may be seen within a summarising expression Condone 10*t* + 4*t*, 7*t* + 7*t* etc but not 14*t* **<u>Examiner's Comments</u>** Part (a) served as a prompt for part (b) and most candidates making an attempt deduced that AB = 5*t*, which enabled them to gain a mark if showing the sum of the four straight sides leading to 14*t*. Candidates could also

					gain a mark for having both AB = 5*t* and angle ABF = 55°. The remaining three marks were for the arc lengths of the two sectors and completing the summation of the perimeter to the given answer without error. Some candidates found the areas of the sectors, but then abandoned their work. Generally, those who made an attempt knew what they were doing and completed the task accurately.
			Total	**7**	
72			8.75 to 8.752 nfww	4	**B2** for 670[.2…], 670.3 or $\frac{640}{3}\pi$ or **M1** for $\frac{1}{3}\pi \times 8^2 \times 10$ AND **M1** for $\sqrt[3]{their(\frac{1}{3}\pi \times 8^2 \times 10)}$ oe Accept answer 8.8 after **B2** seen *their* value must come from correct substitution into given formula **<u>Examiner's Comments</u>** Most of the candidates correctly substituted into the volume formula and most evaluated it accurately, gaining two marks. A good number of candidates continued correctly by attempting to find the cube root of the volume. Others made errors, either finding the square root, dividing by six (the number of faces) and then finding the square root, or dividing by twelve (the number of edges).
			Total	**4**	
73	a		$[AC =] \frac{4}{\cos 30}$ oe $(AC =) \frac{8}{\sqrt{3}}$ or better $\frac{45}{360} \times \pi \times \left(their \frac{8}{\sqrt{3}}\right)^2$ $\frac{45}{360} \times \pi \times \frac{64}{3}$ or better	M2 A2 M1 A1	**M1** for $\frac{4}{AC}$= cos30 oe or for $\frac{\sin 60}{4} = \frac{\sin 90}{AC}$ oe Accept any variable for AC provided not incorrect length Accept longer methods using 4

			or $\frac{1}{8}\times\pi\times\frac{8}{\sqrt{3}}\times\frac{8}{\sqrt{3}}$ $=\frac{8}{3}\pi$		**B1** for $\cos 30=\frac{\sqrt{3}}{2}$ **oe** with no errors seen	tan 30 to find BC then Pythagoras' or sine rule M2 for AC explicit oe for **B1** e.g. $\sin 60=\frac{\sqrt{3}}{2}$ dep on at least **M1** Accept $\frac{1}{8}\times\pi\times\frac{8^2}{3}$
					<u>Examiner's Comments</u> This proved challenging for all but some of the higher performing candidates. There were some successful responses that showed each step of reasoning towards the required area. Some were able to set up a correct trigonometric equation to find AC, but then could not recall the exact value of cos 30 that was needed to complete the solution. There were follow-through marks available for the method using their AC to find the area of the sector, provided candidates had considered a correct trig equation to find AC previously.	
	b		$\frac{8\sqrt{3}}{3}+\frac{8}{3}\pi$	3	**M1** for $\frac{1}{2}\times 4\times\frac{8}{\sqrt{3}}\times\sin 30$ FT *their* AC from (a) or for $\frac{1}{2}\times 4\times 4\times\tan 30$ **B1** for $\sin 30=\frac{1}{2}$ **oe** or for $\tan 30=\frac{\sqrt{3}}{3}$ **oe**	Accept e.g. $\frac{16\sqrt{3}}{6}+\frac{8}{3}\pi$ for 3 marks
					<u>Examiner's Comments</u> Fewer candidates were successful here than in part (a) and there were many that omitted this part. Those that were successful used either trigonometry or Pythagoras' theorem with their AC to find BC, before attempting to find the	

					area of the triangle. The concise method using $\frac{1}{2}$× their AC × 4 sin 30 to find the area was seldom seen.
			Total	**9**	
74			960	2	**M1** for 2.4 × 400 **Examiner's Comments** Most candidates recognised that to work out the mass in grams, 2.4 should be multiplied by 400. Many were unable to complete the calculation correctly and responses involving the figures 96, but not 960, were frequent.
			Total	**2**	
75			85.99… to 86 with correct working	5	**B4** for 7395[…] with correct working OR **M2** for correct method to find angle 125 e.g. 53 + 180 –108 or 360 – 108 – (180 – 53) or **M1** for correct method to find angle 72 or 127 e.g.180 –108 or 180 – 53 and **M2** for $\sqrt{35^2 + 61^2 - 2 \times 35 \times 61 \times \cos(\mathit{their}\ 125)}$ or **M1** for [AC^2=] $35^2 + 61^2$ – 2×35×61×cos (*their* 125) If **0, 1** or **2** marks scored, instead award **SC3** for answer 85.99… to 86 with no or insufficient working If **0** or **1** mark scored, instead award **SC2** for answer 7395[…] with no or insufficient working "Correct working" requires at least **M1** from cosine rule **M2** implied by [angle ABC =] 125 **Examiner's Comments**

					The key to this question is finding angle ABC correctly. Most of those who did then went on to use the cosine rule to find AC. Some assumed that the anti-clockwise angle at B equals the clockwise angle at B, 108°, so they found angle ABC to be 144°. They then used the cosine rule correctly to gain some credit. A few assigned 53° to the angle BAC and so they used the sine rule to find angle ACB and then they solved the triangle.
			Total	**5**	
76			4242 with correct working	6	**M2** for $\sqrt{42.5^2 - 20^2}$ or **M1** for $[\ldots]^2 + 20^2 = 42.5^2$ or **B1** for 20 Accept any correct method for the area e.g. **M1** for (48 + *their* 37.5) × 54 or 4617 **M1** for $\frac{1}{2}$× *their* 37.5 × 20 or 375 **M1** for *their* 4617 – *their* 375 If **0**, **1** or **2** marks scored instead award **SC3** for answer 4242 with no or insufficient working If **0** or **M1** scored instead award **SC2** for 37.5 with no or insufficient working "Correct working" requires evidence of either **M2** or **M1 M1** **M2** implied by 37.5 Alternative for area e.g. : **M1** for 48 × 54 implied by 2592 **M1** for $\frac{1}{2} \times (54 + 34) \times$ *their* 37.5 implied by 1650 **M1** for *their* 2592 + *their*1650 OR **M1** for 34 × *their* 37.5 + $\frac{1}{2}$× *their* 37.5 × 20 implied by 1275 + 375 **M1** for *their* 2592 + *their 1275* + *their 375* i.e adding all *their* areas together Note : **M1 M1 M1** for the area requires a correct method **<u>Examiner's Comments</u>** The key piece of information that candidates needed to find was the perpendicular length

					from point E to line CD produced by using Pythagoras' theorem which many were able to deduce. The pentagon can be divided into many different shapes, so we did see quite a variety of approaches. The most common was to make a rectangle using vertices BAE, another rectangle using DC and a right-angled triangle using ED as the hypotenuse. There were some candidates with the correct method, but they made a calculation error in one of the areas.
			Total	**6**	
77	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	Do not reward work from use of 40.5°. **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… or 265 cos[.] = 201.37 **M2** implied by $\frac{201.37}{265}$ oe and accept 67.24 for 8.2^2 etc Dep. on previous **M1** Dep. on at least **M1** scored For **M2** and **M1** accept alternative methods which must be correct and complete. If **0** scored award **SC1** for 40.54… **Examiner's Comments** Most candidates recognised the need to use the cosine rule, though many of them could not fully manipulate the expression to the form with the angle as the subject or wrote the cosine rule for the wrong angle. Most who reached 265 × cos BAC = 201.37 went on to find the angle, but not all of these gave the more accurate 40.54 that was essential to show the value is indeed 40.5 correct to 1 decimal place. Common errors in the method were substituting 40.5 into the formula and finding the length of BC as 8.2 and a very few used right-angled trigonometry thinking that angle B

					was 90°. A few used the sine rule involving the use of 40.5, which enabled them to find the size of the other two angles; this was not an efficient way to proceed, but it was more often used in part (b). **Misconception** Many candidates thought that angle ABC was 90°.
	b		43.02 to 43.07 or 43[.0] or 43.1	2	**M1** for $\frac{1}{2}$ × 10.6 × 12.5 × sin 40.5… — For **M1** accept alternative methods which must be correct and complete e.g using a different angle **<u>Examiner's Comments</u>** There were many correct answers, however some candidates made it harder for themselves by calculating one or both of the other angles before substituting in the values. Not all candidates used the correct sides for their chosen angle, the most common being when using 40.5 as the angle they would use the side 8.2 in their calculation.
			Total	**5**	
78	a		16, 30, 34 in any order with correct working	5	"Correct working" requires evidence of at least **M1** leading to x = 11 or **M2** if using trials **M1** for $x + 5 + 3x + 1 + 2x + 8 = 80$ may be implied by a subsequent correct equation **M1** for simplifying *their* equation to $ax + b = c$ implied by $6x + 14 = 80$ — Note for all methods: x = 11 scores **M1M1M1** if there is some supporting

					M1 for the first correct step in solving *their ax* + *b* = *c* e.g. 6*x* = 80 – 14 **M1** for substituting *their* 11 into *x* + 5, 3*x* + 1 and 2*x* + 8 <u>Alternative method using trials</u> **M2** for at least one complete correct evaluation of *x* + 5 + 3*x* + 1 + 2*x* + 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 **<u>Examiner's Comments</u>** This question was generally very well answered, with most candidates using an algebraic approach and solving the equation correctly. Some attempted to use trials and we required just one complete evaluation of the three expressions with the number tried, then added and the result clearly seen.	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 *their* 66 ÷ *their* 6 implied by 11 **M1** for substituting *their* 11 into *x* + 5, 3*x* + 1 and 2*x* + 8
	b		*Their* fully correct conclusion after **M2** scored	3	**M2** for $\sqrt{(their16)^2 + (their30)^2}$ correctly evaluated	eg **3** marks for

					or for (*their*16)^2 + (*their*30)^2 and (*their*34)^2 both correctly evaluated OR **M1** for $\sqrt{(their16)^2 + (their30)^2}$ either not evaluated or incorrectly evaluated or for (*their*16)^2 + (*their*30)^2 and (*their*34)^2 either not evaluated or incorrectly evaluated or for (*their*16)^2 + (*their*30)^2 correctly evaluated
					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
					<u>Alternative methods</u> Cosine rule : [cos … =] $\frac{16^2+30^2-34^2}{2\times16\times30}$ = 0 hence angle … = 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 $(x + 5)^2 + (2x + 8)^2 = x2 + 10x + 25 + 4x^2 + 32x + 64 = 5x^2 + 42x + 89$ 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 $\sin[\ldots] = \frac{16}{34}$ *and* $\sin[\ldots] = \frac{30}{34}$ 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. **<u>Examiner's Comments</u>** It was expected that Pythagoras' theorem would be used and clearly demonstrated that it holds for these three values, so showing that the largest angle was a right angle. It was not sufficient to just write down 'Pythagoras' theorem', we required to be shown that it holds for this triangle. The cosine rule was another good method, if a little more demanding. Using normal trigonometry is harder as it assumes the right angle and also the other two angles are irrational numbers, so showing they sum to 90 is difficult.
			Total	**8**	
79			$\frac{200\sqrt{41}}{3}$ or 426.6 to 427 with correct working	5	'Correct working' requires evidence of at least three **M** marks Working may be on diagram **M3** for $\sqrt{14.5^2 - 10^2 - 10^2}$ oe — May be seen in stages Method must be seen for **M3** or — (3.2[0] to 3.211 or $\frac{\sqrt{41}}{2}$ or $\sqrt{10.25}$) **M2** for $14.5^2 - 10^2 - 10^2$ oe — (10.25) or **M1** for $14.5^2 = 10^2 + 10^2 + h^2$ — May be seen in stages or for $10^2 + 10^2$ oe implied by 200 or for $\sqrt{10^2 + 10^2}$ oe implied by 14.1…or $10\sqrt{2}$ — For **M3** and **M2** condone $10\sqrt{2}^2$ for $(10\sqrt{2})^2$ which may lead to wrong answer for

					or for $20^2 + 20^2$ oe implied by 800 or for $\sqrt{20^2+20^2}$ oe implied by 28.2[8..], 28.3 …or $20\sqrt{2}$ AND **M1** for $\frac{1}{3} \times 20 \times 20 \times$ *their* 3.2[0] or for $\frac{1}{3} \times 400 \times$ *their* 3.2[0] If **0** or **1** scored, instead award **SC2** for $\frac{200\sqrt{41}}{3}$ or 426.6 to 427 with no or insufficient working If **0** scored, **SC1** for $\frac{\sqrt{41}}{2}$ or $\sqrt{10.25}$ or 3.2[0] to 3.211 with no or insufficient working	**M2** of 190.25 or for **M3** of 13.79… *Their* 3.2[0] must be in the range 3.2[0] to 3.211 and must come from an attempt at 3D trig or 3D Pythagoras

Examiner's Comments

Most candidates realised this was a Pythagoras' theorem question and many were able to start by finding the diagonal of the base as $\sqrt{20^2+20^2}$ or AO as $\sqrt{10^2+10^2}$. Progress from there varied. Most proceeded to $\sqrt{14.5^2-(10\sqrt{2})^2}$ and, while many evaluated this correctly, there were several different errors made. Some made a simple slip and forgot to take the square root and went on to use 10.25 as the

					vertical height, but a more common error was to calculate $10\sqrt{2}^2$ instead of $(10\sqrt{2})^2$ leading to a vertical height of 13.79…. Some candidates worked in decimals rather than exact form. While they mostly managed to avoid these computational errors, they often introduced an accuracy error through premature rounding of interim answers (such as using 14.1 for $10\sqrt{2}$). Very common wrong answers were 1400 (arising from using triangle AOE with AO = 10) and 1933.3… (from assuming the perpendicular height was the same as the slant length of 14.5). Neither of these methods scored a mark as they had bypassed the 3D nature of the demand. It is possible to use trigonometry to answer this question, but these attempts were rare and often made incorrect assumptions such as angle EAO being 45°. This question required candidates to show working. Therefore, candidates should be showing the Pythagoras' theorem or trigonometry calculations rather than just adding lines and lengths to the diagram or presenting a sketch of a right-angle triangle with the three dimensions stated.
			Total	**5**	
80			[Vol of block ≈ 3 × 5 × 2 =] 30 or [3 × 4.9 × 2 =] 29[.4] or [3 × 4.9 × 2 =] 31 or [3 × 5 × 2.2 =] 33 *their* 30 × *their* 8 or 2400 ÷ *their* 30 or 2400 ÷ *their* 8 240 or 80 or 300 Not reasonable **oe** and 2400 g or 0.24[0] kg shown **oe**	M2 M1 A1 A1	**M1** for 3.1 × 4.9 × 2.2 or with one rounded value[s] Throughout question if the candidate attempts to convert to different units this must be done correctly for method marks **Dep** on at least **M1** **or** for 2400 and *their* 8 used *their* 8 is 7.87, 7.9 or 8 If **M0M0, SC1** for two of 3, 5, 2 and 8 used Accept 2.4 ÷ *their* 30 *their* 8 is 7.87, 7.9 or 8

			or Not reasonable **oe** and 80 or 0.08 kg/cm^3 shown or Not reasonable **oe** and 300 and 30 shown		**Dep** on **M2M1A1**	If these calculations are not shown they may be implied by correct figures for the answers Accept e.g. 0.24 kg Accept e.g. 0.08 kg/cm^3 Allow e.g. wrong/not correct for not reasonable Accept implicit comparison with 2.4 kg if 2400 g or 0.24 kg not shown e.g. it should be 10 times heavier
					<u>Examiner's Comments</u> Successful candidates tended to be very efficient in terms of the strategy, getting an estimate for the volume using the rounded values 3, 5 and 2 as a first step, then correctly multiplying the volume by the rounded density of 8 to get to 240 g. After getting to this point, it was rare for candidates not to compare the quantities correctly, but a few incorrectly stated there were 100 g in 1 kg and thus thought Sam's estimate was reasonable. Some candidates correctly estimated the volume, but then used the density formula incorrectly, e.g. 30 ÷ 8. Some did not recognise the need to estimate the values and attempted much more complex arithmetic than was necessary to answer the question. Almost all candidates were able to score at least 1 mark on this question. **Assessment for learning** Reading the question and looking for key	

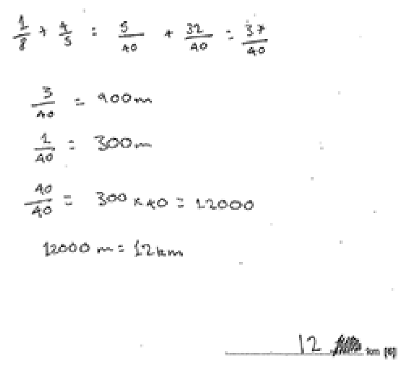
					words within the demand will help candidates to determine next steps. Here the key words 'Use estimation' appears in the demand. The method hence requires rounded values be used, which makes the calculations much easier.
			Total	**5**	
81	a		6	3	**M1** for $\sin 30 = \frac{BD}{12}$ **oe** **B1** for sin 30 = 0.5 **oe soi** Accept e.g. $\sin 30 = \frac{\sqrt{1}}{2}$ Do not allow B1 if contradicted **<u>Examiner's Comments</u>** This question was attempted by most candidates. The majority recognised that it required them to use trigonometry. A small proportion of candidates tried to use angle properties or Pythagoras' theorem and were unsuccessful. Some candidates used the sine rule as opposed to right-angled trigonometry, with varying success. The majority of candidates who used trigonometry correctly identified the need to use sin30 and many completed the calculation to give the correct answer. The most common error for those using trigonometry was using an incorrect value for sin30, or in some cases using cos30.
	b		$6\sqrt{2}$ or $\frac{12}{\sqrt{2}}$ **cao**	3	**B2** for $\sqrt{72}$ **or better** OR **M1** for $\frac{their(a)}{sin45}$ [= *AB*] **oe** or 2(*their* (*a*))^2 **oe** or $\frac{12 \times sin30}{sin45}$[= *AB*] For M1, accept $\frac{their(a)}{cos45}$ [= *AB*] **oe** For M1 , accept e.g. $\frac{their(a) \times sin90}{sin45}$ [= *AB*] M1 implied by e.g. 72

					B1 for $\sin 45 = \frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ oe soi For B1 accept cos $45 = \frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ oe Do not allow B1 if contradicted **Examiner's Comments** Candidates were less successful in this part than in (a). Most candidates who attempted this question used trigonometry rather than Pythagoras' theorem. Those that used sin45 often made a common error in attempting 6 × sin45 rather than $\frac{6}{\sin 45}$. Others using trigonometry used tan45 or were unable to recall the exact value of sin45 within their method. There was a reasonable proportion of candidates who showed a fully correct method, but were unable to simplify their expression involving surds and scored 2 out of the 3 marks. A minority of candidates did not attempt this part at all. **Misconception** Some candidates struggled to rearrange $\sin 45 = \frac{6}{AB}$ to make AB the subject. A common error was 6 × sin45, leading to an incorrect answer of $3\sqrt{2}$.
			Total	**6**	
82			Accept answers that round to 25.7 with correct working	6	**M2** for $\frac{9 \times \sin 30}{\sin 15}$ oe or **M1** for $\frac{9}{\sin 15} = \frac{[...]}{\sin 30}$ oe AND "Correct working" requires evidence of at least **M1** AND **M2** (17.386…)

					M3 for correct cos rule with cos as the subject $\frac{13^2+(\textit{their } 17.386\ldots)^2-8^2}{2\times13\times(\textit{their } 17.386\ldots)}$ oe or **M2** for the above **(M3)** with one error or wrong angle selected or for $8^2 = 13^2 + (\textit{their } 17.386\ldots)^2 - 2\times13\times(\textit{their } 17.386\ldots)\times\cos[\ldots]$ or **M1** for the above **(M2)** with one error or wrong angle selected If **0** or **1** or **2** scored, instead award **SC3** for 25.7 (or an answer rounding to 25.7) with no working or insufficient working If **0** or **1** scored, instead award **SC2** for 0.898 to 0.902 with no working or insufficient working If **0** scored, instead award **SC1** for [QS =] 17.3 to 17.4 with no working **<u>Examiner's Comments</u>** Given the challenge of the question, a reasonable proportion of the candidates	(0.900…) e.g. for $\frac{8^2+(\textit{their } 17.386\ldots)^2-13^2}{2\times8\times(\textit{their } 17.386\ldots)}$ e.g. for $13^2 = 8^2 + (\textit{their } 17.386\ldots)^2 - 2\times8\times(\textit{their } 17.386\ldots)\times\cos[\ldots]$

					realised they needed to find QS first and attempted the sine rule in triangle PQS. Some of these then made some progress with the cosine rule in triangle QRS. 5 or 6 marks were achieved by some candidates who scored less than half marks on the paper as a whole.
			Total	**6**	
83			$10^2 + 6^2 + 4^2$ oe or better 152 oe or better Does not fit and $13^2 = 169$ or $\sqrt{152}$ lies between 12 and 13 oe	M2 A1 A1	**M1** for $10^2 + 6^2$ or $6^2 + 4^2$ or $10^2 + 4^2$ all oe or better M1 implied by 136, 52, or 116 eg $\sqrt{152}$ Dep on M2A1 Accept No and $\sqrt{152}$ is less than 13 or No and $\sqrt{152} = 12.[...]$
			Total	**4**	
84			$14\sqrt{2}$ final answer	3	**M1** for ½ × 8 × 7 × sin 45 oe **B1** for sin 45 = $\frac{1}{\sqrt{2}}$ or better **<u>Examiner's Comments</u>** This was a challenging question and very few responses were seen. **OCR support** A student guide to exact trigonometric ratios, detailing conceptual and pattern spotting techniques, is available here: Teaching activity: 10.05c Exact trigonometric ratios
			Total	**3**	
85			12 with correct working	6	"Correct working" requires evidence of

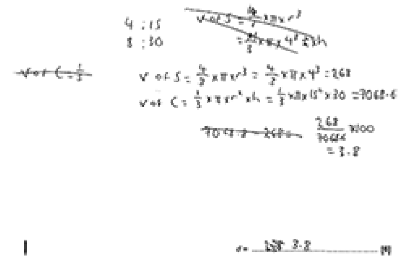
						at least M1M2 or convincing pictorial/alternate convincing approach
					B2 for $\frac{37}{40}$ oe or $\frac{3}{40}$ oe	0.925 or 92.5% or 0.075 or 7.5%
					or **M1** for $\frac{1}{8}+\frac{4}{5}$ oe soi	0.125 + 0.8 or 12.5% + 80%
					M2dep on M1 for [distance in m =] 900 ÷ $\left(1 - their\ \frac{37}{40}\right)$ oe or **M1**dep on M1 for 900 = 1 – *their* $\frac{37}{40}$	eg 900 ÷ 3 = 300 and 300 × 40 = 12000
					M1 for *their* distance ÷ 1000 soi with no further incorrect conversion	allow M1 for 900 ÷ 1000 with no further incorrect conversion seen Must see written distance to convert
					If 0, 1 or 2 scored then instead award **SC3** for answer 12 If 0 or 1 scored then instead award **SC2** for answer 12000	
					Examiner's Comments This question was answered well by more able candidates. Most were able to access the problem in part by adding $\frac{1}{8}$ and $\frac{4}{5}$ and most did this successfully to get $\frac{37}{40}$. Some divided by 3 and then either attempted to multiply by 40 (or 37 in a few cases) with processing errors. A number of candidates could not convert their distance in metres to kilometres. For some, a more	

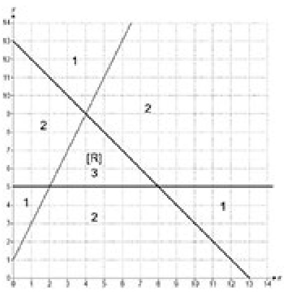
					random approach to the method was shown that did not progress towards the answer. Several candidates incorrectly started by trying to find $\frac{1}{8}$ or $\frac{4}{5}$ of 900. Exemplar 1  This exemplar illustrates a clear systematic approach to working, with each stage set out line by line leading to the correct response.
			Total	**6**	
86	a		A and 120 000 or [0].095 or A and 1200 **and** 950	2	**M1** for correct use of $(10^3)^2$ oe or correct use of $(10^2)^2$ or $(10^1)^2$ if converted to cm^2 — for **M1** ignore units and can be implied by one correct result e.g. 1200 or 950 **Examiner's Comments** Many candidates treated the units as length, so the use of 1000 was prevalent. The most successful responses converted both numbers to cm^2.
	b		39	2	M1 for 3 × 4 × 5 oe **Examiner's Comments** Most candidates found the volume of the cuboid but then divided 0.65 by 60 or the other way round.

			Total	**4**		
87			9.6 with correct working	6	**M5** for $\sqrt{8.3^2 + (5.4\tan 42)^2}$ OR **M2** for 5.4 × tan 42 oe or **M1** for $\tan 42 = \frac{opp}{5.4}$ oe **A1** for 4.8[6…] or 4.9 and **M2** for $\sqrt{8.3^2 + (their\ 4.8[6\ldots])^2}$ or **M1** for 8.3^2 + (*their* 4.8[6..])^2 If **0**, **1** or **2** scored, instead award **SC3** for answer 9.6 with no or insufficient working If **0** or **1** scored, instead award **SC2** for answer 9.619… or 9.62 with no or insufficient working	"Correct working" requires evidence of at least **M1 M1** or **M2** and also accept 2sf numbers 4.8[6…] or 4.9 can imply **M2** if **M1** given Alternative method (sine rule): **M2** for $\frac{5.4 \times \sin 42}{\sin(their 48)}$ oe or **M1** for $\frac{x}{\sin 42} = \frac{5.4}{\sin(their 48)}$ oe 9.619… or 9.6[2] can imply **M2** if **M1** awarded Allow full and correct equivalent trig. methods to score **M2** in both triangles e.g. using the other angle in the first triangle, i.e. *their* 48

					If **0** scored, instead award **SC1** for 4.8[6…] or 4.9 with no or insufficient working **Examiner's Comments** Incorrect use of trigonometry, usually involving cosine, was widely seen. Some candidates attempted to use Pythagoras' theorem with 42 and 5.4 and many candidates were not comfortable using tan. Once a value had been found for the height of the first triangle, most used Pythagoras' theorem in the second triangle. Some did not give their answer correct to two significant figures.
			Total	**6**	
88			10.1 or 10.07 to 10.08 with correct working	6	**M4** for $\frac{4}{3}\times\pi\times4^3 = \frac{1}{3}\times\pi\times(\frac{1}{2}d)^2\times d$ oe — allow 10 only if working supports it **M1** for rearranging *their* equation OR — "Correct working" requires evidence of at least **M2** or **M1 M1** **M1** for $\frac{4}{3}\times\pi\times4^3$ implied by 268.[08…] or 268.1 — **M1** implied by $\frac{256\pi}{3}$ **B1** for [radius of water =] $\frac{1}{2}d$ **M2** for $\frac{1}{3}\times\pi\times(\frac{1}{2}d)^2\times d =$ *their* 268.08… or **M1** for $\frac{1}{3}\times\pi\times(\frac{1}{2}d)^2\times d$ condone one error — Note they can use $h = 2r$ so apply the scheme accordingly, 1024 will become 256 **M1** for rearranging *their* equation e.g. $d^3 = \frac{their\,268.08...\times12}{\pi}$ implied by [d^3 =] 1024 Alternative method — Complete method with trials giving

					M4 for $\dfrac{\frac{256\pi}{3}}{\frac{1}{3}\pi\times15^2\times30}=\left(\dfrac{d}{30}\right)^3$ oe **M1** for rearranging *their* equation OR **M1** for $\frac{4}{3}\times\pi\times4^3$ implied by 268.[08…], 268.1 or $\frac{256\pi}{3}$ **M1** for $\frac{1}{3}\pi\times15^2\times30$ implied by 2250π or 7068[.58…] or 7069 or 7068.6 **M2** for [sf=] $\sqrt[3]{\dfrac{\frac{256\pi}{3}}{\frac{1}{3}\pi\times15^2\times30}}$ oe or 0.33597… rot or **M1** for $\dfrac{\frac{256\pi}{3}}{\frac{1}{3}\pi\times15^2\times30}$ oe or 0.0379… **M1** for *their* sf × 30 If **0** or **1** scored, instead award **SC3** for answer 10.1 or 10.07 to 10.08 with no or insufficient working	the correct answer can score **6** marks **M1** for each correct trial up to a maximum of **M3**
					Examiner's Comments The common response was to start by calculating the volume of the sphere and the volume of the cone. After that most did not know how to work out the scale factor of length. Only a few were able to progress using this method. Alternatively, some realised that the radius of the cone of height d is $\frac{d}{2}$ and so they were able to form an equation and solve it.	

					Exemplar 3  In this exemplar the volume of the sphere and the volume of the cone were correctly worked out. The candidate took a step further by dividing the volumes, but incorrectly converted to a percentage. Instead of multiplying by 100, they needed to find the cube root to give the scale factor for length. This could then be multiplied by the height to give the correct answer. The two volumes have been rounded but these figures would still give an accurate final answer. Candidates should be encouraged to avoid rounding mid-way through calculations as this impacts the accuracy of the final answer.
			Total	**6**	
89			23.2 to 23.25… with correct working	5	**M2** for $\sqrt{3.7^2 + 6.4^2}$ or **M1** for $3.7^2 + 6.4^2$ and **M2** for π × *their* 7.39…oe or **M1** for 2 × π × *their* 7.39… or π × *their* 7.39… × $\frac{1}{2}$ If **0** or **1** scored award **SC2** for answer 23.2 to 23.25 with no working or insufficient working "correct working" requires at least **M1** and **M1** or **M2** from use of Pythagoras' theorem or full and correct method using trigonometry **M2** implied by 7.39… *their* 7.39 includes 54.65 or $\frac{1093}{20}$ **<u>Examiner's Comments</u>** This question was well answered. Most

					candidates used Pythagoras' theorem to find length BA. A few attempted trigonometry and they were usually unsuccessful. In calculating the circumference there were some who used the formula for the area. Many did round values too early in their calculations, for example the diameter should have been given to at least three figures such as 7.39… .
			Total	**5**	
90			E.g. Correct inequalities shown on diagram, correct region R identified and correct area calculation ½ × 6 × 4 [= 12] 	6	**B1** for line $y = 5$ **B1** for line $x + y = 13$ AND **B1** for correct side of $y = 2x + 1$ **B1** for correct side of $y = 5$ **B1** for correct side of $x + y = 13$ AND **M1dep** for ½ × 6 × 4 [= 12] oe Condone good freehand lines, which can be dashed or solid. Lines need only be one square long for line mark but they must be fit for purpose to define their region Mark the region which is labelled, but if no labelling mark the single region which is shaded (or unshaded) or implied by area calculation of correct region R Use diagram for these three marks If extra lines, mark those bounding R. If no R, mark poorest two Dep on region R being correct Accept counting squares but check areas bounding $y = 2x + 1$ Accept split into two triangles 4 and 8 oe **<u>Examiner's Comments</u>** Many candidates drew the correct line for $y = 5$, with only a few instances of $y = 4$, $y = 6$ or $x = 5$ being seen. Candidates had greater difficulty in drawing $x + y = 13$ and the line was often either omitted or else interpreted as

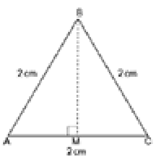
					meaning the two lines $x = 13$ and $y = 13$. Candidates who drew the correct lines often proceeded to identify the correct region for R. Although it should have been straightforward to then find the area of the triangle through ½ × base × height, some candidates attempted $\frac{1}{2}$ *ab*sin*C*, often measuring *a*, *b* and *C* and then fudging the values to obtain an answer of 12 cm^2. Such attempts scored 0 marks for the area unless absolutely accurate. Candidates who did not draw $x + y = 13$ correctly sometimes added the line $y = 9$, therefore creating a trapezium of area 12 cm^2 for an incorrect region R bounded by $y = 5$, $y = 9$, $y = 2x + 1$ and the y-axis. This is an example that scored 2 marks, because $y = 5$ was correct and their region R was the correct side of $y = 5$ but not the correct side of $y = 2x + 1$.
			Total	**6**	
91			2.8 to 2.81 with correct working	6	First M1 may be on diagram or within other M marks **M1** for BAC = 180 − (32 + 43) or 58 + 47 or 105 AND **M2** for AC = $\frac{7.5 \times \sin 32}{\sin(\textit{their } 105)}$ or **M1** for $\frac{AC}{\sin 32} = \frac{7.5}{\sin(\textit{their } 105)}$ oe AND **A1** for AC = 4.11[4…] or 4.115 (M1A1 implies M2A1) AND **M1** for $\frac{AX}{\textit{their } 4.11} = \sin 43$ or *their* 4.11 × sin 43 oe If 0, 1 or 2 scored,
					All methods: “correct working” requires at least **M1**AND**M1**AND**M1** First M1 may be on diagram or within other M marks **M1** for BAC = 180 − (32 + 43) or 58 + 47 or 105 AND **M2** for AB = $\frac{7.5 \times \sin 43}{\sin(\textit{their } 105)}$ or **M1** $\frac{AB}{\sin 43} = \frac{7.5}{\sin(\textit{their } 105)}$ oe AND **A1** for AB = 5.29[5…] or 5.3[0] (M1A1 implies M2A1) AND **M1** for $\frac{AX}{\textit{their } 5.3[0]} = \sin 32$

					instead award **SC3** for 2.8 to 2.81 with no or insufficient working. If 0 or 1 scored, instead award **SC2** for 4.11[4…], 4.115 with no or insufficient working. <u>Alternative Method splitting BC:</u> First M1 may be on diagram or within other M marks. Accept other terms for *d.* Do not accept numerical partition of BC. **M1** for BX = *d* and XC = 7.5 − *d* AND **M2** for $d = \frac{7.5\tan 43}{\tan 32 + \tan 43}$ oe or **M1** for *d*tan32 = (7.5 − *d*)tan 43 oe AND **A1** for *d* =4.49 to 4.5 (M1A1 implies M2A1) AND **M1** for $\frac{AX}{their\ 4.49} = \tan 32$ or *their* 4.49 × tan32 or for $\frac{AX}{(7.5 - their\ 4.49)} = \tan 43$ or (7.5 × *their* 4.49) × tan43 If 0, 1 or 2 scored, instead award **SC3** for 2.8 to 2.81 with no or insufficient working. If 0 or 1 scored,	or *their* 5.3[0] × sin 32 oe If 0, 1 or 2 scored, instead award **SC3** for 2.8 to 2.81 with no or insufficient working. If 0 or 1 scored, instead award **SC2** for 5.29[5…] or 5.3[0] with no or insufficient working First M1 may be on diagram or within other M marks. Accept other terms for *d*. Do not accept numerical partition of BC. **M1** for BX = 7.5 − *d* and XC = *d* AND **M2** $d = \frac{7.5\tan 32}{\tan 43 + \tan 32}$ oe or **M1** for *d*tan43 = (7.5 − *d*)tan 32 oe AND **A1** for *d* = 3 to 3.01 (M1A1 implies M2A1) AND **M1** for $\frac{AX}{their\ 3.01} = \tan 43$ or *their* 3.01× tan43 or $\frac{AX}{(7.5 - their\ 3.01)} = \tan 32$ or (7.5 − *their* 3.01) × tan32 If 0, 1 or 2 scored, instead award **SC3** for 2.8 to 2.81 with no or insufficient

					instead award **SC2** for 4.49[…] or 4.5[0] with no or insufficient working. <u>Alternative Method using Areas</u> The main scheme still applies. The first four marks will be identical and the area method eventually simplifies to the final M1 expression. This is just a much more complex method. — working. If 0 or 1 scored, instead award **SC2** for 4.49[…] or 4.5[0] with no or insufficient working. **<u>Examiner's Comments</u>** There were good responses for this question, showing a good understanding of trigonometry, with working that was easy to follow. Most opted to use the sine rule to find either AB or AC and followed this with simple trigonometry (or sometimes the sine rule with a 90° angle) to find AX. Less efficient methods were seen. For example, having found AB (or AC), some calculated BX (or CX) and followed this with either Pythagoras or the cosine rule. Premature approximation at the various stages of these longer methods tended to lead to final answers that were slightly inaccurate. A few candidates attempted far more complex methods which would work but were rarely successfully completed. For example, finding both AB and AC, then equating the area of the triangle using $\frac{1}{2}$ × AB × AC × sin105 with $\frac{1}{2}$ × 7.5 × AX; or using BX : XC as x : 7.5 − x, then equating and solving $x$tan32 = (7.5 − x)tan43 to find x then AX. Common errors on this question included treating triangle ABC as if it were right-angled, or simply guessing at lengths for BX and XC, usually as 5 cm and 2.5 cm. Alternatively, some candidates only used angles, stopping at the point where they had found all the different angles but they did not work out BAC as 105˚, which may have given them a method mark.

			Total	**6**	
92			42.09[…] with correct working	4	**M3** for $\pi \times \left(\frac{23}{2\pi}\right)^2$ OR M1 for 23 ÷ 2π *or* 23 = 2π*r* or 23 = π*d* **A1** for 3.66[…] **M1** for π×(*their* 3.66)^2 If 0 or 1 scored, instead award **SC2** for 42.09[…] with no or insufficient working If 0 scored, instead award **SC1** for 3.66[…], 42.08[…], 42.10[…], 42.11[. …] or 168[. …] with no or insufficient working Correct working requires evidence of at least **M1** Do not accept starting with 42.1 and working backwards Candidates should use the π button or 3.142. Accept 3.14 and 22/7 for max of **M3** **M1** may be in two steps or seen as diameter here and diameter/2 in the area calculation *their* 3.66 must come from a calculation involving π **<u>Examiner's Comments</u>** Candidates were expected to start with the circumference and work towards the area. A correct answer to an accuracy greater than 3 significant figures is required to demonstrate the given answer fully. The Formulae Sheet included those for the circumference and area of a circle and so very few candidates used incorrect formulae. Those candidates who found the diameter first often introduced an accuracy error due to premature rounding, whereas those who found the radius in one step from 2π*r* = 23 did not have this problem. With full accuracy in the radius and the use of the π-button or 3.142, candidates should have reached an answer of 42.09… . With premature rounding, the candidate usually obtained 42.08… or 42.11… and therefore only scored 3 marks. Presentation of working was often not as clear as it could have been, with jottings and calculations linked by arrows or the values

					being substituted into the formulae not being explicitly shown.
			Total	**4**	
93			8 min 15 sec	4	**B3** for 8.25 or $8\frac{1}{4}$ or $8\frac{15}{60}$ or for answer 8m 25s — eg $\frac{1.5 \times 10^8}{303030[.3...]}$ OR **M1** for $3.3 \times 10^{-6} \times 1.5 \times 10^{8}$ oe soi by figs 495 and **M1FT** for (*their* 495 ÷ 60) — *their* 495 from attempt at a correct M1 expression **<u>Examiner's Comments</u>** Many candidates scored 3 or 4 marks or, alternatively, misinterpreted the question and scored 0 marks. By far the most common misinterpretation was thinking they needed to use 'speed = distance/time' and dividing rather than recognising the need to multiply. Those candidates who multiplied usually obtained the correct intermediate answer of 495. Candidates who changed the values to ordinary form often introduced an error in place value while those who remained in standard form made accurate use of their calculator. Converting 495 seconds into minutes and seconds caused a variety of problems with the answer 8 minutes 25 seconds arising from 495 ÷ 60 = 8.25 minutes being a common error. A few candidates thought that they had found a time of 8 hours 15 seconds or 8 hours 15 minutes, leading to answers such as 480 mins 15 seconds, 495 minutes or occasionally 482 mins 5 secs. Like a few other questions on the paper, this was one where a choice of answers was common. Candidates who were unsure of whether to initially multiply or divide the values often wrote both calculations without indicating which one should be marked.

					Assessment for learning Candidates should not leave a choice of answer or method. If an answer is given, then the method leading to that answer is the one that will be marked. If no answer is given, then the poorer method will usually be marked.
			Total	**4**	
94			Correctly shows $\tan 30^\circ = \frac{1}{\sqrt{3}}$ with supporting working 	4	Using triangle MBC (mark similarly for use of triangle MBA): **B1** for MBC = 30° or MC = 1 [cm] soi by use in Pythagoras **M2** for [BM =] $\sqrt{2^2-1^{[2]}}$ or $\sqrt{4-1}$ [= $\sqrt{3}$] or for [BM^2 =] 2^2–$1^{[2]}$ oe and $\sqrt{3}$ or **M1** for BM^2+ $1^{[2]}$ = 2^2oe OR **B1** for MCB = 60° or MC = 1 [cm] soi by use in cos rule **M2** for $\sqrt{2^2+1^{[2]}-2\times 2\times 1\times\cos 60}$ **and** cos 60 = $\frac{1}{2}$soi [= $\sqrt{3}$] or **M1** for 2^2 + $1^{[2]}$ – 2 × 2 × 1 × cos 60 OR **B1** for MCB = 60° soi by use in sine ratio or sine rule **M2** for [*x* =] 2sin 60 If 0 or 1 scored, **SC2** for $\frac{\sin 30}{\cos 30}=\frac{\frac{1}{2}}{\frac{\sqrt{3}}{2}}$ and tan 30 = $\frac{1}{\sqrt{3}}$ May be on diagram For M2 must show the subtraction, do not allow BM^2+ $1^{[2]}$= $2^2$and then $\sqrt{3}$,this gets M1 only M2 accept [*x* =] $\frac{2\sin 60}{\sin 90}$ **and sin 60 =** $\frac{\sqrt{3}}{2}$ **Dep** on **B1M2** A0 for tan = $\frac{1}{\sqrt{3}}$(without the 30)

					oe **and** sin 60 = $\frac{\sqrt{3}}{2}$ soi [= $\sqrt{3}$] or **M1** for $\frac{\sin 60}{x} = \frac{\sin 90}{2}$ oe **AND** **A1dep** for MBC = 30° stated/on diagram and $\tan 30° = \frac{1}{\sqrt{3}}$ and with no errors seen leading to the answer **<u>Examiner's Comments</u>** This question proved challenging for most candidates. The majority of candidates scored at least 1 mark for annotating the diagram correctly with 30° or 1 cm. There was evidence that candidates have 'learned' the ratios for the trig values as tables were seen on the additional sheet and in the working space here. This information did not assist in this question where the trig ratio for tan 30 had to be established from the diagram. A number of candidates correctly attempted Pythagoras' with 2 and 1 to find BM as $\sqrt{3}$ and then stated the correct conclusion. Some omitted key steps in the working after stating $1^2 + BM^2 = 2^2$ and scored only partial method marks as a consequence. **Misconception** On questions like this that ask candidates to show a particular given answer, candidates need to show every step of their method, using the information in the diagram, with no errors or omissions before stating the given result.	
			Total	**4**		
95			$\frac{5\pi r}{6}$ with correct working	5	**B4** for correct unsimplified answer with correct working	Condone '×' sign oe in simplified answer if otherwise correct

	e.g. $\frac{5}{6}\times \pi r$
OR	"correct working" requires **M1A1M1A1** Condone R for r throughout For method marks, allow use of 3.14, 3.142, 22/7 for π
M1 for $\frac{60}{360}\times[2\times]\,\pi k$ oe	
A1 for $\frac{60}{360}\times 2\pi r$ oe or better isw incorrect cancelling/simplification	
AND	Where k is numeric or algebraic **but does not** come from squaring Allow e.g. k = 2, r, d, 0.4 , 0.4x
M1 for $\frac{60}{360}\times[2\times]\,\pi\frac{3k}{2}$	
A1 for $\frac{60}{360}\times \pi 3r$ oe or better isw incorrect cancelling/simplification	For A1 accept e.g. 0.333 πr Correct expression implies M1A1
If 0 or 1 scored, instead award **SC2** for final answer $\frac{5\pi r}{6}$ oe simplified answer with no or insufficient working	For M1 must use *their* previous k e.g. uses k = 10 for first M1 then uses 15 here for $\frac{3k}{2}$ gets 2nd M1
	unless the expression is correctly stated as $\frac{60}{360}\times \pi 3r$ oe which gets M1A1 Correct expression implies M1A1

<u>Examiner's Comments</u>

Candidates found this question very challenging and there were a number of 'no response'. Some worked out the area of the sector. Those attempting an arc calculation for AB often preferred to replace r with a constant value. In those cases, credit was given for the arc CD if the constant used was consistent with the ratio 2 : 3 for that used in AB.

					A number of candidates gave a correct fraction $\frac{60}{360}$ for the sector but then evaluated this as 6. In this case, method marks were awarded provided the fraction was shown. A small number of candidates found correct expressions in terms of π and r for the two arcs AB and CD and most of these then added correctly and gave a simplified expression. A few misunderstood the demand and gave the full perimeter of the shaded shape ABCD for which they were given partial credit.
			Total	**5**	
96			3 with correct working	5	**M3** for method for three areas correct or for 3600 **or** 800 and 2400 and 400 nfww or **M2** for method for two areas correct (method towards two from 800, 2400, 400) or **M1** for method for one area correct (method towards 800 or 2400 or 400) or for 2400 seen AND **M1dep** for *their* 3600 ÷ 1200, dep on at least M2 If 0 or 1 scored instead award **SC2** for 3 with no or insufficient working but not from wrong working "correct working" requires at least M3 Treat as three separate areas, so trapezium from 0 to 1200 is three areas, trapezium from 0 to 1000 is 2 areas, trapezium from 400 to 1200 is 2 areas. For M marks, mark method not accuracy, so M1 for $\frac{400\times4}{2}$ even if not evaluated as 800. **<u>Examiner's Comments</u>** Most candidates scored at least partial marks for this question for working towards finding the

					correct areas. Most found the three separate areas rather than the area of the trapezium. Of those who scored partial marks, candidates attempting to find the area of the triangles often multiplied the base by the height but did not go on to halve their answer. A common error was to attempt to find the gradients of the sloping lines and then calculate the mean of these combined with the speed at the horizontal section giving an answer 2.66…m/s. A few, however, used this approach alongside a correct proportional argument with the average speeds for each section to arrive at the correct overall average speed and were given full credit. A few ignored the shape of the graph entirely, extending the trapezium to form one rectangle and then found the total distance as 4800m then dividing by the time to reach an answer of 4 m/s. **Finding an average speed** Candidates need to consider that an average speed does not involve finding a mean value but is found by finding the overall distance divided by the time taken.
			Total	**5**	
97			Answer in range 11.8 to 14.2	4dep	**Dep on B1B1** **B1** for bearing of 072° **B1** for bearing of 116° Use overlay as a guide, bearings must be inside or on the boundary lines – they can be short lines. If no lines then T labelled can imply the bearings **M1dep** for 2 × *their* JT ±0.1cm soi **Dep** on T marked oe e.g. with cross etc or on 2 intersecting lines Use ruler to measure JT (Do not allow JK measured if no T) __**Examiner's Comments**__ Many gave fully correct answers by drawing intersecting lines from J and K and then

					multiplying the distance from J to the intersection by 2. There were a number of errors in measuring the bearings including evidence of incorrect positioning of the protractor with the North line, e.g. a bearing of 18° from J rather than 72°. There were also some anticlockwise angles measured. Candidates that indicated the position of the tower on the diagram in some way were given credit for finding their correct scaled distance from J to the tower even when bearings had been incorrectly measured. Other common errors included: using incorrect equipment, usually compasses; joining the two given points up and measuring the distance between them; and halving their measured distance from J to the tower rather than doubling. **Misconception** When measuring bearings with a protractor, always measure clockwise from the North line. In questions requiring intersecting bearings, always draw full lines to represent the bearings from the two points.
			Total	**4**	
98			113 to 114 with correct working	5	Check diagram for incorrect triangle. <u>Correct triangle or no triangle indicated:</u> **M2** for $\sqrt{6.8^2 + 2.8^2}$ [= 7.35…] or for full alternative method or **M1** for $6.8^2 + 2.8^2$ [= 54.08 or 54.1] AND **M2** for $\frac{1}{2}$ or **M1** for $\frac{1}{2}$× 5.6 × “Correct working” requires evidence of at least **M2** AND **M1** ie correct triangle with Pythagoras and area of a triangle eg Finding AC, AO, AE then the height (AC = 7.919…, AE = 7.868…) eg EB found as $\sqrt{6.8^2 + 2.8^2}$ is using an incorrect dimension for OB

					their 7.35… <u>Incorrect triangle indicated:</u>**M1** for complete Pythagoras to find hypotenuse with a maximum of one incorrect dimension If **0** or **M1** scored, instead award **SC2** for answer 113 to 114 with no or insufficient working If **0** scored **SC1** for 7.35 either correctly placed on diagram or with no working **<u>Examiner's Comments</u>** Many candidates made little worthwhile progress. To score any marks candidates needed to realise that the use of Pythagoras was essential in solving the problem. It was evident from the values used and the triangles sketched on the given diagram that many candidates were using triangles that were not part of the surface area. Only the very most able candidates used Pythagoras on the triangle with vertices E, O and the midpoint of BC, which immediately leads to the area of the triangle. A few able candidates eventually and correctly reached the same place after using Pythagoras three times in finding BD, BO, BE and then E to the midpoint of BC. Many candidates started by trying to find BE but took length BO as 2.8 cm – these candidates scored a maximum of one mark.	
			Total	**5**		
99	a		54 nfww	4	**B3** for 90 min and 144 min or for 0.9h or **B2** for 90 min or 144 min or for A: 1.5h and B 2.4h or **M1** for evidence of	For **B3** and **B2** accept 1 h 30 min and 2 h 24 min

					time = distance / speed **Examiner's Comments** **AfL** Candidates generally answered this part very well. Any errors made were usually when converting their decimal times in hours into minutes. Candidates ought to know as a fact that 1.5 hours is 90 minutes and not 150 minutes. Candidates have not often been asked to write an algebraic expression in a time/distance/speed context and many found this short "write down" question to be a challenge. The required response was $\frac{1000x}{3600}$ or a simplified equivalent. The question is assessing correct use of algebraic communication. Answers should **not** have units, such as m/s or km, in the middle of the expression and should **not** be written as a calculation, e.g. 1000 × x ÷ 60 ÷ 60.	
	b		1000*x*/3600 oe isw	2	**B1** for 1000x [m/h] or *x*/3600 [km/s] or *x*1000/3600 oe	For **2** marks, final answer must not have any units within the expression isw wrong simplification after correct answer. Accept *x*/3.6 and (0.277 to 0.28)*x* For **B1** allow *x* × 1000 or *x* ÷ 3600 or these clearly implied in a longer calculation
			Total	**6**		
100			answer with at least 4 sf rounding to 46.9 with correct working	6	**M1** for [vol =] 235 ÷ 7.78 [=30.2…] AND **M2** for	"Correct working" requires evidence of at least **M1** AND **M1** AND **M1** ie using formulas for density, volume and surface

					$r^3 = \frac{their\,30.2... \times 3}{4 \times \pi}$ oe [= 7.2…] or **M1** for *their* 30.2 = $30.2 = \frac{4}{3}\pi r^3$ **A1** for *r* = 1.93… AND **M1** for [SA =] 4 × π × their 1.93...^{2} If **0** scored **SC1** for [*r* =] 1.93… with no working	area After *their* $30.2 = \frac{4}{3}\pi r^3$, *r* = 1.93… scores **M2A1** Condone working in reverse for a maximum of 2 marks: **M1** for 46.9 = 4πr^2 **A1** for *r* = 1.93...

Examiner's Comments

AfL

Candidates were required to show that the surface area of a sphere was 46.9 cm^2, correct to 3 significant figures. There were many good responses, with some candidates scoring at least five marks out of six. When required to show an answer to a specified accuracy, it is important to find and state the answer to a greater accuracy to show that the final calculation has been performed correctly. So, in this question, it was not sufficient to just write the surface area calculation and then the answer 46.9.

The best scripts retained the full value of the intermediate answers, thus avoiding possible inaccuracies through premature rounding.

There were three distinct steps involved in the solution: density, mass and volume; finding the radius from the volume; finding the surface area. The presentation of many scripts was very good, and the use of a few words was helpful and better than elsewhere on the paper. The cube root step when finding the radius from the volume was performed much more successfully than in recent series.

			Total	**6**		
101			20 + 8 π final answer with correct working	6	**B3** for [angle at centre]= 144 with correct working or $\frac{4}{10}$ [of circle] **oe** or **M2** for $\frac{[360\times]40\pi}{\pi\times10^2}$ **oe** or **M1** for $\frac{\theta}{360}\times\pi\times10^2$ **oe** AND **M2** for answer 20 + *k* π where $k=\frac{their\theta}{18}$ or **M1** for $k=\frac{their\theta}{18}$ **oe** or answer 20 + *k* π If 0 scored **SC2** for answer 20 + 8 π	For full marks "correct working" requires evidence of at least M1 AND M1 ie use of formulas for sector area and arc length or alternate convincing approach For B3 "correct working" requires at least M1 for use of formula for sector area M2 method for finding fraction of circle M1 Implied by 8 π For M1 *k* ≠ 0 May be on diagram
			Total	**6**		
102			32	4	**M2** for correct method to find area of L shaped face e.g 6 × 3 – 5 × 2 or **M1** for finding one of the relevant partial lengths of 2 or 5 **M1** for *their* area × 4 OR **M1** for 3 × 4 × 1 **M1** for 5 × 4 × 1 **A1** for 12 or 20 OR **M1** for 6 × 3 × 4 **M1** for 2 × 5 × 4 **A1** for 72 or 40	M1 could be on diagram Treat extra volumes as choice A1 Implies M1 Mark as oe for other correct products if split into two different cuboids that make the solid Not 6 × 3 × 4 × 1 × 1 Treat extra volumes as choice A1 implies M1 unless 72 comes from 6 × 3 ×× 4 × 1 × 1
			Total	**4**		
103			10 nfww	4	**M1** for 5 × 4 **M1** for 200 or 199	nfww for 4 marks no errors in calculating values and at least

					used **M1dep** for *their* 200 ÷ *their* area, **dep** on first M1 **Examiner's Comments** Some candidates tried to complete long decimal calculations instead of making an estimate by rounding the values to 200, 4 and 5 which would have made for a very straightforward calculation. Looking for key words in the demand of the question like 'estimate' should guide candidates to round values in the calculation appropriately.	one of 5, 4, 200 or 199 used Allow for 20 or for 4.9 × 4.1 [20.09] or with one unrounded value [19.6 or 20.5] Allow for 198.5 ÷ (4.9 × 4.1)
			Total	**4**		
104			13 with correct working	7	**M1** for $\frac{BD}{10} = \sin 30$ **oe** **B1** for sin 30 = 0.5 **soi** **A1** for [BD =] 5 **M1** for *their* BD × 2.4 **oe** **A1** for CD = 12 **M1** for (*their* BD)^2 + (*their* CD)^2 [= BC^2] **oe** If 0 scored **SC3** for answer 13 with no working or **SC2** for CD = 12 with no working or **SC1** for BD = 5 with no working	"Correct working" requires evidence of at least M1 or B1 and M1M1 or alternate convincing approach Answer 12 gets A0 unless CD = 12 shown in working or on diagram SCs may be seen on the diagram
			Total	**7**		
105			105 or 104.7 to 104.82	6	**M2** for $\frac{48 \times \sin 53}{85}$ oe implied by 26.8…	"Correct working" requires evidence of at least **M2** or **M1M1**

					or **M1** for $\frac{\sin 53}{85} = \frac{\sin[B]}{48}$ oe **M1** for [C=] 180 − 53 − their 26.807… or 100.19[…] **M2** for $\frac{85 \times \sin theirC}{\sin 53}$ oe or **M1** for $\frac{[AB]}{\sin theirC} = \frac{85}{\sin 53}$ oe <u>Alternative method</u> cosine rule (AB = x) **M3** for quadratic with coefficients evaluated or **M2** for $x^2 + (-2 \times 48 \times \cos53)x + (48^2 - 85^2)$ [=0] oe or **M1** for $85^2 = x^2 + 48^2 - 2 \times x \times 48\cos53$ AND **M2** for correct use of quadratic formula or **M1** for quadratic formula with at most one error If **0** scored **SC2** for 105 or 104.7 to 104.82 with no working or **SC1** for 26.8… with no working	i.e. x^2 – 57.77…x – 4921 [= 0] oe
			Total	**6**		
106	a		complete correct argument e.g. angle ABC = 40° [BO =] e.g. $\frac{6}{\sin 20}$ 17.542… or 17.543	B1 M2 A1dep	**M1** for e.g sin 20 = $\frac{6}{[BO]}$ **dep**. on at least **M1**	accept any correct method not using 17.54 could be on diagram and also accept ABO = 20°, BO’T’ = 70° i.e BO as subject for **M2** and condone sine rule with sin 90° for **M2**
	b		202 or 201.5 to 201.8 with correct working	5	Accept any correct method e.g. **M1** for [height=]	“Correct working” requires evidence of at least **M2** or **M1M1**

					17.54 + 6 or 23.54… **M2** for [half base =] $\frac{6}{\tan 35}$ or $\frac{23.54}{\tan 70}$ or **M1** for tan 35 = $\frac{6}{half\ base}$ or tan 70 $=\frac{23.54}{half\ base}$ **M1** for ½ × *their* base × *their* height oe If **0** scored **SC2** for 202 or 201.6 to 201.8 with no working or **SC1** for 8.56 to 8.57 or 17.1 to 17.2 with no working	Condone use of 8.6 leading to an answer of 202.4… **M2** implied by e.g. 8.56 to 8.57 or 17.1 to 17.2 e.g. ½ × (2 × 8.568…) × 23.54…
			Total	**9**		
107			500 ml with three correct comparisons	3	Allow any correct comparison e.g.(converting all to 500 ml) **B2** for three correct figures to compare or **B1** for two correct figures OR **M1** for one correct appropriate calculation e.g. 1.96 ÷ 4 or 31 × 5 ÷ 3 oe	See appendix for other values e.g. 49[p] is sufficient for **B1** as it compares to 47[p]
			Total	**3**		
108			71.4	2	**M1** for ½×(12.3 + 8.7) ×6.8 oe	
			Total	**2**		