1	$F = \frac{k}{v^2}$ **or** $Fv^2 = k$ oe		3	M1	(NB. Not for $F = \frac{1}{v^2}$) Constant of proportionality must be a symbol such as k	M2 for $6.5 = \frac{k}{4^2}$ oe
	$6.5 = \frac{k}{4^2}$ **or** $k = 6.5 \times 4^2$ **or** $k = 104$			M1	For substitution of F and v into a correct formula	
		$F = \frac{104}{v^2}$		A1	Award 3 marks if $F = \frac{k}{v^2}$ is on the answer line and the value of $k = 104$ is found	
						Total 3 marks

2	$(v =)\ 3t^2 + 2 \times 4t - 5$				M1	2 out of 3 terms differentiated correctly
	$3T^2 + 8T - 5 = V$ **OR** $3T^2 + 8T - 5 - V = 0$				A1	correct equation
	$3(T^2 + \frac{8}{3}T) - 5$ **OR** $3(T^2 + \frac{8}{3}T - \frac{5}{3})$	$(T =)\ \frac{-8 \pm \sqrt{8^2 - 4 \times 3 \times (-5 - V)}}{2 \times 3}$			M1	attempt to complete the square **OR** use quadratic formula (condone one sign error in a, b or c and ft their quadratic with mistake in a or b) (condone + instead of ±)
	$\left(T + \frac{4}{3}\right)^2 = \left(\frac{4}{3}\right)^2 + \frac{V+5}{3}$	$(T =)\ \frac{-8 \pm \sqrt{124 + 12V}}{6}$			M1	sight of this method mark implies the previous M1 (condone + instead of ±) (ft their quadratic with mistake in a or b)
	$T = \frac{-4}{3} \pm \frac{1}{3}\sqrt{16 + 3V + 15}$	$(T =)\ \frac{-8 \pm 2\sqrt{31 + 3V}}{6}$			M1	(condone + instead of ±) (ft their quadratic with mistake in a or b)
			$\frac{-4 + \sqrt{31 + 3V}}{3}$	6	A1	accept $k = 31$ and $m = 3$
						Total 6 marks

3		E.g. 12×9 (=108) **or** $(9 - 6) \times x$ (= $3x$)		4	M1 for one correct relevant area
		E.g. 129 – '108' (= 21) **or** '108' + '$3x$' = 129			M1 (dep on M1) for 129 used correctly with another area **or** for a correct equation (ft) with bracket(s) expanded
		E.g. '21' ÷ (9 – 6) **or** $x = \frac{129 - '108'}{9 - 6}$			M1 for a complete method
			7		A1 Accept 7 cm
					Total 4 marks

4	(a)	$(2x + 5)(x + 1) = 2x^2 + 2x + 5x + 5$ $(= 2x^2 + 7x + 5)$ **or** $(x + 1)(3 - x) = -x^2 + 3x - x + 3$ $(= -x^2 + 2x + 3)$ **or** $(3 - x)(2x + 5) = -2x^2 + 6x - 5x + 15$ $(= -2x^2 + x + 15)$		3	M1 for multiplying out two brackets correctly at least 3 terms correct	M2 for at least 4 terms correct out of a maximum of 8 terms $6x^2 - 2x^3 + 6x - 2x^2 + 15x - 5x^2 + 15 - 5x$
		E.g. $[(2x^2 + 7x + 5)(3 - x) =]$ $-2x^3 - 7x^2 - 5x + 6x^2 + 21x + 15$ **or** $[(-x^2 + 2x + 3)(2x + 5) =]$ $-2x^3 - 5x^2 + 10x + 4x^2 + 6x + 15$ **or** $[(-2x^2 + x + 15)(x + 1) =]$ $-2x^3 - 2x^2 + 15x + x^2 + x + 15$			M1 for at least 3 terms correct out of a maximum of 6 terms **or** for at least 4 terms correct out of a maximum of 8 terms	
			Shown		A1	

5	(a)	$A=\frac{k}{r^2}$		3	M1	oe k can be any letter (must be a letter and not 1)
		$5=\frac{k}{0.3^2}$ oe **or** $k=0.45$ oe			M1	implies first M1 if you see this stage
		Working not required, so correct answer scores full marks (unless from obvious incorrect working)	$A=\frac{0.45}{r^2}$		A1	oe with A as the subject eg $A=\frac{9}{20r^2}$ (allow $A=\frac{k}{r^2}$ where $k=0.45$ oe) (SC if M0 scored then award B2 for $A\propto\frac{0.45}{r^2}$ oe)

6	$\frac{2n}{2}\left[2a+(2n-1)d\right]$ oe		4	M1	for a correct expression for S_{2n}
	$\frac{2n}{2}\left[2a+(2n-1)d\right]=4\times\frac{n}{2}\left[2a+(n-1)d\right]$ oe			M1	dep on M1 for setting up a correct equation for $S_{2n}=4\times S_n$
	$2a-d=4a-2d$ oe			M1	for a correct linear expression in a and d
		$\frac{d}{2}$		A1	(dep on M2) for $\frac{d}{2}$ oe
					Total 4 marks

7	$(S_{10}=)\frac{10}{2}(2a+9d)$ **or** $(S_5=)\frac{5}{2}(2a+4d)$ oe **or** $a+7d=45$		5	M1	for a correct expression for the sum of the first 10 terms (S_{10}) or the first 5 terms (S_5) **or** a correct equation for the 8th term Take 9 as their 10 – 1 and 4 as their 5 – 1 and 7 as their 8 – 1
	$\frac{10}{2}(2a+9d)=4\times\frac{5}{2}(2a+4d)$ oe			M1	for a correct equation relating S_{10} and S_5
	eg $d=2a$ oe **or** $a=\frac{d}{2}$ oe **or** $a+7d=45$ oe **and** eg $10a-5d=0$ oe **or** eg $\frac{10}{2}(2(45-7d)+9d)=4\times\frac{5}{2}(2(45-7d)+4d)$ oe **or** $5d=10(45-7d)$ oe			M1	(dep on M1) for d in terms of a, or vice-versa (must be correct) **or** for $a+7d=45$ oe **and** correctly reducing the equation relating S_{10} and S_5 to an equation with one term in a and one term in d eg $10a-5d=0$ oe **or** substituting a correct expression into their correct equation to obtain an equation in just d
	eg $a+7(2a)=45$ **or** $d=6$ **or** eg $70a-35d=0$ / $5a+35d=225$ + / $(75a=225)$ or $10a-5d=0$ / $10a+70d=450$ – / $(-75d=-450)$			M1	(dep on M2) for a correct equation in just a **or** for $d=6$ **or** for a correct method to eliminate a or d: coefficients of a or d the same **and** correct operation to eliminate selected variable (condone 1 arithmetical error)
		3		A1	Dep on M3
					Total 5 marks

8	eg $\frac{4}{3}\pi r^3\div 2(=\frac{2}{3}\pi r^3)$ oe		6	M1	for finding the volume of hemisphere
	eg $\frac{1}{3}\pi(kr)^2kh-\frac{1}{3}\pi r^2h(=\frac{1}{3}\pi r^2h(k^3-1))$ oe			M1	for finding the volume of the frustum
	eg $\frac{1}{3}\pi r^2h(k^3-1)+\frac{2}{3}\pi r^3$ **or** $\frac{1}{3}\pi r^2h+\frac{2}{3}\pi r^3$ oe			M1	for a correct expression for the volume of Solid **A or** Solid **B**
	eg $\frac{1}{3}\pi r^2h(k^3-1)+\frac{2}{3}\pi r^3=6\left(\frac{1}{3}\pi r^2h+\frac{2}{3}\pi r^3\right)$ oe			M1	for a correct equation using the volumes of Solid **A** and Solid **B** (π could be cancelled out)
	eg $h(k^3-1)-6h=12r-2r$ oe			M1	for simplifying to a point where the h terms are on one side of an equation and other terms the other side – must be correct
	NB: note that simplest form was not required	$\frac{10r}{k^3-7}$		A1	oe eg $\frac{4r-\frac{2}{3}r}{\frac{1}{3}k^3-2\frac{1}{3}}$
					Total 6 marks

9	$8t$ or $\pm 125t^{-2}$ oe		5	M1 for differentiating one term correctly
	$8t-125t^{-2}$ oe or $8t-\frac{125}{t^2}$ oe			A1 for both terms correct
	$8t-125t^{-2}=0$ **and** $(t=)\sqrt[3]{\frac{125}{8}}(=2.5)$			M1 for equating their $8t \pm at^{-2}$ oe or $bt \pm 125t^{-2}$ oe to zero **and** solving for t ie must have correct powers of t and at least one correct coefficient and correct isolation of t
	$4(\text{"2.5"})^2+\frac{125}{\text{"2.5"}}$			M1 dep on previous M mark for substituting into s
		75		A1
				Total 5 marks

10 (b)		$3x$	1	B1	allow $3 \times x$ or $x \times 3$ ft their "3" in (a)

11	eg $k\times\frac{1}{3}\pi r^2 h=\frac{4}{3}\pi r^3$ **or** $k\times\frac{1}{3}\pi r^2 h=\frac{4}{3}\pi r^3$ **or** $k\times\frac{1}{3}\pi r^2 h=\frac{4}{3}\pi r^3$ **or** $k\times h=4r$		6	M1	for setting up an equation with volumes and some simplification (minimum of 2 terms simplified)
	$h=\frac{4r}{k}$			M1	for finding h in terms of r and k in its simplest form (may be seen at a later stage)
	eg $l^2=r^2+\left(\frac{4r}{k}\right)^2$ **or** $l=\sqrt{r^2+\left(\frac{4r}{k}\right)^2}$			M1	for correct substitution into Pythagoras' theorem (accept substitution of $h=\frac{4\pi r}{\pi k}$)
	eg $l=r\sqrt{1+\frac{16}{k^2}}$ **or** $l=r\sqrt{\frac{k^2+16}{k^2}}$ **or** $l=r\frac{\sqrt{k^2+16}}{k}$			M1	for rearranging and removing the r from the square root (may be seen at a later stage)
	eg $\pi r^2\left(\sqrt{1+\frac{16}{k^2}}+1\right)$			M1	for a correct expression for surface area in terms of r and k with πr^2 removed as a factor
	Correct answer scores full marks (unless from obvious incorrect working)	$\pi r^2\left(\frac{k+\sqrt{k^2+16}}{k}\right)$		A1	
					Total 6 marks

12	2^3 **and** 2^{4x} or $(2^4)^x$		5	M1	for writing 16^x **and** 8 as a power of 2 (or all as powers of 4,8 or 16)
	$n=x^2+4x+3$ oe or $x^2+4x+3-n=0$			A1	for writing n in terms of x correct expression implies first M1
	$(n=)(x+2)^2-2^2$..... oe or $(x=)-2\pm\sqrt{n+1}$ $(x=)\frac{-4\pm\sqrt{4^2-4\times1\times(3-n)}}{2}$ oe			M1	for a correct first step in completing the square or using the quadratic formula correctly ft their 3 term quadratic
	$(x=)-2+\sqrt{n+1}$ oe or $(x=)\frac{-4+\sqrt{4^2-4\times1\times(3-n)}}{2}$ oe			A1	for correctly rearranging to make x the subject (must be positive square root)
	Correct answer scores full marks (unless from obvious incorrect working)	$(x=)-2+\sqrt{n+1}$ **and** $n>3$		A1	must be positive square root Accept $(x=)\sqrt{n+1}-2$ oe and $3<n$ Accept $(x=)\frac{-4+\sqrt{4^2-4\times1\times(3-n)}}{2}$ oe **and** $n>3$ or $3<n$
					Total 5 marks

12 ALT	$4^{\frac{1}{2}n}$, $4^{\frac{1}{2}x^2}$, 4^{2x} **and** $4^{\frac{3}{2}}$	$8^{\frac{1}{3}n}$, $8^{\frac{1}{3}x^2}$ **and** $8^{\frac{4}{3}x}$	$16^{\frac{1}{4}n}$, $16^{\frac{1}{4}x^2}$ **and** $16^{\frac{3}{4}}$		5	M1	for all as powers of 4 or 8 or 16
	$n = x^2 + 4x + 3$ oe or $x^2 + 4x + 3 - n = 0$					A1	for writing n in terms of x correct expression implies first M1
	$(n =)(x+2)^2 - 2^2$ ..... oe or $(x =) -2 \pm \sqrt{n+1}$ $(x =) \frac{-4 \pm \sqrt{4^2 - 4\times1\times(3-n)}}{2}$ oe					M1	for a correct first step in completing the square or using the quadratic formula correctly ft their 3 term quadratic
	$(x =) -2 + \sqrt{n+1}$ oe or $(x =) \frac{-4 + \sqrt{4^2 - 4\times1\times(3-n)}}{2}$ oe					A1	for correctly rearranging to make x the subject (must be positive square root)
	Correct answer scores full marks (unless from obvious incorrect working)			$(x =) -2 + \sqrt{n+1}$ **and** $n > 3$		A1	must be positive square root Accept $(x =) \sqrt{n+1} - 2$ oe and $3 < n$ Accept $(x =) \frac{-4 + \sqrt{4^2 - 4\times1\times(3-n)}}{2}$ oe **and** $n > 3$ or $3 < n$
							Total 5 marks