Question	Answer	Marks	Guidance
1	Coefficient of x^2 in $\left(2+\frac{x}{2}\right)^6$ is ${}_6C_2 \times 2^4 \times (½)^2\ (x^2)$ (= 60)	B2,1,0	3 things wanted –1 each incorrect component, must be multiplied together. Allow ${}_6C_4$, $\binom{6}{4}$ and factorial equivalents. Marks can be awarded for correct term in an expansion.
	Coefficient of x^2 in $(a+x)^5$ is ${}_5C_2 \times a^3\ (x^2)$ (= $10a^3$)	B1	Marks can be awarded for correct term in an expansion.
	→ $60 + 10a^3 = 330$	M1	Forms an equation '*their 60*' + '*their 10a³*' = 330, OK with x^2 in all three terms initially. This can be recovered by a correct answer.
	$a = 3$	A1	Condone ±3 as long as +3 is selected.
		5	

Question	Answer	Marks	Guidance
2(i)			A complete method as far as finding a set of values for k by:
	Either $(x-3)^2 + k - 9 > 0$, $k - 9 > 0$		Either completing the square and using '*their k – 9*' > or ⩾ 0 OR
	or $2x - 6 = 0 \to (3, k - 9)$, $k - 9 > 0$	M1	Differentiating and setting to 0, using '*their x=3*' to find y and using '*their k – 9*' > or ⩾0 OR
	or $b^2 < 4ac$ oe → $36 < 4k$		Use of discriminant < or ⩽ 0. Beware use of > and incorrect algebra.
	→ $k > 9$ Note: not ⩾	A1	T&I leading to (or no working) correct answer 2/2 otherwise 0/2.
		2	

Question	Answer	Marks	Guidance
2(ii)	**EITHER**		
	$x^2 - 6x + k = 7 - 2x \rightarrow x^2 - 4x + k - 7$ $(= 0)$	*M1	Equates and collects terms.
	Use of $b^2 - 4ac = 0$ $(16 - 4(k - 7) = 0)$	DM1	Correct use of discriminant = 0, involving k from a 3 term quadratic.
	OR		
	$2x - 6 = -2 \rightarrow x = 2$ $(y = 3)$	*M1	Equates their $\frac{dy}{dx}$ to ± 2, finds a value for x.
	(*their* 3) or 7– 2(*their* 2) = (*their* 2)^2 – 6(*their* 2) + k	DM1	Substitutes their value(s) into the appropriate equation.
	$\rightarrow k = 11$	A1	
		3	

Question	Answer	Marks	Guidance
3(i)	$r = 1.02$ or $\frac{102}{100}$ used in a GP in some way.	B1	Can be awarded here for use in S_n formula.
	Amount in 12th week = 8000 (*their r*)^{11} or (*their a from* $\frac{8000}{their\ r.}$) (*their r*)^{12}	M1	Use of ar^{n-1} with a = 8000 & n = 12 or with a = $\frac{8000}{1.02}$ and n = 13.
	= 9950 (kg) awrt	A1	Note: Final answer of either 9943 or 9940 implies M1. Full marks can be awarded for a correct answer from a list of terms.
		3	

Question	Answer	Marks	Guidance
3(ii)	In 12 weeks, total is $\dfrac{8000\left(\left(their\ r\right)^{12}-1\right)}{\left(\left(their\ r\right)-1\right)}$	M1	Use of S_n with a = 8000 and n = 12 or addition of 12 terms.
	= 107000 (kg) awrt	A1	Correct answer but no working 2/2
		2	

Question	Answer	Marks	Guidance
4(i)	$a + ½b = 5$	B1	Alternatively these marks can be awarded when ½ and –1 appear after a or b has been eliminated.
	$a – b = 11$	B1	
	→ $a = 7$ and $b = – 4$	B1	
		[3]	
4(ii)	$a + b$ or *their a* + *their b* (3)	B1	Not enough to be seen in a table of values – must be selected. Graph from their values can get both marks. **Note: Use of $b^2 – 4ac$ scores 0/3**
	$a – b$ or *their a* – *their b* (11).	B1	
	→ $k < 3$, $k > 11$	B1	Both inequalities correct. Allow combined statement as long as correct inequalities if taken separately. Both answers correct from T & I or guesswork 3/3 otherwise 0/3
		3	

Question	Answer	Marks	Guidance
5(i)	$\overrightarrow{DA} = 6\mathbf{i} - 4\mathbf{k}$	B1	
	$\overrightarrow{CA} = 6\mathbf{i} - 5\mathbf{j} - 4\mathbf{k}$	B1	
		2	
5(ii)	Method marks awarded only for ***their*** vectors $\pm\overrightarrow{CA}$ & $\pm\overrightarrow{DA}$		Full marks can be obtained using $\overrightarrow{AC}$ & $\overrightarrow{AD}$
	$\overrightarrow{CA}.\overrightarrow{DA} = 36 + 16\ (= 52)$	M1	Using $x_1x_2+y_1y_2+z_1z_2$
	$\lvert\overrightarrow{DA}\rvert = \sqrt{52}$, $\lvert\overrightarrow{CA}\rvert = \sqrt{77}$	M1	Uses modulus twice
	$52 = \sqrt{77}\sqrt{52}\cos C\hat{A}D$ oe	M1	All linked correctly
	$\text{Cos } C\hat{A}D = 0.82178.. \rightarrow C\hat{A}D = 34.7^\circ$ or 0.606^c awrt	A1	Answer must come from +ve cosine ratio
		4	

Question	Answer	Marks	Guidance
6(i)	AT or $BT = r\tan\theta$ or $OT = \dfrac{r}{\cos\vartheta}$	B1	May be seen on diagram.
	$\frac{1}{2}r^2 2\theta$, & $\frac{1}{2}\times r\times(r\tan\theta$ or $AT)$ or $\frac{1}{2}\times r\times(\dfrac{r}{\cos\vartheta}$ or $OT)\sin\theta$	M1	Both formulae, ($\frac{1}{2}r^2\theta$, $\frac{1}{2}bh$ *or* $\frac{1}{2}ab\sin\theta$), seen with 2θ used when needed.
	$\frac{1}{2}r^2 2\theta = 2\times\frac{1}{2}\times r\times r\tan\theta - \frac{1}{2}r^2 2\theta$ oe $\rightarrow 2\theta = \tan\theta$ **AG**	A1	Fully correct working from a correct statement. Note: $\frac{1}{2}r^2 2\theta = \frac{1}{2}r^2\tan\theta$ is a valid statement.
		3	

Question	Answer	Marks	Guidance
6(ii)	$\theta = 1.2$ or sector area = 76.8	**B1**	
	Area of kite = 165 awrt	**B1**	
	164.6 – 76.8 = 87.8 awrt	**B1**	awrt 87.8 with little or no working can be awarded 3/3. SC Final answers that round to 88 with little or no working can be awarded 2/3.
		3	

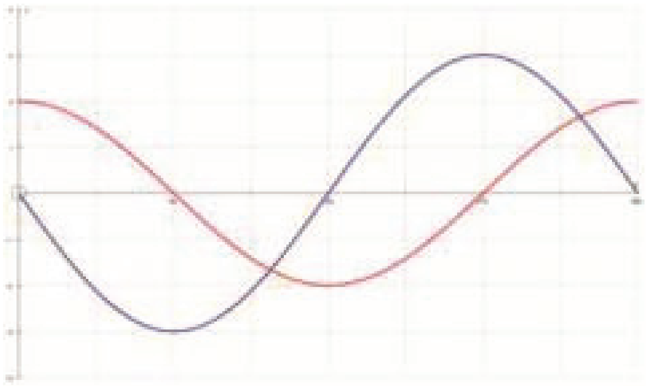
Question	Answer	Marks	Guidance
7(i)	$25 - 2(x + 3)^2$	**B1 B1**	Mark expression if present: B1 for 25 and B1 for – $2(x + 3)^2$. If no expression award $a = 25$ B1 and $b = 3$ B1.
		2	
7(ii)	(–3, 25)	**B1FT**	FT from answers to (i) or by calculus
		1	
7(iii)	(k) = –3 also allow x or $k \geqslant -3$	**B1FT**	FT from answer to (i) or (ii) **NOT** $x = -3$
		1	

Question	Answer	Marks	Guidance
7(iv)	**EITHER**		
	$y = 25 - 2(x+3)^2 \rightarrow 2(x+3)^2 = 25 - y$	*M1	Makes their squared term containing x the subject or equivalent with x/y interchanged first. Condone errors with +/- signs.
	$x + 3 = (\pm)\sqrt{½(25-y)}$	DM1	Divide by ±2 and then square root allow ±.
	OR		
	$y = 7 - 2x^2 - 12x \rightarrow 2x^2 + 12x + y - 7 (= 0)$	*M1	Rearranging equation of the curve.
	$x = \dfrac{-12 \pm \sqrt{12^2 - 8(y-7)}}{4}$	DM1	Correct use of their 'a, b and c' in quadratic formula. Allow just + in place of ±.
	$g^{-1}(x) = \sqrt{\left(\dfrac{25-x}{2}\right)} - 3$ oe isw if substituting $x = -3$	A1	± gets A0. Must now be a function of x. Allow $y =$
		3	

Question	Answer	Marks	Guidance
8	**EITHER**		
	Gradient of bisector $= -\frac{3}{2}$	**B1**	
	gradient $AB = \frac{5h-h}{4h+6-h}$	***M1**	Attempt at $\frac{y-step}{x-step}$
	Either $\frac{5h-h}{4h+6-h} = \frac{2}{3}$ or $-\frac{4h+6-h}{5h-h} = -\frac{3}{2}$	***M1**	Using $m_1m_2 = -1$ appropriately to form an equation.
	OR		
	Gradient of bisector $= -\frac{3}{2}$	**B1**	
	Using gradient of AB and A, B or midpoint $\to \frac{2}{3}x + \frac{h}{3} = y$ oe	***M1**	Obtain equation of AB using gradient from $m_1m_2 = -1$ and a point.
	Substitute co-ordinates of one of the other points	***M1**	Arrive at an equation in h.
	h = 2	**A1**	
	Midpoint is $\left(\frac{5h+6}{2}, 3h\right)$ or (8, 6)	**B1FT**	Algebraic expression or FT for numerical answer from '*their h*'
	Uses midpoint and '*their h*' with $3x + 2y = k$	**DM1**	Substitutes '*their midpoint*' into $3x + 2y = k$. If $y = -\frac{3}{2}x + c$ is used (expect $c = 18$) the method mark should be withheld until they ×2.
	$\to k = 36$ soi	**A1**	
		7	

Question	Answer	Marks	Guidance
9(i)	$y = \frac{2}{3}\left(4x+1\right)^{\frac{3}{2}} \div 4\ (+\text{C})\ \left(=\frac{\left(4x+1\right)^{\frac{3}{2}}}{6}\right)$	**B1 B1**	B1 without ÷ 4. B1 for ÷ 4 oe. Unsimplified OK
	Uses $x = 2,\ y = 5$	**M1**	Uses (2, 5) in an integral (indicated by an increase in power by 1).
	→ ***c* = ½** oe isw	**A1**	No isw if candidate now goes on to produce a straight line equation
		4	
9(ii)	$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{\mathrm{d}y}{\mathrm{d}t} \div \frac{\mathrm{d}x}{\mathrm{d}t}$		
	$\frac{dx}{dt} = 0.06 \div 3$	**M1**	Ignore notation. Must be 0.06÷3 for M1.
	= 0.02 oe	**A1**	Correct answer with no working scores 2/2
		2	
9(iii)	$\frac{\mathrm{d}^2 y}{\mathrm{d}x^2} = ½\left(4x+1\right)^{-½} \times 4$	**B1**	
	$\frac{\mathrm{d}^2 y}{\mathrm{d}x^2} \times \frac{\mathrm{d}y}{\mathrm{d}x} = \frac{2}{\sqrt{4x+1}} \times \sqrt{4x+1}\quad (= 2)$	**B1FT**	Must either show the algebraic product and state that it results in a constant or evaluate it as '= 2'. Must not evaluate at x =2. ft to apply only if $\frac{\mathrm{d}^2 y}{\mathrm{d}x^2}$ is of the form $k\left(4x+1\right)^{-½}$
		2	

Question	Answer	Marks	Guidance
10(i)	$2\cos x = -3\sin x \rightarrow \tan x = -\frac{2}{3}$	M1	Use of tan=sin/cos to get tan =, or other valid method to find sin or cos =. M0 for $\tan x = +/-\frac{3}{2}$
	$\rightarrow x = 146.3°$ or $326.3°$awrt	A1 A1FT	FT for 180 added to an incorrect first answer in the given range. The second A1 is withheld if any further values in the range $0° \leqslant x \leqslant 360°$ are given. Answers in radians score A0, A0.
		3	

Question	Answer	Marks	Guidance
10(ii)	No labels required on either axis. Assume that the diagram is 0º to 360º unless labelled otherwise. Ignore any part of the diagram outside this range.		
		**B1**	Sketch of $y = 2\cos x$. One complete cycle; start and finish at <u>top of curve</u> at roughly the same positive y value and go below the x axis by roughly the same distance. (Can be a poor curve but not straight lines.)
		B1	Sketch of $y = -3\sin x$ One complete cycle; start and finish on the x axis, must be inverted and go below and then above the x axis by roughly the same distance. (Can be a poor curve but not straight lines.)
		B1	Fully correct answer including the sine curve with clearly larger amplitude than cosine curve. Must now be reasonable curves.
			Note: Separate diagrams can score 2/3
		3	
10(iii)	$x < 146.3^\circ$, $x > 326.3^\circ$	**B1FT B1FT**	Does not need to include 0º, 360º. √ from their answers in (i) Allow combined statement as long as correct inequalities if taken separately. SC For two correct values including ft but with ⩽ and ⩾ B1
		2	

Question	Answer	Marks	Guidance
11(i)	$y = \frac{x}{2} + \frac{6}{x} = 4 \to x = 2$ or 6	**B1 B1**	Inspection or guesswork OK
	$\frac{dy}{dx} = \frac{1}{2} - \frac{6}{x^2}$	**B1**	Unsimplified OK
	When $x = 2$, $m = -1 \to x + y = 6$ When $x = 6$, $m = \frac{1}{3} \to y = \frac{1}{3}x + 2$	***M1**	Correct method for either tangent
	Attempt to solve simultaneous equations	**DM1**	Could solve BOTH equations separately with $y = x$ and get $x = 3$ both times.
	(3,3)	**A1**	Statement about $y = x$ not required.
		6	

Question	Answer	Marks	Guidance
11(ii)	$V = (\pi)\int\left(\frac{x^2}{4}+6+\frac{36}{x^2}\right)(dx)$	*M1	Integrate using $\pi\int y^2dx$ (doesn't need π or dx). Allow incorrect squaring. Not awarded for $\pi\int\left\{4-\left(\frac{x}{2}+\frac{6}{x}\right)\right\}^2 dx$. Integration indicated by increase in any power by 1.
	Integration $\rightarrow \frac{x^3}{12}+6x-\frac{36}{x}$	A2,1	3 things wanted —1 each error, allow + C. (Doesn't need π)
	Using limits '*their 2*' to '*their 6*' ($53\frac{1}{3}\pi$, $\frac{160}{3}\pi$, 168 awrt)	DM1	Evidence of their values 6 and 2 from **(i)** substituted into their integrand and then subtracted. $48-\left(-\frac{16}{3}\right)$ is enough.
	Vol for line: integration or cylinder ($\rightarrow 64\pi$)	M1	Use of πr^2h or integration of 4^2 (could be from $\left\{4-\left(\frac{x}{2}+\frac{6}{x}\right)\right\}^2$)
	Subtracts $\rightarrow 10\frac{2}{3}\boldsymbol{\pi}$ oe $\left(\text{e.g.}\frac{32}{3}\pi, 33.5\text{awrt}\right)$	A1	

Question	Answer	Marks	Guidance
11(ii)	**OR**		
	V = $(\pi)\int 4^2-\left(\frac{x}{2}+\frac{6}{x}\right)^2\,(\mathrm{d}x)$	**M1 *M1**	Integrate using $\pi\int y^2\mathrm{d}x$ (doesn't need π or dx) Integration indicated by increase in any power by 1.
	$=(\pi)\int 16-\left(\frac{x^2}{4}+6+\frac{36}{x^2}\right)\,(\mathrm{d}x)$		
	$=(\pi)\left[16x-\left(\frac{x^3}{12}+6x-\frac{36}{x}\right)\right]\,(\mathrm{d}x)$	**A2,1**	Or $\left[10x-\frac{x^3}{12}+\frac{36}{x}\right]$
	$=(\pi)\,(48-37\tfrac{1}{3})$	**DM1**	Evidence of their values 6 and 2 from (i) substituted
	$=10\frac{2}{3}\boldsymbol{\pi}$ oe $\left(\text{eg}\,\frac{32}{3}\pi, 33.5\,\text{awrt}\right)$	**A1**	
		6	