Question	Answer	Mark	Comments
1	**Alternative method 1: working in terms of π**		
	π (×) 4^2 (×) 10 or 160π or [502, 503]	M1	oe accept 3 or better for π accept 480 or 496
	$\frac{2}{3}$ (×) π (×) 6^3 or 144π or [452, 453]	M1	oe accept 3 or better for π accept 0.66 or 0.67 or better for $\frac{2}{3}$ accept 432 or 446(.4)
	160π and 144π or [502, 503] and [452, 453]	A1	oe values accept 480 and 432 or 496 and 446(.4)
	160π and 144π and cylinder or [502, 503] and [452, 453] and cylinder or cylinder is 16π greater	A1ft	ft correct decision for their 160π and their 144π with M1M1 scored accept 480 and 432 and cylinder or 496 and 446(.4) and cylinder
	Alternative method 2: working without π		
	4^2 (×) 10 or 160	M1	oe
	$\frac{2}{3}$ (×) 6^3 or 144	M1	oe accept 0.66 or 0.67 or better for $\frac{2}{3}$
	160 and 144	A1	oe values
	160 and 144 and cylinder	A1ft	ft correct decision for their 160 and their 144 with M1M1 scored
	Additional Guidance for this question is on the next page		

	Additional Guidance	
1	Better than 3 for π could be 3.1, 3.14, 3.142 or $\frac{22}{7}$	
	160π with incorrect method for hemisphere	M1M0A0A0
	144π with incorrect method for cylinder	M0M1A0A0
	160π and 144π with incorrect decision or no decision	M1M1A1A0
	160 and 144 with incorrect or no decision	M1M1A1A0
	Accept values given as fractions for the first A mark, but for the second A mark, they must have a common denominator. eg 160π and $\frac{432\pi}{3}$ and cylinder eg $\frac{480}{3}$ and $\frac{432}{3}$ and cylinder	 M1M1A1A0 M1M1A1A1
	Working with π for one value but not the other can only score M1 eg 160π and 144 (with or without a decision)	M1 only
	Do not allow M1 for a correct formula as part of an incorrect formula eg $\frac{1}{3} \times \pi \times 4^2 \times 10$	M0

Question	Answer	Mark	Comments
2	hexagon-based pyramid	B1	

Q	Answer	Mark	Comments
3	**Alternative method 1**		
	$4 \times 26 \times 15$ or 1560	M1	
	$\pi \times (26 \div 2)^2 \times 15 (\div 2)$ or $\pi \times 13^2 \times 15 (\div 2)$ or $2535\pi (\div 2)$ or $\pi \times (26 \div 2)^2 \div 2 (\times 15)$ or $\pi \times 13^2 \div 2 (\times 15)$ or $\frac{169\pi}{2} (\times 15)$ or $84.5\pi (\times 15)$ or [265.3, 265.5] (× 15) or [7959.9, 7965] (÷ 2)	M1	oe accept [3.14, 3.142] for π
	$\frac{2535\pi}{2}$ or 1267.5π or [3979.95, 3982.5]	M1dep	dep on previous mark
	[5539, 5543]	A1	
	Alternative method 2		
	4×26 or 104	M1	
	$\pi \times (26 \div 2)^2 \div 2$ or $\pi \times 13^2 \div 2$ or $\frac{169\pi}{2}$ or [265.3, 265.5]	M1	accept [3.14, 3.142] for π
	(their 104 + their $\frac{169\pi}{2}$) × 15 or [369.3, 369.5] × 15	M1dep	dep on M1M1
	[5539, 5543]	A1	

Q	Answer	Mark	Comment
4	$n + 2$	B1	

Q	Answer	Mark	Comment
5	cylinder	B1	

Q	Answer	Mark	Comments
6	**Alternative method 1 – expressions in x**		
	$4\pi x^2 \div 2$ or $2\pi x^2$ or πx^2 or $\pi(3x)^2$ or $9\pi x^2$ or $2 \times \pi(3x)^2$ or $18\pi x^2$ or $2\pi x(3x)$ or $6\pi x^2$	M1	oe area of curved face of hemisphere oe area of flat face of hemisphere oe area of one flat face of cylinder oe area of both flat faces of cylinder oe area of curved face of cylinder
	$4\pi x^2 \div 2 + \pi x^2$ or $3\pi x^2$ or $\pi(3x)^2 + \pi(3x)^2 + 2\pi x(3x)$ or $9\pi x^2 + 9\pi x^2 + 6\pi x^2$ or $24\pi x^2$	M1dep	oe total surface area of the hemisphere oe total surface area of the cylinder
	$3\pi x^2$ and $24\pi x^2$ and 1 : 8	A1	either order
	Alternative method 2 – substituting a value for x		
	Substitutes a value for x and works out the area of at least one of area of curved face of hemisphere area of flat face of hemisphere area of one flat face of cylinder area of both flat faces of cylinder area of curved face of cylinder	M1	eg using $x = 5$, at least one of 50π 25π 225π 450π 150π
	Substitutes a value for x and works out an expression for the total surface area of the hemisphere or the cylinder	M1dep	eg using $x = 5$ total surface area of hemisphere = $25\pi + 50\pi$ or 75π or total surface area of cylinder = $225\pi + 225\pi + 150\pi$ or 600π
	Both correct total surface areas for their value of x and 1 : 8	A1	either order

6 cont	Additional Guidance	
	1 : 8 or 8 : 1 without correct working or values	M0M0A0
	Condone π missing consistently for all marks	
	Allow 'correct' and consistent values of π throughout (eg 3, 3.14, $\frac{22}{7}$)	
	Condone use of r for x throughout	
	Do not allow $3\pi x^2$ from $3x \times \pi \times x$ oe	

Q	Answer	Mark	Comments
7	**Alternative method 1** Compares 70% of volume of hemisphere with volume of water		
	$\frac{4}{3} \times \pi \times 12^3$ or 2304π or [7216, 7239.2] or $\frac{2}{3} \times \pi \times 12^3$ or 1152π or [3581, 3638]	M1	oe eg $\frac{4}{3}\pi \times 1728$ allow without any multiplication signs eg $\frac{4}{3}\pi 12^3$
	0.7 × their 1152π or 806.4π or [2506, 2547]	M1dep	oe 0.7 × their [3581, 3638] or $\frac{4032}{5}\pi$ must be using volume of hemisphere
	325 × 8 or 2600	M1	oe
	[2506, 2547] and 2600 and Yes	A1	oe
	Alternative method 2 Works out volume of water as proportion of volume of hemisphere		
	$\frac{4}{3} \times \pi \times 12^3$ or 2304π or [7216, 7239.2] or $\frac{2}{3} \times \pi \times 12^3$ or 1152π or [3581, 3638]	M1	oe eg $\frac{4}{3}\pi \times 1728$ allow without any multiplication signs eg $\frac{4}{3}\pi 12^3$
	325 × 8 or 2600	M1	oe
	their 2600 ÷ their 1152π or [0.71, 0.73]	M1dep	oe eg their 2600 ÷ their [3581, 3638] or 72% dep on M2 must be using volume of hemisphere
	[71, 73](%) and Yes	A1	oe eg 0.72 and 0.7 and Yes

7 cont	**Alternative method 3** Works out time to fill 70% of volume of hemisphere		
	$\frac{4}{3} \times \pi \times 12^3$ or 2304π or [7216, 7239.2] or $\frac{2}{3} \times \pi \times 12^3$ or 1152π or [3581, 3638]	M1	oe eg $\frac{4}{3}\pi \times 1728$ allow without any multiplication signs eg $\frac{4}{3}\pi 12^3$
	0.7 × their 1152π or 806.4π or [2506, 2547] or their $1152\pi \div 325$ or [11, 11.2]	M1dep	oe 0.7 × their [3581, 3638] or $\frac{4032}{5}\pi$ or their [3581, 3638] ÷ 325 must be using volume of hemisphere
	0.7 × their $1152\pi \div 325$ or 0.7 × their [3581, 3638] ÷ 325 or [7.7, 7.84]	M1dep	oe their [2506, 2547] ÷ 325 or 0.7 × their [11, 11.2]
	[7.7, 7.84] and Yes	A1	oe

	Additional Guidance	
7 cont	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts	
	Allow 1.33(…) for $\frac{4}{3}$	
	Allow 0.66(…) or 0.67 for $\frac{2}{3}$	
	π may be seen as [3.14, 3.142] eg Alt 1 $\frac{2}{3} \times 3.14 \times 12^3$	M1
	If a number (or calculation) in terms of π is seen but π is subsequently omitted, treat as a miscopy for M marks eg Alt 1 1152π $0.7 \times 1152 = 806.4$ $325 \times 8 = 2600$ Yes	 M1 M1dep M1A0
	Yes cannot be implied by inequalities	
	Alts 1 and 2 $325\,\text{cm}^3 \times 8$ seen is M1 even if evaluated incorrectly $325^3 \times 8$ seen is M0 unless recovered to 2600	
	Do not allow misreads of the given formula unless recovered eg1 using 12^2 instead of 12^3 eg2 using $\frac{3}{4}$ instead of $\frac{4}{3}$	
	For $0.7 \times$ their 1152π, do not accept $70\% \times$ their 1152π unless recovered	

Q	Answer	Mark	Comments
8	$\frac{1}{2} \times (14 + 20) \times 11$ or 187	M1	oe any correct method to find the area of the trapezium
	$\frac{1}{2} \times 10 \times 7$ or 35	M1	oe eg $\frac{1}{2} \times 10 \times 7 \times \sin 90$
	222	A1	
	Additional Guidance		
	Up to M2 may be awarded for correct work, with no or incorrect answer, even if this is seen amongst multiple attempts		
	Ignore Pythagoras' theorem, trigonometry or perimeter calculations		
	$14 \times 11 + \frac{1}{2} \times 6 \times 11$		M1
	Missing brackets must be recovered eg1 $\frac{1}{2} \times 20 + 14 \times 11$ and 187 eg2 $\frac{1}{2} \times 20 + 14 \times 11$		 M1 M0
	$20 \times 11 = 220$		M0M0A0

Q	Answer	Mark	Comment
9	$\frac{1}{3} \times 9^2 \times 30 \times \pi$ or 810π or [2543, 2545.1]	M1	oe
	$\frac{2}{3} \times 6^3 \times \pi$ or 144π or [452.1, 452.5]	M1	
	$30 \times \frac{6}{9}$ or 20 or $\left(\frac{6}{9}\right)^3$	M1	oe implied by 240π or [753.6, 754.1]
	$\frac{1}{3} \times 9^2 \times 30 \times \pi - \frac{1}{3} \times 6^2 \times$ their $20 \times \pi$ or $\frac{1}{3} \times 9^2 \times 30 \times \pi - \frac{1}{3} \times 9^2 \times 30 \times \left(\frac{6}{9}\right)^3 \times \pi$ or $810\pi - 240\pi$ or their [2543, 2545.1] – their [753.6, 754.1] or 570π or [1788.9, 1791.5]	M1dep	dep on 1st and 3rd M1
	426π or [1336, 1339.4]	A1	
	Additional Guidance		
	All values may be seen on diagrams		

Q	Answer	Mark	Comments
10a	Correct statement	B1	eg she used the height instead of the slant height or she used the vertical height or she used 12 (instead of 13)
	Additional Guidance		
	Check diagram		
	For 'vertical' accept anything that implies she has used the wrong height		
	Condone 'length' to mean 'height' or 'slant height'		
	12 or 13 circled on the diagram must be accompanied by a supporting statement		
	Indicates '12' in the calculation	B1	
	She should have done $\pi \times 5 \times 13$	B1	
	It should be 65π	B1	
	She used the wrong height / the (value of) l is wrong	B1	
	She hasn't used the slant height (she used the (vertical) height)	B1	
	She hasn't used the 13	B1	
	She hasn't used the 13 and should be $5 \times 12 \times 13 \times \pi$	B0	
	The multiplication used the wrong number(s)	B0	
	She hasn't used a value for π	B0	
	An incorrect statement with a correct statement eg she used 13 instead of 12 and didn't square the radius	B0	

Q	Answer	Mark	Comments
10b	$\pi \times 5 \times 5$ or 25π or $3 \times 5 \times 5$	M1	oe accept [3.14, 3.142] or $\frac{22}{7}$ for π
	75	A1	
	Additional Guidance		
	$\pi 25$	M1	

Q	Answer	Mark	Comments
10c	'More than' indicated or implied by statement and valid reason	B1	eg valid reasons 3.14 is greater (than 3) Beth's number is bigger (than Adam's) (the correct answer is) 78.5 (with their answer to (b) less than 78.5)
	Additional Guidance		
	If calculations are used, the outcomes must be correct		
	Accept 78 or 79 for 78.5 unless from incorrect working		
	'Less than' indicated	B0	
	Do not penalise use of the same incorrect formula in (b) and (c) eg $3 \times 10 = 30$ in (b) and $3.14 \times 10 = 31.4$ in (c) with 'More than' ticked	B1	
	Ignore a non-contradictory reason with a correct reason eg 3.14 is bigger than 3 and nearer the true value of pi	B1	
	Acceptable reasons		
	Adam has rounded (pi) down / Adam only used 3	B1	
	There is an extra 0.14 to multiply by	B1	
	Her number has decimal places	B1	
	Her number is to more significant figures	B1	
	Non-acceptable reasons		
	3.14 will give a bigger answer / 3.14 is more accurate	B0	

Q	Answer	Mark	Comments
11	**Alternative method 1: works out a scale factor**		
	$\frac{1}{2} \times 3(L) \times 4(L) \times 12(L)$ or $72(L^3)$ where L is any variable or any positive value	M1	oe volume eg $(L=2)$ $\frac{1}{2} \times 6 \times 8 \times 24$ or 576
	1125 ÷ their 72 or $\frac{125}{8}$ or 15.625	M1dep	oe eg $1125 \times 2 \div (3 \times 4 \times 12)$ eg $(L=2)$ 1125 ÷ their 576 or $\frac{125}{64}$
	$\sqrt[3]{\text{their } \frac{125}{8}}$ or $\frac{5}{2}$ or 2.5	M1dep	oe eg $(L=2)$ $\sqrt[3]{\text{their } \frac{125}{64}}$ or $\frac{5}{4}$ or 1.25
	2 × 3 × their 2.5 + 2 × 4 × their 2.5 + 2 × 5 × their 2.5 + 3 × 12 × their 2.5	M1dep	oe eg $(L=2)$ 2 × 6 × their 1.25 + 2 × 8 × their 1.25 + 2 × 10 × their 1.25 + 3 × 24 × their 1.25
	150	A1	SC4 [119, 119.1]

11 cont	**Alternative method 2: works out a value of a, b, c or d**		
	Correct expression for volume in terms of a or b eg $\frac{1}{2} \times a \times \frac{4a}{3} \times \frac{12a}{3}$ or $\frac{8a^3}{3}$ or $\frac{1}{2} \times \frac{3b}{4} \times b \times \frac{12b}{4}$ or $\frac{9b^3}{8}$	M1	oe in terms of c or d eg $\frac{1}{2} \times \frac{3c}{5} \times \frac{4c}{5} \times \frac{12c}{5}$ or $\frac{72c^3}{125}$ or $\frac{1}{2} \times \frac{3d}{12} \times \frac{4d}{12} \times d$ or $\frac{d^3}{24}$ may be implied by an equation eg $a \times \frac{4a}{3} \times \frac{12a}{3} = 1125 \times 2$
	$a^3 = 1125 \div$ their $\frac{8}{3}$ or $a^3 = \frac{3375}{8}$ or $b^3 = 1125 \div$ their $\frac{9}{8}$ or $b^3 = 1000$	M1dep	oe eg $c^3 = 1125 \div$ their $\frac{72}{125}$ or $c^3 = \frac{15\,625}{8}$ or $d^3 = 1125 \div$ their $\frac{1}{24}$ or $d^3 = 27\,000$
	$a = \sqrt[3]{\text{their } \frac{3375}{8}}$ or $a = 7.5$ or $b = \sqrt[3]{1000}$ or $b = 10$	M1dep	oe eg $c = \sqrt[3]{\text{their } \frac{15\,625}{8}}$ or $c = 12.5$ or $d = \sqrt[3]{27\,000}$ or $d = 30$
	$2 \times$ their $a + 2 \times \frac{4}{3} \times$ their a $+ 2 \times \frac{5}{3} \times$ their $a + 3 \times \frac{12}{3} \times$ their a or $2 \times \frac{3}{4} \times$ their $b + 2 \times$ their b $+ 2 \times \frac{5}{4} \times$ their $b + 3 \times 3 \times$ their b	M1dep	oe correct method using their c or their d
	150	A1	SC4 [119, 119.1]
	Additional Guidance		
	Up to M3 may be awarded for correct work with no answer or incorrect answer, even if this is seen amongst multiple attempts		

Q	Answer	Mark	Comments
12(a)	**Alternative method 1**		
	$\frac{4}{3}\pi r^3 = \pi r^2 h$	M1	
	$\frac{4}{3}r = h$ or $4r = 3h$	M1dep	oe equation with π and r^2 cancelled
	3 : 4 with M2 awarded	A1	oe ratio eg $\frac{3}{4}$: 1 or 1 : $\frac{4}{3}$ accept 1.33 or better for $\frac{4}{3}$
	Alternative method 2		
	$\frac{4}{3}\pi r^3 = \pi r^2 h$ or substitution of the same value of r into $\frac{4}{3}\pi r^3$ and $\pi r^2 h$	M1	the substitution must be shown
	Substitution of the same value of r into $\frac{4}{3}\pi r^3$ and $\pi r^2 h$ and correct value of h for their value of r	A1	the substitution must be shown their h should be exactly $\frac{4}{3}\times$ their r eg $r = 2$ and $h = \frac{8}{3}$ (oe fraction) do not allow rounded values
	3 : 4 with M1A1 awarded	A1	oe ratio eg $\frac{3}{4}$: 1 or 1 : $\frac{4}{3}$ accept 1.33 or better for $\frac{4}{3}$
	Additional Guidance		
	Accept h : r = 4 : 3 for final mark with M2 or M1A1 awarded		

Q	Answer	Mark	Comments
12(b)	$(\pi)(3r)^2(2h)$ or $3^2 \times 2$	M1	oe ft their formula for a cylinder from part (a) in the form $k\pi r^2 h$ with k as a positive constant
	18	A1	
	Additional Guidance		
	Answer 18 from choosing values for r and h eg $\pi \times 3^2 \times 4 = 36\pi$ and $\pi \times 9^2 \times 8 = 648\pi$ and $648\pi \div 36\pi = 18$		M1A1
	Answer 18 from rounding a decimal		M0A0