1	$f'(x) = (2x-5)^2 \times 2 + 1$ or $24\left(x - \frac{5}{2}\right)^2 + 1$ > 0 (allow $\geq$)	**B1B1** **B1** √ **[3]**	**B1** for $3(2x-5)^2$, **B1** for $(\times 2 + 1)$ SC B1 for $24x^2 - 120x + 151$ Dep on $k(2x-5)^2 + c$ $(k > 0)$, $(c \geq 0)$ Subst of particular values is B0
2	**(i)** $1 - 6px \quad +15p^2x^2$	**B1B1** **[2]**	Simplificn of nCr can be scored in (ii)
	(ii) $15p^2 \times 1 - 6p \times -1$ $3p(5p + 2) = 0$ $p = -\frac{2}{5}$ oe	**M1** **DM1** **A1** **[3]**	Obtain & attempt to solve quadratic Allow $p = 0$ in addition
3	**(i)** $(OAB) = \frac{1}{2} \times 8^2 \alpha$, $(OAC) = \frac{1}{2} \times \pi \times 4^2$ $\alpha = \frac{\pi}{8}$	**B1B1** **B1** **[3]**	Accept 25.1 (for OAC)
	(ii) $8 + 8 \times$ their $\alpha + \frac{1}{2} \times 8 \times \pi$ $8 + 5\pi$	**B1** √ **B1** **[2]**	23.7 gets B1B0 SC B1 for e.g. 5π (omitted OB)
4	**(i)** $ar^2 = -108$, $ar^5 = 32$ $r^3 = \frac{32}{-108} = \left(-\frac{8}{27}\right)$ $r = \left(-\frac{2}{3}\right)$ or –0.666 or –0.667	**B1** **M1** **A1** **[3]**	Eliminating a $-\frac{2}{3}$ from little or no working $\rightarrow \frac{3}{3}$ www
	(ii) $a = -243$	**B1** √ **[1]**	ft on *their* r $\left(-\frac{108}{r^2} \text{ or } \frac{32}{r^5}\right)$
	(iii) $S_\infty = \frac{-243}{1 + \frac{2}{3}} = -\frac{729}{5}$ or –145.8	**M1A1** **[2]**	Accept –146. For M1 $\lvert r \rvert$ must be < 1
5	**(i)** $\frac{\sin\theta(\sin\theta - \cos\theta) + \cos\theta(\sin\theta + \cos\theta)}{(\sin\theta + \cos\theta)(\sin\theta - \cos\theta)}$ $\frac{\sin^2\theta - \sin\theta\cos\theta + \cos\theta\sin\theta = \cos^2\theta}{\sin^2\theta - \cos^2\theta}$ $\frac{1}{\sin^2\theta - \cos^2\theta}$ **AG**	**M1** **A1** **A1** **[3]**	www

	(ii) $s^2-(1-s^2)=\frac{1}{3}$ or $1-c^2-c^2=\frac{1}{3}$ or $3(s^2-c^2)=c^2+s^2$ $\sin\theta=(\pm)\sqrt{\frac{2}{3}}$ or $\cos\theta=(\pm)\sqrt{\frac{1}{3}}$ or $\tan\theta=(\pm)\sqrt{2}$ $\theta=54.7°, 125.3°, 234.7°, 305.3°$	**M1** **A1** **A1A1** **[4]**	Applying $c^2+s^2=1$ Or $s=(\pm)\ 0.816$, $c=(\pm)\ 0.577$, $t=(\pm)\ 1.414$ any 2 solutions for 1st A1 >4 solutions in range max A1A0
6	**(i)** **OA.OC** $=-4p^2-q^2+4p^2+q^2$ $=0$	**M1** **A1** **[2]**	Attempt scalar product. Allow M1 even for e.g. **OA.OB** $=2pq-2pq$ etc.
	(ii) **CA = OA – OC** $=(\pm)(1+4p^2+q^2)$ **(i)** $\lvert\mathbf{CA}\rvert=1+4p^2+q^2$	**M1** **A1** **[2]**	Ignore **CA = OC–OA** Not $\sqrt{(1+4p^2+q^2)^2}$
	(iii) **BA** = **OA** – **OB** = **i** + 6**j** + 2**k** – (2**j** – 6**k**) $=(\pm)(\mathbf{i}+4\mathbf{j}+8\mathbf{k})$ $\frac{x\mathbf{i}+y\mathbf{j}+z\mathbf{k}}{\sqrt{x^2+y^2+z^2}}\rightarrow\frac{1}{9}(\mathbf{i}+4\mathbf{j}+8\mathbf{k})$	**M1** **M1A1** **[3]**	Allow subtn reversed for both M marks M1 independent of 1st M1
7	**(i)** $x^2-4x+4=x\Rightarrow x^2-5x+4=0$ $(x-1)(x-4)(=0)$ or other valid method (1, 1), (4, 4) Mid-point = (2½, 2½)	**M1** **M1** **A1** **A1** √ **[4]**	Eliminate y to reach 3-term quadratic Attempt solution ft dependent on 1st M1
	(ii) $x^2-(4+m)x+4=0\rightarrow(4+m)^2-4(4)=0$ $4+m=\pm4$ or $m(8+m)=0$ $m=-8$ $x^2+4x+4=0$ $x=-2,\ y=16$	**M1** **DM1** **A1** **M1** **A1** **[5]**	Applying $b^2-4ac=0$ Attempt solution Ignore $m=0$ in addition Sub non-zero m and attempt to solve Ignore (2, 0) solution from $m=0$
Alt (ii)	$2x-4=m$ $x^2-4x+4=(2x-4)x$ $x=-2$ (ignore +2) $m=-8$ (ignore 0) $y=16$	**M1** **DM1** **A1** **A1** **A1**	**OR** $2x-4=m$ Sub $x=\frac{m+4}{2}, y=\frac{m(m+4)}{2}$ into quad $m=-8$ from resulting quad $m(m+8)=0$ $x=-2$ $y=16$
8	**(i)** $2(x-3)^2-5$ or $a=2, b=-3, c=-5$	**B1B1B1** **[3]**	
	(ii) 3	**B1** √ **[1]**	ft on – *their b*. Allow $k\geq3$ or $x\geq3$

	(iii) $(y) \geq 27$	**B1** **[1]**	Allow >. Allow $27 \leq y \leq \infty$ etc. **OR** (x/y interchange as 1st operation)
	(iv) $2(x-3)^2 = (y+5)$	**M1**	$x = 2(y-3)^2 - 5$
	$x - 3 = (\pm)\sqrt{\frac{1}{2}(y+5)}$	**M1**	$(y-3)^2 = \frac{1}{2}(x+5)$
	$x = 3 + /\pm \sqrt{\frac{1}{2}(y+5)}$	**A1** √	$y - 3 = (\pm)\sqrt{\frac{1}{2}(x+5)}$
	$(f^{-1}(x)) = 3 + \sqrt{\frac{1}{2}(x+5)}$ for $x \geq 27$	**A1B1** √ **[5]**	ft on *their* 27 from **(iii)**
9	**(i)** $3u + \frac{3}{u} - 10 = 0$	**B1**	Or $3x - 10\sqrt{x} + 3 = 0$ Or $(3\sqrt{x} - 1)(\sqrt{x} - 3)$ or apply formula etc.
	$3u^2 - 10u + 3 = 0 \Rightarrow (3u-1)(u-3) = 0$	**M1**	
	$\sqrt{x} = \frac{1}{3}$ or 3	**A1**	
	$\sqrt{x} = \frac{1}{9}$ or 9	**A1** **[4]**	
	(ii) $f''(x) = \frac{3}{2}x^{-\frac{1}{2}} - \frac{3}{2}x^{-\frac{3}{2}}$	**B1**	Allow anywhere
	At $x = \frac{1}{9}$		
	$f''(x) = \frac{3}{2}(3) - \frac{3}{2}(27)\,(= -36) < 0 \rightarrow$ Max	**M1**	Valid method. Allow innac subs, even 3, $\frac{1}{3}$
	At $x = 9$		
	$f''(x) = \frac{3}{2} \times \frac{1}{3} - \frac{3}{2} \times \frac{1}{27} (= \frac{4}{9}) > 0 \rightarrow$ Min	**A1** **[3]**	Fully correct. No working, no marks.
	(iii) $f(x) = 2x^{\frac{3}{2}} + 6x^{\frac{1}{2}} - 10x \ (+c)$	**B2**	B1 for 2/3 terms correct. Allow in **(i)**
	$-7 = 16 + 12 - 40 + c$	**M1**	Sub (4, –7). c must be present.
	$c = 5$	**A1** **[4]**	
10	**(i)** $\frac{dy}{dx} = 4(x-2)^3$	**B1**	Or $4x^3 - 24x^2 + 48x - 32$
	Grad of tangent = –4	**M1**	Sub $x = 1$ into *their* derivative
	Eq. of tangent is $y - 1 = -4(x-1)$	**M1**	Line thru (1, 1) and with m from deriv
	$\rightarrow$ B $(\frac{5}{4}, 0)$	**A1**	
	Grad of normal = $\frac{1}{4}$	**M1**	Use of $m_1 m_2 = -1$
	Eq. of normal is $y - 1 = \frac{1}{4}(x-1) \rightarrow C(0, \frac{3}{4})$	**A1** **[6]**	

(ii) $AC^2 = 1^2 + \left(\frac{1}{4}\right)^2$	**M1**	
$\frac{\sqrt{17}}{4}$	**A1** [2]	Allow $\sqrt{\frac{17}{16}}$
(iii) $\int (x-2)^4 \, dx = \frac{(x-2)^5}{5}$	**B1**	Or $\frac{x^5}{5} - 2x^4 + 8x^3 - 16x^2 + 16x$
$\left[0 - (-\frac{1}{5})\right] = \frac{1}{5}$	**M1**	Apply limits $1 \rightarrow 2$ for curve
$\Delta = \frac{1}{2} \times 1 \times (their \frac{5}{4} - 1) = \frac{1}{8}$	**M1**	Or $\int_1^{\frac{5}{4}} (-4x + 5) \, dx = \frac{1}{8}$
$\frac{1}{5} - \frac{1}{8} = \frac{3}{40}$ or 0.075	**A1** [4]	