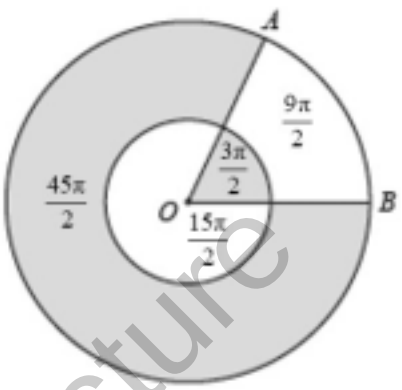
1(a)	$2\pi\times10^2+2\pi\times8^2+\pi\times10^2-\pi\times8^2$	**M2**	**M1** for $2\pi\times10^2$ seen or $2\pi\times8^2$ seen or $\pi\times10^2-\pi\times8^2$ seen
	Completion to 364π with at least one intermediate step isw AG	**A1**	**A0** if any errors or if π evaluated as 3.14[2…] or $\frac{22}{7}$ before getting to 364π
2	12 nfww	**2**	**M1** for 8 × 9
3(a)(i)	84	**2**	**M1** for correct area of a relevant triangle or trapezium
3(a)(ii)	50 nfww	**3**	**M2** for $\sqrt{(12-4)^2+(15-9)^2}$ soi OR **M1** for $\sqrt{8^2+k^2}$ oe or $\sqrt{k^2+6^2}$ oe **M1** for $12+15+4+9+$ *theirh* where *theirh* is from use of Pythagoras
3(b)	8.49 to 8.5[0…]	**3**	**M2** for $r^3=\frac{2572\times3}{4\times\pi}$ oe or **M1** for $\frac{4}{3}\pi r^3=2572$
3(c)(i)	384	**3**	**M2** for (2×6 + 2×22.5 + 6×22.5) [×2] oe or **M1** for two different face areas seen
3c(ii)	$x^2=\frac{their384}{6}$ OR $6x^2=$ *their* **(c)(i)** $\rightarrow x^2=$ *their*64 OR $6x^2=$ *their* **(c)(i)** $\rightarrow x=\sqrt{\frac{their384}{6}}$	**M2**	**M1** for $6x^2=$ *their* **(c)(i)** oe
	8 cao	**B1**	
4	8.15	**2**	**B1** for answer figs 815 or for 0.85 seen or 900 seen
5	7π final answer	**2**	**M1** for $\frac{360-80}{360}\times\pi\times3^2$ oe If 0 scored, **SC1** for answer 2π
6(a)	$\frac{3\times110}{\pi\times3.5^2}$ oe	**M2**	**M1** for $\frac{1}{3}\times\pi\times3.5^2\times h=110$ oe
	= 8.573 to 8.574...	**A1**	
6(b)	9.26 or 9.256 to 9.262	**2**	**M1** for $3.5^2+8.57^2$

6(c)	135.7 to 136.1… nfww	**4**	**M3** for $\frac{360\times\pi\times7}{2\times\pi\times their\,9.26}$ oe or **M2** for $\frac{x}{360}\times2\times\pi\times their\,9.26=\pi\times7$ oe or **M1** for $\frac{x}{360}\times2\times\pi\times their\,9.26$ seen or $\pi\times7$ oe seen Alternative method: **M3** for $\frac{360\times\pi\times3.5\times their\,9.26}{\pi\times(their\,9.26)^2}$ oe or **M2** for $\frac{x}{360}\times\pi\times(their\,9.26)^2=\pi\times3.5\times their\,9.26$ oe or **M1** for $\frac{x}{360}\times\pi\times(their\,9.26)^2$ seen or $\pi\times3.5\times their\,9.26$ seen
6(d)	8.01...	**2**	**M1** for $\sqrt[3]{\frac{165}{110}}$ oe or $\sqrt[3]{\frac{110}{165}}$ oe or $\left(\frac{7}{x}\right)^3=\frac{110}{165}$ oe
7(a)	[W =] $x + 5$ [L =] $2(x + 5)$ oe final answers	**2**	**B1** for [W =] $x + 5$ or **B1FT** for [L =] $2\times$*their* algebraicW
7(b)	$(x+5)\times2(x+5)+2(x\times(x+5))+2(x\times2(x+5))$ oe	**M2**	**FT** *their* algebraic expressions in x for length and width **B1FT** for two different areas seen e.g. two of $(x + 5)\times2(x +5)$, $x(x + 5)$, $x \times 2(x + 5)$ or $2((x + 5)\times2(x +5) + x(x + 5) + x \times 2(x + 5))$
	$2x^2 + 20x + 50 + 2x^2 + 10x + 4x^2 + 20x = 210$	**M1**	Set equal to 210 and expansion of brackets. Must have three different areas from width and length of form $ax + b$, a and $b \neq 0$
	Correct simplification to $4x^2+25x-80=0$	**A1**	

8(a)	$6\pi l+\pi\times6^2$ OR $84\pi-\pi\times6^2$	**M1**	
	$6\pi l+\pi\times6^2=84\pi$ leading to $l = 8$ OR $6\pi l=84\pi-\pi\times6^2$ leading to $l = 8$	**A1**	**A0** if any errors or omissions
8(b)	199 or 200 or 199.4 to 199.5…	**3**	**M2** for $\frac{1}{3}\pi\times6^2\times\sqrt{8^2-6^2}$ or **M1** for $8^2 – 6^2$ or $\frac{1}{3}\pi\times6^2\times$*their h*
8(c)	4.5 nfww	**2**	**B1** for $\sqrt{\frac{47.25\pi}{84\pi}}$ soi or $\sqrt{\frac{84\pi}{47.25\pi}}$ soi or **M1** for a correct equation in r

9(a)(i)	$\pi\times\left(\frac{9}{2}\right)^2\times16=\frac{1}{2}\times\frac{4}{3}\times\pi\times r^3$	**M2**	**M1** for $\pi\times\left(\frac{9}{2}\right)^2\times16$ oe or $\frac{1}{2}\times\frac{4}{3}\times\pi\times r^3$ oe
	$r^3=\frac{3}{2}\times\left(\frac{9}{2}\right)^2\times16$ or $r=\sqrt[3]{\frac{3}{2}\times\left(\frac{9}{2}\right)^2\times16}$	**M1**	
	r = 7.862...	**A1**	
9(a)(ii)	1030 or 1040 or 1034.6 to 1035.1...	**3**	**M1** for $\pi\times9\times16$ oe **M1** for $2\times\pi\times7.86^2$ oe or $3\times\pi\times7.86^2$ oe
10(a)	376.99 to 377.04	**2**	**M1** for $\pi\times10^2\times$ figs12
10(b)	767 or 766.5 to 766.6…	**3**	**M2** for $\pi\times10^2+\pi\times2\times10\times(3+3+$ figs 12$)$ or **M1** for $\pi\times10^2$ or $\pi\times2\times10\times(3+3+$ figs 12$)$
10(c)	28.79 to 28.80…	**3**	**M2** for $200=\frac{x}{360}\times\pi\times10.3^2\times7.5$ or **M1** for $\frac{x}{360}\times k\pi$ used
11(a)	9300 or 9299 to 9301	**3**	**M2** for $\frac{1}{3}\pi\times16^2\times60-\frac{1}{3}\pi\times12^2\times45$ oe or **M1** for $\frac{1}{3}\pi\times16^2\times60$ or $\frac{1}{3}\pi\times12^2\times45$
11(b)	c^2 =]12^2+45^2	**M1**	
	[c =]46.57…	**A1**	
11(c)	1820 or 1816 to 1819.[0…]	**4**	**B2** for l = 62.09 to 62.13 or **M1** for $\sqrt{60^2+16^2}$ oe and **M1** for $\pi\times16\times$*their* 62.1 $-\pi\times12\times46.6$ [$+\pi\times12^2$] If 0 scored, **SC1** for $\pi\times12^2$
12	1.6 oe	**3**	**M2** for $5\times4\times h=400\times0.08$ oe or **M1** for 400×0.08 or for $\frac{0.08}{5\times4}$
13	12	**3**	**B2** for $y=6$ or **M1** for $2\times y^2+4\times y\times 2y$ [= 360] oe If 0 scored, **SC1** for $ky^2=360$ seen, leading to $\sqrt{\frac{360}{k}}$

14	24	**4**	**M1** for $\frac{60}{360}\times\pi\times3^2$ oe **AND** **M2** for $\frac{300}{360}\times\pi\times\left(6^2-3^2\right)$ oe **or** $\pi\times6^2-\pi\times3^2-\frac{60}{360}\times\pi\times\left(6^2-3^2\right)$ oe or **M1** for $\frac{300}{360}\times\pi\times6^2$ oe **or** $\frac{300}{360}\times\pi\times3^2$ oe **or** $\pi\times6^2$ oe **or** $\pi\times3^2$ oe 
15(a)	13.8 or 13.78 to 13.79	**2**	**M1** for $\frac{1}{2}\times6\times6\times\sin130$ oe After 0, **SC1** for answer 55.2 or 55.15 to 55.16
15(b)	15.7 or 15.70 to 15.71	**2**	**M1** for $\frac{180-130}{360}\times\pi\times6^2$ oe After 0, **SC1** for answer 62.8 or 62.83 to 62.84
16(a)(i)	25.7 or 25.72 to 25.73	**2**	**M1** for $\frac{134}{360}\times2\times\pi\times11$ oe
16(a)(ii)	4.3[0] or 4.298…	**2**	**M1** for $\cos\left(\frac{134}{2}\right)=\frac{d}{11}$ or $\sin\left(\frac{180-134}{2}\right)=\frac{d}{11}$ oe
16(b)(i)	$\frac{1}{3}\pi r^2\times9.5=115$ or $r^2=\frac{3V}{\pi h}$ or better	**M1**	Correct substitution into volume equation or correct rearrangement
	$r=3.39[9\ldots]$ or 3.40[00]	**A1**	
16-(b)(ii)	108 or 107.7 to 107.8	**3**	**M2** for $\pi\times3.4\times\sqrt{9.5^2+3.4^2}$ or **M1** for $l^2=9.5^2+3.4^2$ soi

17(a)	7.54	**2**	**M1** for $\pi \times 0.4^2 \times 15$
17(b)	53.7	**4**	**M1** for $\frac{1}{2} \times 4.5^2 \times \sin 110$ oe **M1** for $\frac{250}{360} \times \pi \times 4.5^2$ or $\frac{110}{360} \times \pi \times 4.5^2$ **M1** for *their* 9.514 + *their* 44.18 oe
18(a)	236	**2**	**M1** for $2 \times 5 \times 11 + 2 \times 5 \times 6 + 11 \times 6$ oe or **C1** for 302
18(b)	30	**1**	
19(a)	32.56 to 32.58 or 32.6	**3**	**M2** for $\frac{72}{360} \times \pi \times 20 + 20$ oe or **M1** for $\frac{72}{360} \times \pi \times 20$ **A1** for 12.56 to 12.58 or 12.6 After 0 or 1, **SC1** for *their* 'arc length' + 10 + 10 soi
19(b)(i)	62.83 to 62.84 or 62.8	**2**	**M1** for $\frac{72}{360} \times \pi \times 10^2$
19(b)(ii)	4(.00) to 4.08 nfww	**3**	FT from *their* **(b)(i)** – (58.76 to 58.8) provided answer not negative **M2** for *their* **(b)(i)** – $2 \times \frac{1}{2} \times 10 \times 10 \times \sin\left(\frac{72}{2}\right)$ oe or **M1** for [2×] $\frac{1}{2} \times 10 \times 10 \times \sin\left(\frac{72}{2}\right)$ oe soi
20	600 WWW	**3***	**M2** for $\frac{\pi \times 20^2 \times 16}{\frac{4}{3} \times \pi \times 2^3}$ or **B1** for (Volume of water =) $\pi \times 20^2 \times 16$ or for (Volume of one drop =) $\frac{4}{3} \times \pi \times 2^3$ soi
21 (a)	14	2*	**M1** for $25 - 1 \times 1 - 2 \times 2 - \frac{1}{2} \times 4 \times 3$ oe dissection.
(b)	18 nfww	2*	**B1** for sloping side = 5

22 (a) (i)	5.06 to 5.08	**4**	**B1** for $r + 3.5$ seen **B1** for $\pi(r + 3.5)^2 - \pi r^2$ or $20\pi(r + 3.5)^2 - 20\pi r^2$ **B1** for $20\pi(r + 3.5)^2 - 20\pi r^2 = 3000$ or better
(ii)	Solid II by 2.5 – 2.6	**4**	**B3** 11.25 to 11.3 cm or **M1** for $\frac{1}{3} \times \pi r^2 \times 2r = 3000$ or better and **M1** for $r^3 = \frac{3000 \times 3}{2 \times \pi}$ (= 1432)
(b)	630 to 632	**4**	**M1** for $\frac{1}{2} \times 8 \times 8 \times \sin 60$ or $\frac{1}{2} \times 8 \times \sqrt{48}$ oe **M1** for 8×24 soi or 192 soi **M1** for $3 \times 8 \times 24 + 2 \times$ *their* (triangle area)

23 (a)	320	3*	**M2** for $\frac{a}{360} \times \pi \times (3r)^2 = 8\pi r^2$ oe OR **M1** for $\frac{a}{360} \times \pi \times (3r)^2$ oe seen or for $8\pi r^2$ seen
(b)	$6r + \frac{16\pi r}{3}$ final answer	2*	**C1** for $kr + \frac{16\pi r}{3}$, where $k \geqslant 0$ OR **M1 FT** for $\frac{their 320}{360} \times 2\pi \times 3r$ oe or for $6r + \frac{their 320}{360} \times n\pi r$ oe where n is a positive integer

24 (a) (i)	2.62	**2**	**M1** for $\frac{25}{360} \times 2\pi \times 6$
(ii)	7.85	**2**	**M1** for $\frac{25}{360} \times \pi \times 6^2$
(b) (i)	39.3	**1ft**	
(ii)	88.8	**3ft**	**B1** for 30 or 60 or **M1** for 5× (a)(i) and indep **M1** for 2×(a)(ii)
(iii)	471 to 472	**2ft**	**B1** for height = 15 and radius = 12 soi
(c) (i)	$(h =) \frac{800}{\pi r^2}$	**1**	

25 (a) (i)	2.12	**2**	**M1** for $\frac{1}{2}\times\frac{4}{3}\times\pi\times r^3 = 20$ soi or **SC1** for 1.68
(ii)	6.79	**2**	**B1** for $\sqrt[3]{\frac{50}{20}}$ or $\sqrt[3]{\frac{20}{50}}$ oe or **M1** for $\left(\frac{5}{x}\right)^3 = \frac{20}{50}$ oe
(b)	187	**3**	**M1** for π(figs 15)^2 oe and **M1** for $\left[\frac{1}{2}\times\right]4\times\pi\times$ (figs 55)^2 – 50 × their πr^2

26 (a)	63.7 or 63.6 (m)	**2**	**M1** for $\pi\times\frac{d}{2}=100$
(b)	9540 to 9560	**3ft**	**M1** for πr^2 soi and **M1** for *their* circular area + 100 × *their* **(a)**
(c) (i)	18.7 to 19.0 (m)	**3ft**	**M1** for $2\pi R$ And **M1** for *their* $2\pi R - 200$ or $\pi R - 100$
(ii)	30.8 to 31.1	**2ft**	**M1** for $\frac{\theta}{360}\times 2\pi r$ oe

27 (a)	10	**1**	
(b)	216	**2**	**M1** for $\pi\times 6\times 10 = \frac{x}{360}\times\pi r^2$ or $2\times\pi\times 6 = \frac{x}{360}\times 2\pi r$ where $r = 10$ or *their*(a). Where radians are used, method must include multiplication by $\frac{180}{\pi}$.
28 (a)	720	**1**	
(b)	20	**2**	**M1** for ($\pi\times 62\times d$) (oe) = $k\pi$ where $k = 720$ or *their*(a)

29	**(a) (i)** 874	**3**	**M2** for (2) $\pi r^2 + 2\pi r \times 8$ or **M1** for either (2) πr^2 or $2\pi rh$
	(ii) 3070	**2ft**	**M1** for Figs [(*their* 874 + 150) × 3] or **B1** for $\div 10^4$
	(b) (i) 77 (.0)	**1**	
	(ii) 500	**3ft**	**M2** for $\pi R^2 - 4\pi r^2$ + **4(b)(i)** or **M1** for $\pi R^2 - 4\pi r^2$ or **4(b)(i)**
	(iii) 2410	**3**	**M2** for $\pi R^2 \times 8 - 4 \times \frac{2}{3} \times \pi \times r^3$ or **M1** for $\pi R^2 \times 8$ or $4 \times \frac{2}{3} \times \pi \times r^3$