Mark scheme

Question			Answer/Indicative content	Marks	Guidance	
1			$3\sqrt{10}$ final answer	2	B1 for $\sqrt{90}$ or $\frac{3\sqrt{20}}{\sqrt{2}}$	Do not award **B1** for e.g. $\sqrt{180} = \sqrt{2}\sqrt{90}$ alone
			Total	**2**		
2	a		$\frac{1}{4}$ oe	1		
	b		$3^x \times 3^{2y} = 3^3$ $x + 2y = 3$ one further step leading to $y = \frac{3-x}{2}$	M2 M1 A1	**B1** for 3^{2y} or 3^3 **M1 dep on M2**	For **M2** accept equivalent work with all terms in other bases e.g. 9 Accept $(3^2)^y$ for 3^{2y} Allow **B1** for writing one other term correctly in base 9 e.g. $[3^x =] 9^{\frac{x}{2}}$ For **M1** accept correct equivalent equation
			Total	**5**		
3	a		26π **final answer**	4	M2 for $\sqrt{12^2+5^2}$ oe or **M1** for 12^2 and 5^2 **oe** **M1dep** for $2 \times \pi \times$ *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 $\frac{their60}{360}\times\pi\times 12^2$ **oe** or $\frac{x}{360}\times\pi\times 12^2$	0 < *their* 45 < 90 **M1** for e.g. $\frac{4[\pi]}{2[\pi]12}\times\pi\times 12^2$
			Total	**8**		
4			$\frac{1}{6}$ **oe**	4	B2 for $[-]\frac{14}{15}$ **oe** or **M1** for $[-]\frac{2}{5}\times\frac{7}{3}$ **oe** or $[-]\frac{14}{35}\div\frac{15}{35}$ **oe** M1 for $\frac{33}{30}-\frac{28}{30}$ **oe FT** *their* $\frac{14}{15}$ or [1] $\frac{3}{30}-\frac{14}{15}$ **oe FT** *their* $\frac{14}{15}$ If **0** or **1** scored, award instead **SC2** for answer $\frac{49}{30}$ **oe** If **0** scored, **SC1** for $\frac{7}{10}$ **oe** in working	$\frac{5}{30}$ is awarded 4 marks Allow pairs of equivalent fractions for the product or division for **M1** Allow pairs of equivalent fractions both over a common denominator for **M1** From correct processing but wrong order
			Total	**4**		
5	a		$\frac{1}{8}$ or [0].125 -6	2	**B1** for each	
	b		4 4	2	**B1** for each	
			Total	**4**		
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 $\frac{4}{3}(\times)\pi(\times)\left(4\times10^{-4}\right)^3$ **soi** **A1** for $(\frac{256\pi}{3})\times 10^{-12}$ or $2.68\ldots \times 10^{-10}$ **oe** and **M1dep** (on **M1M1**) for $\frac{\textit{their}\text{ volume of bowl}}{\textit{their}\text{ volume of raindrop}}$ Alternative method: **M4** for $20^3 \div (4^3 \times 10^{-12})$ or 1.25×10^{14} **oe** or **M3** for $\left[\frac{\frac{4}{3}\times\pi}{\frac{4}{3}\times\pi}\right]\frac{20^3}{\left(4\times10^{-4}\right)^3}$ **oe** and **M1dep** for 0.5 × *their* vol. scale factor If **0**, **1** or **2** scored, instead award **SC3** for answer 6.25 ×	"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

					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			$\frac{6\sqrt{2}-5}{\sqrt{32}+4} \times \frac{\sqrt{32}-4}{\sqrt{32}-4}$ $\frac{6\sqrt{2}\times\sqrt{32}-24\sqrt{2}-5\sqrt{32}+4\times5}{\sqrt{32}\times\sqrt{32}+4\sqrt{32}-4\sqrt{32}-4\times4}$ $\sqrt{32} = 4\sqrt{2}$ **soi** Simplifying *their* fraction e.g. $\frac{68-44\sqrt{2}}{32-16}$ or better $\frac{17-11\sqrt{2}}{4}$	M1 M1 M1 M1dep A1	May be in a separate table $\sqrt{32}+4$ in both numerator and denominator **Dep** on at least three terms in the numerator **FT** *their* fraction with surds **A1 dep** on **M4**	Multiply by conjugate of denominator Multiply out numerator giving at least three terms and denominator accept equivalents e.g. denominator as 32 – 16 or 16 Implied by $[-5\sqrt{32} =]\ -20\sqrt{2}$ or $-44\sqrt{2}$ e.g. collecting like terms in numerator and in the denominator
			Total	**5**		
8			$14\sqrt{2}+21\pi$ 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	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**

					cos45° **oe** or **M1** for $\frac{x}{14} = \cos 45$ **oe** **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 $14^2 + 14^2$	e.g. done in stages implies **M1M1** **M2 oe** accept e.g. [AB^2 =] $14^2 + 14^2$ [– 2.14.14.cos 90] 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] <u>associated</u> 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**		
9			$6x^{3.5}$ **nfww** final answer	4	Mark coefficient and indices separately: **B1** for 6 from $\frac{4\times 3}{2}$	Accept equivalent fractions in place of decimal powers If attempting both

					AND **B3** for $x^{3.5}$ **nfww** or **B2** for $x^{6.5}$ from $x^6 \times \sqrt{x}$ or for $x^{-2.5}$ or $\frac{1}{x^{2.5}}$ from $\frac{\sqrt{x}}{x^3}$ or **B1** for $\sqrt{x} = x^{\frac{1}{2}}$ or $x^{0.5}$ **B1** for x^3 from $\frac{x^6}{x^3}$	$\frac{x^6}{x^3}$ and $\frac{\sqrt{x}}{x^3}$ mark to candidate's benefit rather than choice
			Total	**4**		
10	a		$\frac{1}{4}$ or [0].25 −6	2	**B1** for each **Examiner's Comments** Few candidates had both *k* and *m* correct and just over half had neither correct. The most common wrong answers were −4 for *k* and 6 for *m*.	
	b		8 9	2	**B1** for each **Examiner's Comments** The mark distribution was almost identical to part (a). *m* was correct more often than *k*. The most common wrong answers were 6 for *k* and 6 for *m*.	
			Total	**4**		
11			6.25 × 10^{13} with correct working	6	**B5** an answer equivalent to 6.25 ×	Correct working requires

					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 $\frac{1}{2}(\times)\frac{4}{3}(\times)\pi(\times)15^3$ or **M1** for $\frac{4}{3}(\times)\pi(\times)15^3$ or 4500π or 14137 to 14139 and **M1** for $\frac{4}{3}(\times)\pi(\times)(3\times10^{-4})^3$ soi **A1** for $3.6\pi \times 10^{-11}$ or $1.13... \times 10^{-10}$ oe and **M1dep** (on M1M1) for $\frac{\textit{their}\text{ volume of bowl}}{\textit{their}\text{ volume of raindrop}}$ Alternative method: **M4** for $15^3 \div (3^3 \times 10^{-12})$ or 1.25×10^{14} oe or **M3** for $\left[\frac{4}{3}\times\pi\right]\frac{15^3}{(3\times10^{-4})^3}$ 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	evidence of at least **M1M1** *their* answer to($3\times 10^{-4})^3$ *Their* volumes must have come from use of correct formulas for hemisphere and sphere or for two spheres

					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 $3.6\pi \times 10^{-11}$ or $1.13\ldots \times 10^{-10}$ with no or insufficient working	

Examiner's Comments

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**	
12			$4\sqrt{5}$ final answer	2	**B1** for $\sqrt{80}$ or $2\sqrt{20}$ or $\frac{4\sqrt{10}}{\sqrt{2}}$ Do not award B1 for e.g. $\sqrt{160} = \sqrt{2}\ \sqrt{80}$ alone **Examiner's Comments** Most candidates attempted this question, and many were successful in completing the first step in obtaining $\sqrt{80}$. Candidates that were less successful attempted to simply $\sqrt{160}$ and did not consider the division by $\sqrt{2}$.
			Total	**2**	
13	a		$\frac{1}{2}$ oe	1	**Examiner's Comments** Many candidates attempted to answer this part, and a few were successful. Common incorrect answers were $\frac{1}{24}$, 24, $\sqrt[3]{8}$ and 2^{-3}.
	b		$2^x \times 2^{2y} = 2^4$ $x + 2y = 4$ one further step leading to $y = 2 - \frac{x}{2}$	M2 M1 A1	**B1** for 2^{2y} or 2^4 **M1 dep on M2** For M2 accept equivalent work with all terms in other bases e.g. 4 Accept $(2^2)^y$ for 2^{2y} Allow B1 for writing one other term correctly in base 4 or base 16 e.g. $[2^x =]\ 4^{\frac{x}{2}}$ or $[4^y =]\ 16^{\frac{y}{2}}$ For M1 accept correct equivalent equation **Examiner's Comments** Candidates who recognised that all the terms could be written in terms of base 2

					often achieved full credit. Many unsuccessful candidates attempted to substitute values or $y = 2 - \frac{x}{2}$ into the original equation.
			Total	**5**	
14	a		20π final answer	4	**M2** for $\sqrt{8^2 + 6^2}$ oe or **M1** for 6^2 and 8^2 oe **M1dep** for $2 \times \pi \times$ 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**	
15			$\frac{17}{18}$ oe	4	**B2** for $[-]\frac{8}{9}$ oe or **M1** for $[-]\ \frac{2}{3}\times\frac{4}{3}$ oe or $[-]\frac{8}{12}\div\frac{9}{12}$ oe **M1** for $\frac{33}{18}-\frac{16}{18}$ oe FT *their* $\frac{8}{9}$ or $[1]\frac{15}{18}-\frac{16}{18}$ oe FT *their* $\frac{8}{9}$ If 0 or 1 scored, award instead **SC2** for answer $\frac{14}{9}$ oe If 0 scored, **SC1** for $\frac{7}{6}$ oe in working Allow pairs of equivalent fractions for the product or division for M1 Allow pairs of equivalent fractions both over a common denominator for M1 From correct processing but wrong order **Examiner's Comments** A number of candidates answered this well. The most common error was to carry out the calculation in the wrong order, subtracting $\frac{2}{3}$ from $1\frac{5}{6}$ first before dividing by $\frac{3}{4}$. A few candidates approached the problem in the correct order but made arithmetic mistakes when dividing by $\frac{3}{4}$ and when subtracting the answer from $1\frac{5}{6}$. A few candidates attempted to convert fractions into decimals. **Assessment for learning** When working with calculations involving fractions, candidates should not write a fraction with a decimal in the numerator or denominator.
			Total	**4**	

16	a		BF = DE or BF = $4t$ and [opposite sides of a] rectangle [are equal] AB = BF [= $4t$] and radii [of a sector/circle]	1 1	For **2 marks**, $4t$ must be seen in at least one statement as BF or on the diagram as BF	
	b		ABF = 65 and BC = $2t$ $\frac{their\ 65}{360} \times 2\pi \times their\ 4t$ $\frac{25}{360} \times 2\pi \times 2t$ $4t + 2t + 4t + 2t$ $\frac{25}{360} \times 2\pi \times 2t + \frac{65}{360} \times 2\pi \times 4t$ $+4t + 2t + 4t + 2t$ $\frac{31}{18}\pi t + 12t$	B1 M1 M1 M1 A1		Stated or seen on diagram All **M** marks may be seen within a summarising expression Condone $8t + 4t$, $6t + 6t$ etc but not $12t$
			Total	**7**		
17			2.1×10^{-3} $\frac{1}{472}$ 0.22% 0.02	4	**B3** for all 4 expressed in an equivalent comparable form or **B2** for 3 expressed in an equivalent comparable form or **B1** for 2 expressed in an equivalent comparable form	Equivalent comparable form is either decimal, percentage or standard index form. Fractions only acceptable as comparable form with common denominators. For final answer, accept some or all given as equivalent form on answer line. e.g. Full marks for 0.0021, 0.00218[…], 0.0022, 0.02

					or $\frac{21}{10000}, \frac{1}{472}, \frac{11}{5000}, \frac{1}{50}$ Where choice of comparable form, mark to candidate's advantage.	
					Likely comparable form (award best row): 0.22% | $\frac{1}{472}$ | 0.02 | 2.1×10^{-3} 0.22[%] | 0.211[8…][%] | 2[%] | 0.21[%] 0.0022 | 0.00211[8…] | 0.02 | 0.0021 2.2×10^{-3} | $2.11[8\ldots] \times 10^{-3}$ | 2×10^{-2} | 2.1×10^{-3} $\frac{1298}{590000}$ | $\frac{1250}{590000}$ | $\frac{11800}{590000}$ | $\frac{1239}{590000}$	
			Total	**4**		
18			6561 with no extras	3	**M1** for $\frac{x^{-\frac{1}{4}} \times x^{\frac{7}{8}}}{x^{\frac{1}{2}}}$ = 3 or better **M1** for $\frac{-1}{4}+\frac{7}{8}-\frac{1}{2}=\frac{1}{8}$ or better e.g. $x^{\frac{1}{8}} = 3$	<u>Alternative method:</u> **M1** for $x^{\frac{1}{2}-\frac{7}{8}}$ or $x^{-\frac{3}{8}}$ or $x^{-\frac{1}{4}+\frac{7}{8}}$ or $x^{\frac{5}{8}}$ **M1** for $x^{-\frac{1}{4}-other-\frac{3}{8}}$ or $x^{\frac{5}{8}-\frac{1}{2}}$ or $x^{\frac{1}{8}}$ Could be $x^{\frac{3}{8}}$ or $x^{-\frac{1}{8}}$ depends on which side of the equation
			Total	**3**		
19			[*a* =] $^{-}$20 [*b* =] 28 with correct working	6	**M1** for $\frac{4-2\sqrt{8}}{\sqrt{8}+3} \times \frac{\sqrt{8}-3}{\sqrt{8}-3}$ **M1** for multiplying *their* numerator e.g. $4\sqrt{8} - 12 - 2 \times 8 + 6\sqrt{8}$ **oe** or better **M1** for simplifying *their* numerator e.g. $10\sqrt{8} - 28$ **M1** for multiplying *their* denominator	"Correct working" requires at least **M1M1M1M1** <u>Alternative method</u> **M1** for $\sqrt{8} = 2\sqrt{2}$ **M1** for $\frac{4-4\sqrt{2}}{2\sqrt{2}+3} \times \frac{2\sqrt{2}-3}{2\sqrt{2}-3}$ **M1** for multiplying *their* numerator $8\sqrt{2} - 12 - 8 \times 2 + 12\sqrt{2}$ **oe** or better **M1** for simplifying *their* numerator e.g.

					e.g. $8+3\sqrt{8}-3\sqrt{8}-9$ **oe** or better e.g. 8 – 9 or ⁻1 **M1** for $\sqrt{8}=2\sqrt{2}$ at any stage and may be implied in working **A1dep** for [*a* =] ⁻20 or [*b* =] 28 **dep** on only **M4** awarded Alternative method **M1** for $[4-2\sqrt{8}]=(a\sqrt{2}+b)(\sqrt{8}+3)$ **M1** for $a\sqrt{2}\sqrt{8}+3a\sqrt{2}+b\sqrt{8}+3b$ **oe** or better **M1** for $\sqrt{2}\sqrt{8}=4$ or $\sqrt{8}=2\sqrt{2}$ **M1** for $4a+3a\sqrt{2}+2b\sqrt{2}+3b$ **M1** for 4 = 4*a* + 3*b* **oe** and ⁻4 = 3*a* + 2*b* **oe** **A1dep** for [*a* =] ⁻20 or [*b* =] 28 **dep** on only **M4** awarded If **0** scored, **SC1** for [*a* =] ⁻20 and [*b* =] 28	$20\sqrt{2}-28$ **M1** for $8+6\sqrt{2}-6\sqrt{2}-9$ **oe** or better e.g. 8 – 9 or ⁻1 **A1dep** for [*a* =] ⁻20 or [*b* =] 28 **dep** on only **M4** awarded Note: working may be implied by use rather than explicitly seen and follow through from any errors if subsequent working is correct
			Total	**6**		
20	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**		
21			$\frac{1}{7}$	2	**B1** for answer; $\frac{1}{n}$ or for answer with $\sqrt{49}$ or better	After correct answer **isw** any attempt to convert to decimal Allow **B1** for e.g. answer $^{-}7$
			Total	**2**		
22			$12a^7$ final answer	2	**B1** for answer ka^7 or $12a^k$ or for correct answer seen then spoiled	
			Total	**2**		
23			$6x^{3.5}$ nfww final answer	4	Mark coefficient and indices separately: **B1** for 6 from $\frac{9\times 2}{3}$ AND	Accept equivalent fractions in place of decimal powers

					B3 for $x^{3.5}$ nfww or **B2** for $x^{7.5}$ from $x^7 \times \sqrt{x}$ or for $x^{-3.5}$ or $\frac{\square}{x^{3.5}}$ from $\frac{\sqrt{x}}{x^4}$ or **B1** for $\sqrt{x} = x^{\frac{1}{2}}$ or $x^{0.5}$ **B1** for x^3 from $\frac{x^7}{x^4}$	If attempting both $\frac{x^7}{x^4}$ and $\frac{\sqrt{x}}{x^4}$ mark to candidate's benefit rather than choice
					Examiner's Comments Only about 10% of candidates scored full marks here. The most commonly scored marks were B1 for 6 from $\frac{9 \times 2}{3}$ and B1 for x^3 from $\frac{x^7}{x^4}$. Very few candidates demonstrated that they knew $\sqrt{x} = x^{\frac{1}{2}}$, with many just ignoring it, or treating it as x or even x^2. A few candidates tried to deal with the $\sqrt{x}$ by squaring expressions, often the starting one. This would have led to $36x^7$, which is the square of the answer and so would need to have been squared at the end, however candidates did not progress that far, with errors often being made at the squaring stage. Other unsuccessful approaches included multiplying top and bottom by x^4.	
			Total	**4**		
24			$12\sqrt{3}$ + 16 π final answer with correct working	7	**M1** for angle of major sector = 240° or $\frac{240}{360}$ oe soi **M1** for $\frac{their\,240}{360} \times 2 \times \pi \times 12$ **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 24π ÷ 3 × 2 oe eg

					M2 for [2 ×] 12 cos30° oe or **M1** for $\frac{x}{12}$cos30 oe **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	done in stages implies M1M1 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 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] <u>associated</u> 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 <u>Implicit methods may include</u> $AB^2 + (12\sin 30)^2 = 12^2$ 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 $\frac{\sin120}{AB}=\frac{\sin30}{12}$ oe or better Award B1 for sin 120 = $\frac{\sqrt{3}}{2}$ **and** sin 30 = $\frac{1}{2}$soi **Examiner's Comments** 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**	

25			$\frac{\sqrt{3}+2}{\sqrt{48}-6} \times \frac{\sqrt{48}+6}{\sqrt{48}+6}$ $\frac{\sqrt{3}\times\sqrt{48}+6\sqrt{3}+2\sqrt{48}+2\times6}{\sqrt{48}\times\sqrt{48}+6\sqrt{48}-6\sqrt{48}-6\times6}$ $\sqrt{48} = 4\sqrt{3}$ soi Simplifying *their* fraction e.g $\frac{24+14\sqrt{3}}{48-36}$ or better $\frac{12+7\sqrt{3}}{6}$	M1 M1 M1 M1dep A1	may be in a separate table **FT** $\sqrt{48}-6$ in both numerator and denominator **Dep** on at least three terms in the numerator **FT** *their* fraction with surds **A1** dep on **M4**	multiply by conjugate of denominator multiply out numerator giving at least three terms and denominator accept equivalents e.g. denominator as 48 – 36 or 12 implied by $[2\sqrt{48} =]\ 8\sqrt{3}$ or $14\sqrt{3}$ e.g. collecting like terms in numerator and in the denominator
			Examiner's Comments Candidates often tried to use their calculator for this but found it to be little help. They needed to multiply the numerator and the denominator by the conjugate of the denominator and those that didn't do that were unable to make much progress with the question.			
			Total	**5**		
26	a		7.83[30] × 10^7 or 7.833 × 10^7 or 7.8 × 10^7	3	**B2** for 78 330 000 or 78 300 000 or 78 000 000 oe or **M1** for 0.5222 × figs 15 soi by figs 783	oe is other correct answers not in standard form e.g. 78.33 × 10^6
	b		29.09[3…] or 29.1 or 29	2	**M1** for 4 364 000 000 ÷ figs 15 soi by figs 29	

			Total	**5**		
27			6 nfww	3	**M2** for $7k + 4$ [= 46] or $7k = 42$ or **M1** for $7k$ or 2^4 soi <u>Alternative method:</u> **M2** for $2^k = \sqrt[7]{2^{42}}$ or $2^k = 64$ or **M1** for $(2^k)^7$ = any of the below $\frac{2^{46}}{2^4}$, 2^{42}, $4.398... \times 10^{12}$, $4.4[0] \times 10^{12}$	Could be implied by manipulation of powers followed by ÷ 7 Accept $\frac{2^{46}}{2^4}$, $4.398... \times 10^{12}$ or $4.4[0] \times 10^{12}$ in place of 2^{42} Do not accept $(2^k)^7 = \frac{2^{46}}{16}$
			Total	**3**		
28	a		$5\sqrt{6}$ final answer	2	**B1** for $\sqrt{150}$ or $[\sqrt{30} =]\sqrt{5}\sqrt{6}$	
	b		$\frac{5\sqrt{14}}{2}$ or $\frac{5\sqrt{7}\sqrt{2}}{2}$ final answer	3	**B2** for $\frac{35\sqrt{14}}{14}$ or $\frac{35\sqrt{7}\sqrt{2}}{14}$ or **M1** for $\frac{35}{\sqrt{14}} \times \frac{\sqrt{14}}{\sqrt{14}}$ or better	
	c		32	2	**M1** for $\sqrt[3]{8}^5$ soi or **B1** for $\sqrt[3]{8} = 2$	
			Total	**7**		
29	a		5.46×10^5	1		Condone trailing zeros
	b		[0].0029	1		Condone trailing zeros
			Total	**2**		

30	a		$[\sqrt{7}\sqrt{21} =]$ $\sqrt{147} = \sqrt{49\times3}$ or $\sqrt{49}\times\sqrt{3}$ $[= 7\sqrt{3}]$ or $[[\sqrt{7}\sqrt{21} =]$ $\sqrt{7}\times\sqrt{7}\sqrt{3}$ or $\sqrt{7}\times\sqrt{7\times3}$ or $\sqrt{7\times7\times3}$ $[= 7\sqrt{3}]$	1		
	b		$\frac{\sqrt{7}(5-\sqrt{21})}{(5+\sqrt{21})(5-\sqrt{21})}$ $5\sqrt{7} - \sqrt{7}\sqrt{21}$ **oe** or better 25 [+ $5\sqrt{21} - 5\sqrt{21}$] – 21 $\frac{5\sqrt{7}-7\sqrt{3}}{4}$	M1 M1 M1 A1	Condone missing bracket for this **M1** if recovered later in numerator or denominator May be in a grid May be in a grid Dep on **M1M1M1** and no errors seen	Multiplying by $\sqrt{21}$ – 5 is eligible for **M1** and then **FT** but **A1** must be correct form Multiplying by 5 + $\sqrt{21}$ scores **0** Equivalents likely to be seen for $\sqrt{7}\sqrt{21}$ include $\sqrt{147}$ and $7\sqrt{3}$ An error is e.g. missing bracket in first **M1**
			Total	**5**		
31	a		4.57×10^{-3}	1		Condone trailing zeros
	b		24 696 or 24 700	2	**M1** for $3.43 \times 10^{-1} \times 60^2 \times 20$ **oe**	Note : $60^2 \times 20 = 72\,000$
	c		5 with correct working	3	**M2** for $\sqrt[3]{\frac{4.41\times10^9}{180\times3.00\times10^5}}$ **oe** OR	"Correct working" requires evidence of at least **M1** or **M2** if trials are used **M2** implied by 4.338…] or 4.34 or $\sqrt[3]{81.6...}$

					M1 for $\frac{4.41\times10^9}{3.00\times10^5}$ **oe** or $\frac{4.41\times10^9}{180}$ **oe** or $180 \times 3.00 \times 10^5$ **oe** If **0** scored **SC1** for answer 5 with no or insufficient working	or $n^3 = 81.66\ldots$ Condone use of a value $179 \le$ value ≤ 180 instead of 180 which should lead to 4.34… **M1** may be seen within a larger calculation e.g. $\frac{4.41\times10^9}{180\times3.00\times10^5}$ or $\sqrt[3]{\frac{4.41\times10^9}{3.00\times10^5}}$ **M1** implied by 14 700 or 2.45×10^7 **oe** or 5.4×10^7 **oe** or 81.6 <u>Use of trials</u> **M1** for each correct trial using integer values of *n* up to a maximum of **M2** e.g. $\frac{their\ 14700}{5^3}$ **oe and** 117 to 118 or 1.95 to 1.97 $\frac{their\ 14700}{4^3}$ **oe and** 229[. ..] or 3.8[…] *Their* 14 700 comes from 3×10^5 and 4.41×10^9
					Other trials, condone **rot** : $\frac{their\ 14700}{2^3}$ **oe and** 1837[.5…] or 30[.6…] $\frac{their\ 14700}{3^3}$ **oe and** 544[.4….] or 9[.07…] $\frac{their\ 14700}{6^3}$ **oe and** 68[.05…] or 1[.1…] Or they might try to see how far they go at each warp speed in 3 minutes (**rot** at least	

					2 figures): Warp 2 : $2^3 \times 3 \times 10^5 \times 180 = 432\,000\,000$ Warp 3 : $3^3 \times 3 \times 10^5 \times 180 = 1\,458\,000\,000$ Warp 4 : $4^3 \times 3 \times 10^5 \times 180 = 3\,456\,000\,000$ Neptune 4 410 000 000 Warp 5 : $5^3 \times 3 \times 10^5 \times 180 = 6\,750\,000\,000$ Warp 6 : $6^3 \times 3 \times 10^5 \times 180 = 11\,664\,000\,000$ Mark as trials so M1 each correct trial.	
			Total	**6**		
32			8	2	**M1** for $[\sqrt[5]{32} =]2$ or $[32^3 =]$ 32768	**M1** implied by answer $\frac{1}{8}$
			Total	**2**		
33			Correct method to establish $x = \frac{4}{5}$ e.g. $p^{\frac{3}{4}} = p^{\frac{3}{5}}$ or better or $m^{\frac{3x}{4}} = m^{\frac{3}{5}}$ or $\frac{3x}{4} = \frac{3}{5}$ or $p = \left(\sqrt[3]{\left(\sqrt[5]{m}\right)^3}\right)^4$ **or better** $p^{\frac{1}{4}} = m^{\frac{1}{5}}$ leading to $p = m^{\frac{4}{5}}$ or $\frac{3}{5} \times \frac{4}{3} \times \frac{4}{5}$ or $15x = 12$ leading to $\frac{4}{5}$ or $p = \left(\sqrt[5]{m}\right)^{(3\times4)}$ **or better** leading to $p = m^{\frac{4}{5}}$	M2 A1	**M1** for $p^{\frac{3}{4}}$ or $m^{\frac{3}{5}}$ or $\left[\sqrt[4]{(m^x)^3} =\right] m^{\frac{3x}{5}}$ or for first step in making p the subject $p^3 = \left(\sqrt[5]{m^3}\right)^4$ or $\sqrt[4]{p} = \sqrt[3]{\left(\sqrt[5]{m^3}\right)}$ **or better** If **0** scored, **SC1** for $[p =]\sqrt[5]{m^4}$ written After **M2** earned and with no errors seen	or better **e.g.** $\sqrt[4]{p} = \sqrt[15]{m^3}$ **e.g.** or better for **M2** $p = \sqrt[15]{m^{12}}$ Maximum mark is **SC1** for those working backwards from $x = \frac{4}{5}$ and this mark is for interpreting the index $m^{\frac{4}{5}}$ as $\sqrt[5]{m^4}$
			Total	**3**		
34	a		$2^{11} \times 3^4 \times 5^5$	2	**M1** for $[10^5 =]\ 2^5 \times 5^5$ seen, expanded or used or for answer including 2^{11}	Correct answer in expanded form implies $2^5 \times 5^5$ used for **M1**
	b		16000	2		

					B1 for $2^7 \times 5^3$	
			Total	**4**		
35			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**		
36			-4 + $2\sqrt{5}$ final answer	3	**B2** for answer $p + 2\sqrt{5}$ or **M1** for $[\sqrt{80} =] 4\sqrt{5}$ seen or $\frac{\sqrt{80}}{\sqrt{4}}$ seen **B1** for answer $^-4 + \sqrt{k}$ or $^-4 + 2\sqrt{k}$	$p \neq 0$ $k > 0$ but not 80
			Total	**3**		
37			$\frac{7\pi r}{12}$ 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	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

					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 If 0 or 1 scored, instead award **SC2** for final answer $\frac{7\pi r}{12}$ oe simplified answer with no or insufficient working	Where *k* is numeric or algebraic **but does not** come from squaring Allow e.g. *k* = 3, *r*, *d*, $\frac{3}{7}r, \frac{3}{7}x$ For A1 accept e.g. 0.25 π*r* Correct expression 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**		
38			$3\sqrt{3}$ final answer	3	**M2** for $5\sqrt{3}$ and $2\sqrt{3}$ Or **M1** for $\sqrt{25 \times 3}$ or better or $\sqrt{4 \times 3}$ or better	
			Total	**3**		
39			$x^2 + y^2 = 124$ final answer	4	**B2** for 124 Or **B1** for 108 Or **M1** for $4^2 + (6\sqrt{3})^2$ **oe**	

					B1 for $x^2 + y^2 = k$ as final answer	Accept '= k' or numeric value where $k > 0$
			Total	**4**		
40			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**		
41			-3	1		
			Total	**1**		

42	a		BD = EF or BD = $2t$ and [opposite sides of a] rectangle [are equal] BC = BD [= $2t$] and radii [of a sector/circle]	1 1	For two marks, $2t$ must be seen in at least one statement as BD or on the diagram as BD **Examiner's Comments** 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 = $2t$ and then BC = BD because they are both radii of the same sector/circle'.
	b		ABF = 55 and AB = $5t$ $\frac{their\,55}{360} \times 2\pi \times their\,5t$ $\frac{35}{360} \times 2\pi \times 2t$ $5t + 2t + 5t + 2t$ $\frac{35}{360} \times 2\pi \times 2t + \frac{55}{360} \times 2\pi \times 5t + 5t + 2t + 5t + 2t$ $\frac{23}{12}\pi t + 14t$	B1 M1 M1 M1 A1	Stated or seen on diagram All **M** marks may be seen within a summarising expression Condone $10t + 4t$, $7t + 7t$ etc but not $14t$ **Examiner's Comments** Part (a) served as a prompt for part (b) and most candidates making an attempt deduced that AB = $5t$, which enabled them to gain a mark if showing the sum of the four straight sides leading to $14t$. Candidates could also gain a mark for having both AB = $5t$ 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**	
43			$\frac{1}{333}$, 3.1×10^{-3}, 0.36%, 0.03	4	**B3** for all 4 expressed in an equivalent comparable form or **B2** for 3 expressed in an equivalent comparable form or **B1** for 2 expressed in an equivalent comparable form Likely comparable form (award best row): Equivalent comparable form is either decimal, percentage or standard index form. Fractions only acceptable as comparable form with common denominators. For final answer, accept some or all given as equivalent form on answer line. eg. Full marks for 0.003[003…], 0.0031, 0.0036, 0.03 or $\frac{1}{333}, \frac{31}{10\,000}, \frac{9}{2500}, \frac{3}{100}$ Where choice of comparable form, mark to candidate's advantage.

0.36%	$\frac{1}{333}$	0.03	3.1×10^{-3}
0.36[%]	0.00003[003…][%]	3[%]	0.31[%]
0.0036	$3[.003\ldots] \times 10^{-3}$	3×10^{-2}	3.1×10^{-3}
3.6×10^{-3}	$3[.003\ldots] \times 10^{-3}$	3×10^{-2}	3.1×10^{-3}
$\frac{11\,988}{3\,330\,000}$	$\frac{10\,000}{3\,330\,000}$	$\frac{99\,900}{3\,330\,000}$	$\frac{10\,323}{3\,330\,000}$

					Examiner's Comments The greatest success was achieved by candidates changing each value to its decimal equivalent, but many could not do this correctly for 0.36%. A few candidates tried to convert to fractions, but rarely managed to have a common denominator across all four values. Candidates who showed no working could gain four marks if correct, but most responses without working were incorrect and so gained zero. If working was shown, B1, B2 and B3 were available to candidates who made some correct conversions. **Assessment for learning** Even if a question does not say 'you must show your working', it is wise to assume that a four-mark question (such as this one) will have up to three marks available for the working or method.
			Total	**4**	
44			$\frac{1}{6}$	2	**B1** for answer $\frac{1}{n}$ or for answer with $\sqrt{36}$ or better After correct answer isw any attempt to convert to decimal Allow B1 for e.g. answer –6 **Examiner's Comments** There were few correct responses for this question and there were a range of incorrect values given. Partial marks were given for those that were able to interpret either the negative part of the index or the root of 36 in their answer.
			Total	**2**	
45	a		$[AC =] \frac{4}{\cos 30}$ oe	M2 A2 M1 A1	

			$(AC =)\frac{8}{\sqrt{3}}$ 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 or $\frac{1}{8}\times\pi\times\frac{8}{\sqrt{3}}\times\frac{8}{\sqrt{3}}$ $=\frac{8}{3}\pi$		**M1** for $\frac{4}{AC}=\cos30$ oe or for $\frac{\sin 60}{4}=\frac{\sin 90}{AC}$ 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 4 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 $\frac{1}{8}\times\pi\times\frac{8^2}{3}$
					Examiner's Comments 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 $\frac{1}{2}\times4\times\frac{8}{\sqrt{3}}\times\sin30$ FT *their* AC from (a) or for $\frac{1}{2}\times4\times4\times\tan30$	Accept e.g. $\frac{16\sqrt{3}}{6}+\frac{8}{3}\pi$ for 3 marks

					B1 for sin 30 = $\frac{1}{2}$ **oe** or for tan 30 = $\frac{\sqrt{3}}{3}$ **oe** **Examiner's Comments** 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 $\frac{1}{2}\times$ their AC × 4 sin 30 to find the area was seldom seen.
			Total	**9**	
46			$12a^7$ final answer	2	**B1** for answer ka^7 or $12a^k$ or for correct answer seen then spoiled **Examiner's Comments** Almost all candidates answered this correctly.
			Total	**2**	
47			625 with no extras	3	**M1** for $\frac{x^{-\frac{1}{6}}\times x^{\frac{3}{4}}}{x^{\frac{1}{3}}}=5$ or better **M1** for $-\frac{1}{6}+\frac{3}{4}-\frac{1}{3}=\frac{1}{4}$ or better e.g. $x^{\frac{1}{4}}=5$ Alternative method : **M1** for $x^{\frac{1}{3}-\frac{3}{4}}$ or $x^{\frac{-5}{12}}$ or $x^{-\frac{1}{6}+\frac{3}{4}}$ or $x^{\frac{7}{12}}$ and **M1** for $x^{-\frac{1}{6}-their\frac{-5}{12}}$ or $x^{\frac{7}{12}-\frac{1}{3}}$ or $x^{\frac{3}{12}}$ or $x^{\frac{1}{4}}$ could be $x^{\frac{5}{12}}$ or $x^{\frac{-1}{4}}$ depends on which side of the equation

					Examiner's Comments The candidates were required to know and apply the laws of indices to be able to answer this question and most of them could not do this. The best attempts used the law on the right-hand side to get $x^{\frac{1}{3}} \div x^{\frac{3}{4}} = x^{-\frac{5}{12}}$ and a few were able to obtain the correct answer from the use of one or more of these laws.	
			Total	**3**		
48			[a =] 21 [*b* =] –31 with correct working	6	**M1** for $\frac{2-3\sqrt{18}}{\sqrt{18}+4} \times \frac{\sqrt{18}-4}{\sqrt{18}-4}$ **M1** for multiplying *their* numerator e.g. $2\sqrt{18} - 8 - 3 \times 18 + 12\sqrt{18}$ oe or better **M1** for simplifying *their* numerator e.g. $14\sqrt{18} - 62$ **M1** for multiplying *their* denominator e.g. $18 + 4\sqrt{18} - 4\sqrt{18} - 16$ oe or better e.g. 18 – 16 or 2 **M1** for $\sqrt{18} = 3\sqrt{2}$ at any stage and may be implied in working **A1dep** for [*a* =] 21 or [*b* =] –31 dep. on only **M4** awarded Alternative: **M1** for $[2 - 3\sqrt{18}] = (a\sqrt{2} + b)(\sqrt{18} + 4)$ **M1** for $a\sqrt{2}\sqrt{18} + 4a\sqrt{2} + b\sqrt{18} + 4b$ oe or better **M1** for $\sqrt{2}\sqrt{18} = 6$ or $\sqrt{18} = 3\sqrt{2}$ **M1** for $6a + 4a\sqrt{2} + 3b\sqrt{2} + 4b$ **M1** for $2 = 6a + 4b$	"Correct working" requires at least **M1M1M1M1** alternative : **M1** for $\sqrt{18} = 3\sqrt{2}$ **M1** for $\frac{2-9\sqrt{2}}{3\sqrt{2}+4} \times \frac{3\sqrt{2}-4}{3\sqrt{2}-4}$ **M1** for multiplying *their* numerator $6\sqrt{2} - 8 - 3 \times 18 + 36\sqrt{2}$ oe or better **M1** for simplifying *their* numerator e.g. $42\sqrt{2} - 62$ **M1** for $18 + 12\sqrt{2} - 12\sqrt{2} - 16$ oe or better e.g. 18 – 16 or 2 **A1dep** for [*a* =] 21 or [*b* =] –31 dep. on only **M4** awarded Note : working may be implied by use rather than explicitly seen and follow through from

					oe and -9 = 4*a* + 3*b* oe **A1dep** for [*a* =] 21 or [*b* =] –31 dep. on only **M4** awarded If **0** scored **SC1** for [*a* =] 21 and [*b* =] –31	any errors if subsequent working is correct
					Examiner's Comments A few candidates were able to complete this correctly showing all the working. This can be worked out on some calculators now, but the question demanded each step of working to be shown. Many candidates did not attempt it. Many candidates did not know that $\sqrt{18} = \sqrt{9 \times 2} = 3\sqrt{2}$ and many of them did not know how to rationalise the denominator by multiplying the numerator and denominator by $(\sqrt{18} - 4)$.	
			Total	**6**		
49	a		3.86×10^{-3}	1		Condone trailing zeros
					Examiner's Comments This question was answered very well, with only a few putting 10^3 instead of 10^{-3}. A few candidates gave the incorrect answer of 3.86×10^{-5} when counting the decimal point to the end of the number and a few dropped the 6 and wrote 3.8×10^{-3}.	
	b		29 635[.2] or 29 640 or 29 600	2	**M1** for $3.43 \times 10^{-1} \times 60^2 \times 24$ oe If **0** scored **SC1** for 14 817.6, 14 818, 14 820 or 14 800	Note: $60^2 \times 24 = 86\,400$
					Examiner's Comments The majority of candidates answered this question correctly. Those that didn't usually	

					only multiplied by 24 and one 60 or multiplied by 24 and three 60s.	
	c		5 with correct working	3	**M2** for $\sqrt[3]{\frac{4.41\times10^9}{120\times3.00\times10^5}}$ oe OR **M1** for $\frac{4.41\times10^9}{3.00\times10^5}$ oe or $\frac{4.41\times10^9}{120}$ oe or $120\times3.00\times10^5$ oe If **0** scored **SC1** for answer 5 with no or insufficient working	"Correct working" requires evidence of at least **M1** or **M2** if trials are used **M2** implied by 4.966… or 4.97 or $\sqrt[3]{122.5}$ or $n^3 = 122.5$ condone use of a value 119 ≤ value ≤ 120 instead of 120 which should lead to 4.98 **M1** may be seen within a larger calculation e.g. $\frac{4.41\times10^9}{120\times3.00\times10^5}$ or $\sqrt[3]{\frac{4.41\times10^9}{3.00\times10^5}}$ **M1** implied by 14 700 or 3.675×10^7 oe or 3.6×10^7 oe or 122.5 <u>use of trials</u> **M1** for each correct trial using integer values of *n* up to a maximum of **M2** e.g. $\frac{their\ 14700}{5^3}$ oe **and** 117 to 118 or 1.95 to 1.97 $\frac{their\ 14700}{4^3}$ oe **and** 229[...] or 3.8[…] *their* 14 700 comes from 3×10^5 and 4.41×10^9 Other trials, condone rot :

					$\frac{their\ 14700}{2^3}$ oe **and** 1837[.5…] or 30[.6…] $\frac{their\ 14700}{3^3}$ oe **and** 544[.4….] or 9[.07…] $\frac{their\ 14700}{6^3}$ oe **and** 68[.05…] or 1[.1…] Or they might try to see how far they go at each warp speed in 2 minutes (rot at least 2 figures): Warp 2 : $2^3 \times 3 \times 10^5 \times 120$ = 288 000 000 Warp 3 : $3^3 \times 3 \times 10^5 \times 120$ = 972 000 000 Warp 4 : $4^3 \times 3 \times 10^5 \times 120$ = 2 304 000 000 Neptune 4 410 000 000 Warp 5 : $5^3 \times 3 \times 10^5 \times 120$ = 4 500 000 000 Warp 6 : $6^3 \times 3 \times 10^5 \times 120$ = 7 776 000 000 Mark as trials so M1 each correct trial. **Examiner's Comments** Many candidates found this part difficult. It was common to award a method mark for either $\frac{4.41 \times 10^9}{120}$ or $\frac{4.41 \times 10^9}{3 \times 10^5}$. Some attempted to calculate $\sqrt[3]{14700}$ and others $\sqrt[3]{3.675 \times 10^7}$. A common error was to invert the fraction given above or add the powers of ten instead of subtracting them when the calculation was not done completely on their calculator. Some candidates got to 122.5 but forget that $n^3 = 122.5$. A few candidates used square rooting instead of cube rooting. A popular approach was to use trials, however only a handful got the correct answer from this method. There were some who only used 5 as a trial , but it was not clear how they had arrived at this value. If trials are used, we commonly expect to see at least two attempts to reach the correct answer. There was much confusion between distance and speed so incorrect formulae were used.
			Total	**6**	

50	a		$[\sqrt{11}\sqrt{22} =]$ $\sqrt{242} = \sqrt{121 \times 2}$ or $\sqrt{121} \times \sqrt{2}$ $[= 11\sqrt{2}]$ or $[\sqrt{11}\sqrt{22} =]$ $\sqrt{11} \times \sqrt{11}\sqrt{2}$ or $\sqrt{11} \times \sqrt{11 \times 2}$ or $\sqrt{11 \times 11 \times 2}$ $[= 11\sqrt{2}]$	1	**Examiner's Comments** A majority of candidates demonstrated a good understanding of the manipulation of simple surds. The most common issue was candidates skipping steps in this 'Show that…' question. For example, after $\sqrt{11} \times \sqrt{22} = \sqrt{242}$, it was necessary to then give $\sqrt{121} \times \sqrt{2}$ before writing the given answer. Less able candidates struggled with setting out their work, with many giving a continuous line of expressions connected by '=' symbols that were not actually equal to each other; others had statements connected by arrows. This was particularly a problem when $\sqrt{22}$ was rewritten elsewhere on the page as $\sqrt{11} \times \sqrt{2}$. Some candidates resorted to decimal calculations to show the equivalence, an approach neither rigorous nor exact enough for a 'Show that…' question. **Assessment for learning** Candidates should be reminded to show all details of their working in a 'Show that…' question, no matter how trivial they seem.
	b		$\frac{\sqrt{11}(13 - \sqrt{22})}{(13 + \sqrt{22})(13 - \sqrt{22})}$ $13\sqrt{11} - \sqrt{11}\sqrt{22}$ oe or better $169\ [+13\sqrt{22} - 13\sqrt{22}] - 22$ $\frac{13\sqrt{11} - 11\sqrt{2}}{147}$	M1 M1 M1 A1	Condone missing bracket for this **M1** if recovered later in numerator or denominator May be in a grid May be in a grid	Multiplying by $\sqrt{22} - 13$ is eligible for **M1** and then FT but **A1** must be correct form Multiplying by $13 + \sqrt{22}$ scores **0** Equivalents likely to be seen for $\sqrt{11}\sqrt{22}$ include $\sqrt{242}$ and $11\sqrt{2}$

					Dep on **M1M1M1** and no errors seen	An error is eg missing bracket in first **M1**
					Examiner's Comments Candidates who knew to multiply the numerator and denominator by the conjugate were usually able to complete the process successfully. Common errors involved slips in the multiplications (usually with the signs when multiplying the denominator) or giving the expansion without showing the required working. Occasionally candidates omitted essential brackets or the fraction line at the first stage. It was clear that some had an understanding of what was required but started off by not using the correct conjugate. Some multiplied the numerator and denominator by terms such as $13+\sqrt{22}$, or just $\sqrt{22}$. A high proportion of candidates made no attempt at a response. There were also some who seemingly used their calculator to find the answer and then attempted to construct a solution that led to this. These solutions were often full of small mistakes and creative manipulation; they usually did not have the required minimum two terms for the denominator expansion, for example.
			Total	**5**		
51			16	2	**M1** for $\left[\sqrt[3]{64}=\right]$ or [64^2 =] 4096	M1 implied by answer $\frac{1}{16}$ **Examiner's Comments** A small majority of the candidates answered this correctly. Some found the cube root of 64 as 4 and were given partial credit. A common error was then to do 4 × 2 = 8. A small number attempted to square 64 first (some were successful), but difficulty was had in finding the square root

					of 4096. A minority of candidates were unable to interpret the index notation and multiplied 64 by $\frac{2}{3}$.
			Total	**2**	
52			Correct method to establish $x = \frac{5}{3}$ e.g. $p^{\frac{2}{5}} = m^{\frac{2}{3}}$ or better or $m^{\frac{2x}{5}} = m^{\frac{2}{3}}$ or $\frac{2x}{5} = \frac{2}{3}$ or $p = \left(\sqrt{\left(\sqrt[3]{m}\right)^2}\right)^5$ **or better** $p^{\frac{1}{5}} = m^{\frac{1}{3}}$ leading to $p = m^{\frac{5}{3}}$ or $\frac{2}{3} \times \frac{5}{2} = \frac{5}{3}$ or $6x = 10$ leading to $\frac{5}{3}$ or $p = \left(\sqrt[3]{m}^{(2\times5)}\right)$ **or better** leading to $p = m^{\frac{5}{3}}$	M2 A1	**M1** for $p^{\frac{2}{5}}$ or $m^{\frac{2}{3}}$ or $[\sqrt[5]{(m^x)^2} =] m^{\frac{2x}{5}}$ or for first step in making *p* the subject $p^2 = \left(\sqrt[3]{m}^2\right)^5$ or $\sqrt[5]{p} = \sqrt{\left(\sqrt[3]{m}^2\right)}$ **or better** If 0 scored, **SC1** for $[p =] \sqrt[3]{m^5}$ written After M2 earned and with no errors seen	or better **e.g.** $\sqrt[5]{p} = \sqrt[6]{m^2}$ e.g. or better for M2 $p = \sqrt[6]{m^{10}}$ Maximum mark is SC1 for those working backwards from $x = \frac{5}{3}$ and this mark is for interpreting the index $m^{\frac{5}{3}}$ as $\sqrt[3]{m^5}$

Examiner's Comments

This proved very challenging for candidates and the majority did not make any attempt to answer it. Many of those making an attempt did not know really where to start and often misinterpreted the meaning of the root and index notation in the question, e.g. $\sqrt[5]{p^2} = p^{\frac{5}{2}}$ or $\sqrt[10]{p}$. Some tried to use a numeric value instead of *p* and/or *m*.

The most successful strategy used was to express both expressions in p and m using correct index notation $p^{\frac{2}{5}} = m^{\frac{2}{3}}$. To arrive at $x = \frac{5}{3}$ candidates needed then to show that

					$p=\left(m^{\frac{2}{3}}\right)^{\frac{5}{2}}$ leading to $\frac{2}{3}\times\frac{5}{2}=\frac{5}{3}$. A number were able to set up the index equation to earn method marks, but fewer were able to complete it correctly without errors seen, to earn the final mark Other successful strategies made p the subject of the formula $\sqrt[5]{p^2}=(\sqrt[3]{m})^2$, where candidates showed correct single step line by line inverse operations involving the roots and indices.
			Total	**3**	
53			7 nfww	3	**M2** for $6k + 3$ [= 45] or **M1** for $6k$ or 2^3 soi <u>Alternative method:</u> **M2** for $2^k=\sqrt[6]{2^{42}}$ or $2^k = 128$ or **M1** for $(2^k)^6$ = any of the below $\frac{2^{45}}{2^3}$, 2^{42}, $4.398\ldots \times 10^{12}$, $4.4[0] \times 10^{12}$ Could be implied by manipulation of powers followed by ÷ 6 Accept $\frac{2^{45}}{2^3}$, $4.398... \times 10^{12}$ or $4.4[0] \times 10^{12}$ in place of 2^{42} Do not accept $(2^k)^6=\frac{2^{45}}{8}$ **<u>Examiner's Comments</u>** This question differentiated the more able candidates from the rest. The most efficient approach was to change 8 into 23 and then apply the laws of indices to obtain and solve $6k + 3 = 42$. Less efficient and less

					successful, was first to use a calculator to find $\sqrt[4]{\frac{2^{45}}{8}}$ and then to recognise that $128 = 2^7$.
			Total	**3**	
54	a		$4.36[35] \times 10^9$ or 4.364×10^9 or 4.4×10^9	3	**B2** for 4 363 500 000 or 4 400 000 000 oe or **M1** for 29.09 × figs 15 soi by figs 436 oe is other correct answers not in standard form eg 43.635×10^8 **Examiner's Comments** Most candidates showed the correct process of multiplication and only a few candidates tried to convert 1.5×10^8 into ordinary form beforehand. As most calculators present the answer in ordinary form, many candidates did not convert this back into standard form to get the final answer mark.
	b		0.52[2…]	2	**M1** for 78 340 000 ÷ figs 15 soi by figs 52 **Examiner's Comments** While the need to divide was recognised by most candidates, some used 29.09 rather than 1.5×10^8. Others gave incorrect answers that started with the correct figures of 52, suggesting they had mis-keyed a value into their calculator. **Assessment for learning** In standard form questions in calculator exams, it is unlikely there will be a mark for converting a value into ordinary form. It is,

					therefore, generally advisable to use the calculator facility to enter the values in standard form rather than trying to convert and make a mistake.
			Total	**5**	
55	a		$3\sqrt{5}$ final answer	2	**B1** for $\sqrt{45}$ or $\left[\sqrt{15} =\right]\sqrt{5}\sqrt{3}$ **Examiner's Comments** There was some good work seen here and many scored 2 marks or a partial mark for showing either $\sqrt{45}$ or $\sqrt{15} = \sqrt{3}\sqrt{5}$ in working.
	b		$\frac{8\sqrt{15}}{3}$ or $\frac{8\sqrt{5}\sqrt{3}}{3}$ final answer	3	**B2** for $\frac{40\sqrt{15}}{15}$ or $\frac{40\sqrt{5}\sqrt{3}}{15}$ or **M1** for $\frac{40}{\sqrt{15}} \times \frac{\sqrt{15}}{\sqrt{15}}$ or better **Examiner's Comments** This was not as well answered as the previous part but those that realised that multiplication by $\frac{\sqrt{15}}{\sqrt{15}}$ was the first step were usually successful in this part. A few did not then simplify the answer.
	c		81	2	**M1** for $\sqrt[3]{27^4}$ soi or **B1** for $\sqrt[3]{27} = 3$ **Examiner's Comments** Answers varied in this part. Those that were able to interpret the index correctly were able to process correctly and get the answer. Many were not able to interpret the fractional index and instead, incorrectly divided by 3 and multiplied by 4.
			Total	**7**	
56	a		[0].000 82	1	Condone trailing zeros

					Examiner's Comments Candidates often answered this correctly, sometimes one zero was omitted giving an answer of 0.0082.
	b		6.54×10^4	1	Condone trailing zeros **Examiner's Comments** This was well answered, the common error was not to write the first number as a number between 1 and 10, for example, 654×10^2.
			Total	**2**	
57	a		$2^{12} \times 3^5 \times 5^6$	2	**M1** for $[6^5 =] 2^5 \times 3^5$ seen, expanded or used or for answer including 2^{12} or 3^5 Correct answer in expanded form implies $2^5 \times 3^5$ used for **M1** **Examiner's Comments** Some candidates efficiently changed 6^5 into $2^5 \times 3^5$, and were then usually successful in writing the correct final answer. Other candidates often adopted an inefficient approach by 're-starting' a full prime factor decomposition. This resulted in extensive working for the 2 marks available and a lack of space, which did not seem to be questioned. Some did reach 3^5 or 2^{12} in their final answer, either of which scored 1 mark. Those candidates that could not answer part (a) correctly would invariably not get very far in this part of the question. These candidates would attempt to make the correction that they had stated in part (a), e.g. trying to write an answer in standard index form or restating the given answer in a different order or different form such as

					128 × 15625 × 7776.  In part (a), the candidate had correctly identified that 6 was not a prime number. They efficiently take the given $2^7 \times 5^6 \times 6^5$ and re-write 6^5 as $(2 \times 3)^5$ and then as $2^5 \times 3^5$. Finally, they simplify $2^7 \times 2^5$.
	b		20 000	2	**B1** for $2^5 \times 5^4$ **Examiner's Comments** Many candidates did not appear familiar with finding the HCF with numbers in index form. Attempts at finding the LCM or random selections of values chosen from the 2 sets of factors were often seen. A small number of candidates used a Venn diagram approach. More common was simply listing factors and identifying common terms. There were occasional inaccurate evaluations of identified HCFs and omission of zeros but it was rare to award the method mark in this part.
			Total	**4**	
58			8 min 15 sec	4	**B3** for 8.25 or $8\frac{1}{4}$ or $8\frac{15}{60}$ or for answer 8m 25s 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) eg $\frac{1.5 \times 10^{8}}{303030[.3\ldots]}$ *their* 495 from attempt at a correct M1 expression **Examiner's Comments**

					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**	
59			$\frac{5\pi r}{6}$ with correct working	5	**B4** for correct unsimplified answer with correct working | Condone '×' sign oe in simplified answer if

					OR **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 **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 If 0 or 1 scored, instead award **SC2** for final answer $\frac{5\pi r}{6}$ oe simplified answer with no or insufficient working	otherwise correct e.g. $\frac{5}{6} \times \pi r$ "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. $k = 2$, r, d, 0.4 , $0.4x$ For A1 accept e.g. 0.333 πr Correct expression implies M1A1 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
					Examiner's Comments 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**	
60			$-3+\sqrt{11}$ final answer	3	**B2** for answer $p+\sqrt{11}$ or M1 for $[\sqrt{44}=]\ 2\sqrt{11}$ seen or $\frac{\sqrt{44}}{\sqrt{4}}$ seen — $p \neq 0$ **B1** for answer $-3+\sqrt{k}$ — $k > 0$ but not 44 **Examiner's Comments** A minority of candidates gave a correct simplified expression. Many did not attempt to simplify the surd $\sqrt{44}$ as part of the method and answers such as $-3+\sqrt{22}$ were common. Some misinterpreted the division by 2 and multiplied by 2 instead, giving answers such as $-12+\sqrt{88}$
			Total	**3**	
61	a		1.5×10^4 nfww isw	4	**B3** for 15000 oe — eg 15000 may be 15×10^3

					or 1.49[0..] × 10^4 or **B2** for 14900 oe or **M1** for figs 181 – figs 32 If **0** scored **SC1** for *their* value correctly rounded to 2 significant figures	Subtraction may be implied by figs 15 or figs 149 *Their* unrounded value must be seen
					Examiner's Comments **AfL** Similarly in this part, where candidates needed to find the difference between two of the values, giving the final answer in standard form correct to 2 significant figures. While the ability to use the standard form facility on a calculator is expected, the numbers were chosen so that the calculator would usually show 14 900 as the answer. Those using this standard form facility reached 14 900 quickly and accurately, whereas those who converted the two numbers first took longer and made mistakes. Candidates of all abilities often did not give the answer in the required form, with 15 000 and 1.49 × 10^4 being very common.	
	b		5120	1		
	c		Topozero, Tana, Mweru, Ladoga, Victoria or 986, 3200, 5120, 18 100, 68 900 oe in standard form	2	**B1** for Topozero as smallest or Victoria as largest or all in correct reverse order	9.86 × 10^2, 3.20 × 10^3, 5.12 × 10^3, 1.81 × 10^4, 6.89 × 10^4 condoning superfluous zeros and slip in index

					Examiner's Comments **AfL** Although the vast majority of candidates scored at least five marks out of seven, the methods used were often inefficient. In this part, candidates were required to order five numbers given in standard form. In such questions, it is usual for the marks to be given for the order, either fully correct or partially correct, rather than any working. Stronger responses were able to write down the correct order by focussing on the exponent; responses which scored lower converted all five numbers into ordinary form, sometimes with an error, to create their order.
			Total	**7**	
62			5 $5\sqrt{5}$ final answer	3	**M2** for $2\sqrt{5}$ and $3\sqrt{5}$ or **M1** for $\sqrt{4\times5}$ or better or $\sqrt{9\times5}$ or better
			Total	**3**	
63			$x^2 + y^2 = 123$ final answer	4	**B2** for 123 or **B1** for 98 or **M1** for $5^2 + 5^2 + (7\sqrt{2})^2$ **oeB1** for $x^2 + y^2 = k$ as final answer	Accept '= k' or numeric value where $k > 0$
			Total	**4**	
64			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**	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

					AND **M2** for answer 20 + $k\pi$ where $k = \frac{their\theta}{18}$ or **M1** for $k = \frac{their\theta}{18}$ **oe** or answer 20 + $k\pi$ If 0 scored **SC2** for answer 20 + 8 π	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 $k \neq 0$ May be on diagram
			Total	**6**		
65			$^{-}4$	1		
			Total	**1**		