Question	Answer	Marks	Guidance
1(i)	Coefficient of $x = 80(x)$	**B2**	Correct value must be selected for both marks. SR +80 seen in an expansion gets **B1** or −80 gets **B1** if selected.
	Total:	**2**	
1(ii)	Coefficient of $\frac{1}{x} = -40\left(\frac{1}{x}\right)$	**B2**	Correct value soi in (ii), if powers unsimplified only allow if selected. SR +40 soi in (ii) gets **B1**.
	Coefficient of $x = (1 \times \text{their } 80) + (3 \times \text{their} - 40) = -40(x)$	**M1 A1**	Links the appropriate 2 terms only for **M1**.
	Total:	**4**	
2(i)	Gradient = 1.5 Gradient of perpendicular = $-⅔$	**B1**	
	Equation of AB is $y-6=-⅔(x+2)$ Or $3y+2x=14$ oe	**M1 A1**	Correct use of straight line equation with a changed gradient and (− 2, 6), the (− (− 2)) must be resolved for the **A1** ISW.
			Using $y = mx + c$ gets **A1** as soon as c is evaluated.
	Total:	**3**	
2(ii)	Simultaneous equations → Midpoint (1, 4)	**M1**	Attempt at solution of simultaneous equations as far as $x =$, or $y =$.
	Use of midpoint or vectors → B (4, 2)	**M1A1**	Any valid method leading to x, or to y.
	Total:	**3**	

Question	Answer	Marks	Guidance
3(i)	LHS = $\left(\frac{1}{c}-\frac{s}{c}\right)^2$	M1	Eliminates tan by replacing with $\frac{\sin}{\cos}$ leading to a function of sin and/or cos only.
	$= \frac{(1-s)^2}{1-s^2}$	M1	Uses $s^2 + c^2 = 1$ leading to a function of sin only.
	$= \frac{(1-s)(1-s)}{(1-s)(1+s)} = \frac{1-\sin\theta}{1+\sin\theta}$	A1	AG. Must show use of factors for **A1**.
	Total:	**3**	
3(ii)	Uses part (i) $\rightarrow 2-2s = 1+s$		
	$\rightarrow s = ⅓$	M1	Uses part (i) to obtain $s = k$
	$\theta = 19.5°$ or $160.5°$	A1A1 FT	FT from error in 19.5° Allow 0.340^c (0.3398^c) & 2.80(2) or $0.108\pi^c$ & $0.892\pi^c$ for **A1** only. Extra answers in the range lose the second **A1** if gained for 160.5°.
	Total:	**3**	
4(i)	$(AB) = 2r\sin\theta$ (or $r\sqrt{2-2cos2\theta}$ or $\frac{rsin2\theta}{\sin\left(\frac{\pi}{2}-\theta\right)}$)	B1	Allow unsimplifed throughout eg r + r, $\frac{2\theta}{2}$ etc
	(Arc AB) = $2r\theta$	B1	
	$(P =)\ 2r + 2r\theta + 2r\sin\theta$ (or $r\sqrt{2-2cos2\theta}$ or $\frac{rsin2\theta}{\sin\left(\frac{\pi}{2}-\theta\right)}$)	B1	
	Total:	**3**	

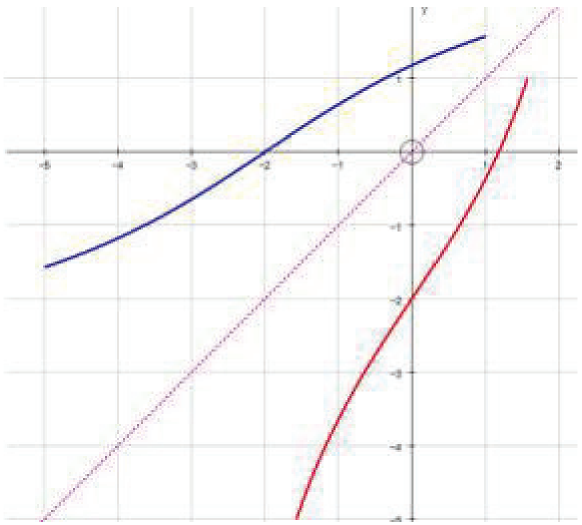
Question	Answer	Marks	Guidance
4(ii)	Area sector AOB = (½ r^2 2θ) $\frac{25\pi}{6}$ or 13.1	B1	Use of segment formula gives 2.26 **B1B1**
	Area triangle AOB = (½×2$r$sinθ×$r$cosθ or ½ × r^2 sin2θ) $\frac{25\sqrt{3}}{4}$ or 10.8	B1	
	Area rectangle $ABCD$ = (r × 2$r$sinθ) 25	B1	
	(Area =) Either 25 – (25π/6 – 25√3/4) or 22.7	B1	Correct final answer gets **B4**.
	Total:	**4**	
5(i)	Crosses x-axis at (6, 0)	B1	$x = 6$ is sufficient.
	$\frac{dy}{dx} = (0 +) -12\,(2-x)^{-2} \times (-1)$	B2,1,0	−1 for each incorrect term of the three or addition of + C.
	Tangent $y = ¾(x-6)$ or $4y = 3x - 18$	M1 A1	Must use dy/dx, x= their 6 but not x = 0 (which gives m = 3), and correct form of line equation.
			Using $y = mx + c$ gets **A1** as soon as c is evaluated.
	Total:	**5**	
5(ii)	If x = 4, dy/dx = 3		
	$\frac{dy}{dt} = 3 \times 0.04 = 0.12$	M1 A1FT	**M1** for (“their m” from $\frac{dy}{dx}$ and x = 4) × 0.04. Be aware: use of x = 0 gives the correct answer but gets **M0**.
	Total:	**2**	

Question	Answer	Marks	Guidance
6	$\text{Vol} = \pi \int (5-x)^2 \, dx - \pi \int \frac{16}{x^2} dx$	M1*	Use of volume formula at least once, condone omission of π and limits and dx.
		DM1	Subtracting volumes somewhere must be <u>after</u> squaring.
	$\int (5-x)^2 dx = \frac{(5-x)^3}{3} \div -1$	B1 B1	**B1** Without $\div(-1)$. **B1** for $\div(-1)$
	(or $25x - 10x^2/2 + \frac{1}{3}x^3$)	(B2,1,0)	−1 for each incorrect term
	$\int \frac{16}{x^2} dx = -\frac{16}{x}$	B1	
	Use of limits 1 and 4 in an integrated expression and subtracted.	DM1	Must have used "y^2" at least once. Need to see values substituted.
	$\rightarrow 9\pi$ or 28.3	A1	
	Total:	7	
7(a)	$(S_n =)\ \frac{n}{2}\left[32 + (n-1)8\right]$ and 20000	M1	**M1** correct formula used with d from $16 + d = 24$
		A1	**A1** for correct expression linked to 20000.
	$\rightarrow n^2 + 3n - 5000$ (<,=,> 0)	DM1	Simplification to a three term quadratic.
	$\rightarrow (n = 69.2) \rightarrow 70$ terms needed.	A1	Condone use of 20001 throughout. Correct answer from trial and improvement gets 4/4.
	Total:	4	

Question	Answer	Marks	Guidance
7(b)	$a = 6,\ \dfrac{a}{1-r} = 18 \to r = \tfrac{2}{3}$	M1A1	Correct $S\infty$ formula used to find r.
	New progression $a = 36,\ r = \dfrac{4}{9}$ oe	M1	Obtain new values for a and r by any valid method.
	New $S\infty = \dfrac{36}{1-\dfrac{4}{9}} \to 64.8$ or $\dfrac{324}{5}$ oe	A1	(Be aware that $r = -\tfrac{2}{3}$ leads to 64.8 but can only score M marks)
	Total:	**4**	
8(i)	Uses scalar product correctly: $3 \times 6 + 2 \times 6 + (-4) \times 3 = 18$	M1	Use of dot product with $\overrightarrow{OA}$ or $\overrightarrow{AO}$ & $\overrightarrow{OB}$ or $\overrightarrow{BO}$ only.
	$\lvert\overrightarrow{OA}\rvert = \sqrt{29}$, $\lvert\overrightarrow{OB}\rvert = 9$	M1	Correct method for any one of $\lvert\overrightarrow{OA}\rvert$, $\lvert\overrightarrow{AO}\rvert$, $\lvert\overrightarrow{OB}\rvert$ or $\lvert\overrightarrow{BO}\rvert$.
	$\sqrt{29} \times 9 \times \cos AOB = 18$	M1	All linked correctly.
	$\to AOB = 68.2°$ or 1.19^c	A1	Multiples of π are acceptable (e.g. $0.379\pi^c$)
	Total:	**4**	
8(ii)	$\overrightarrow{AB} = 3\mathbf{i} + 4\mathbf{j} + (3+2p)\mathbf{k}$	*M1	For use of $\overrightarrow{OB} - \overrightarrow{OA}$, allow with p = 2
	Comparing "**j**"	DM1	For comparing, $\overrightarrow{OC}$ must contain p & q. Can be implied by $\overrightarrow{AB} = 2\overrightarrow{OC}$.
	$\to p = 2\tfrac{1}{2}$ and $q = 4$	A1 A1	Accuracy marks only available if $\overrightarrow{AB}$ is correct.
	Total:	**4**	

Question	Answer	Marks	Guidance
9(i)	$\frac{dy}{dx} = 4x^{-½} - 2$	B1	Accept unsimplified.
	$= 0$ when $\sqrt{x} = 2$		
	$x = 4, y = 8$	B1B1	
	Total:	**3**	
9(ii)	$\frac{d^2y}{dx^2} = -2x^{-\frac{3}{2}}$	B1FT	FT providing –ve power of x
	$\left(\frac{d^2y}{dx^2} = -\frac{1}{4}\right) \to$ Maximum	B1	Correct $\frac{d^2y}{dx^2}$ and x=4 in (i) are required. Followed by"< 0 or negative" is sufficient" but $\frac{d^2y}{dx^2}$ must be correct if evaluated.
	Total:	**2**	
9(iii)	*EITHER:* Recognises a quadratic in $\sqrt{x}$	(M1	Eg $\sqrt{x} = u \to 2u^2 - 8u + 6 = 0$
	1 and 3 as solutions to this equation	A1	
	$\to x = 9, x = 1.$	A1)	

Question	Answer	Marks	Guidance
	OR: Rearranges then squares	(M1	$\sqrt{x}$ needs to be isolated before squaring both sides.
	$\rightarrow x^2 - 10x + 9 = 0$ oe	A1	
	$\rightarrow x = 9, x = 1.$	A1)	Both correct by trial and improvement gets 3/3
	Total:	3	
9(iv)	$k > 8$	B1	
	Total:	1	
10(i)	$3\tan\left(\frac{1}{2}x\right) = -2 \rightarrow \tan\left(\frac{1}{2}x\right) = -⅔$	M1	Attempt to obtain $\tan\left(\frac{1}{2}x\right) = k$ from $3\tan\left(\frac{1}{2}x\right) + 2 = 0$
	$½x = -0.6\ (-0.588) \rightarrow x = -1.2$	M1 A1	$\tan^{-1} k$. Seeing $½x = -33.69°$ or $x = -67.4°$ implies **M1M1**.
			Extra answers between -1.57 & 1.57 lose the **A1**. Multiples of π are acceptable (eg -0.374π)
	Total:	3	
10(ii)	$\frac{y+2}{3} = \tan\left(\frac{1}{2}x\right)$	M1	Attempt at isolating $\tan(½x)$
	$\rightarrow f^{-1}(x) = 2\tan^{-1}\left(\frac{x+2}{3}\right)$	M1 A1	Inverse tan followed by × 2. Must be function of x for **A1**.
	$-5, 1$	B1 B1	Values stated **B1** for -5, **B1** for 1.
	Total:	5	

Question	Answer	Marks	Guidance
10(iii)		**B1 B1 B1**	A tan graph through the first, third and fourth quadrants. (**B1**) An invtan graph through the first, second and third quadrants.(**B1**) Two curves clearly symmetrical about $y = x$ either by sight or by exact end points. Line not required. Approximately in correct domain and range. (Not intersecting.) (**B1**) Labels on axes not required.
	Total:	**3**	