Question	Answer	Marks	Guidance
1(i)	Ind term $= (2x)^3 \times \left(\dfrac{k}{x}\right)^3 \times {}_6C_3$	B2,1,0	Term must be isolated
	$= 540 \rightarrow k = 1\frac{1}{2}$	B1	
		3	
1(ii)	Term, in x^2 is $(2x)^4 \times \left(\dfrac{k}{x}\right)^2 \times {}_6C_2$	B1	All correct – even if k incorrect.
	$15 \times 16 \times k^2 = 540$ (or $540x^2$)	B1	**FT** For $240k^2$ or $240k^2x^2$
		2	

Question	Answer	Marks	Guidance
2(i)	Eliminates x or $y \to y^2-4y+c-3=0$ or $x^2+(2c-16)x+c^2-48=0$	M1	Eliminates x or y completely to a quadratic
	Uses $b^2=4ac \to 4c-28=0$	M1	Uses discriminant = 0. (c the only variable) Any valid method (may be seen in part **(i)**)
	$c=7$	A1	
	Alternative method for question 2(i)		
	$\frac{dy}{dx}=\frac{1}{2\sqrt{(x+3)}}=\frac{1}{4}$	M1	
	Solving	M1	
	$c=7$	A1	
		3	
2(ii)	Uses $c=7$, $y^2-4y+4=0$	M1	Ignore (1,–2), c=-9
	(1, 2)	A1	
		2	

Question	Answer	Marks	Guidance
3	Uses $A = ½r^2\theta$	M1	Uses area formula.
	$\theta = \dfrac{2A}{r^2}$	A1	
	$P = r + r + r\theta$	B1	
	$P = 2r + \dfrac{2A}{r}$	A1	Correct simplified expression for P.
		4	

Question	Answer	Marks	Guidance
4(i)	Gradient of $AB = -½ \rightarrow$ Gradient of $BC = 2$	M1	Use of $m_1.m_2 = -1$ for correct lines
	Forms equation in h $\frac{3h-2}{h} = 2$	M1	Uses normal line equation or gradients for h.
	$h = 2$	A1	
	Alternative method for question 4(i)		
	Vectors AB.BC=0	M1	Use of vectors AB and BC
	Solving	M1	
	$h = 2$	A1	
	Alternative method for question 4(i)		
	Use of Pythagoras to find 3 lengths	M1	
	Solving	M1	
	$h = 2$	A1	
		3	
4(ii)	y coordinate of D is 6, (3 × 'their' h) $\frac{6-0}{x-4} = 2 \rightarrow x = 7 \rightarrow D\ (7, 6)$	B1	**FT**
	Vectors: AD.AB=0	M1 A1	Must use y = 6 Realises the y values of C and D are equal. Uses gradient or line equation to find x.
		3	

Question	Answer	Marks	Guidance
5(i)	$-2(x-3)^2+15$ ($a=-3$, $b=15$)	B1 B1	Or seen as $a=-3$, $b=15$ B1 for each value
		2	
5(ii)	($\mathrm{f}(x)\leqslant$) 15	B1	**FT** for ($\leqslant$) their "b" Don't accept (3,15) alone
		1	
5(iii)	$\mathrm{gf}(x)=2(-2x^2+12x-3)+5=-4x^2+24x-6+5$	B1	
	$\mathrm{gf}(x)+1=0\rightarrow-4x^2+24x=0$	M1	
	$x=0$ or 6	A1	Forms and attempts to solve a quadratic Both answers given.
		3	

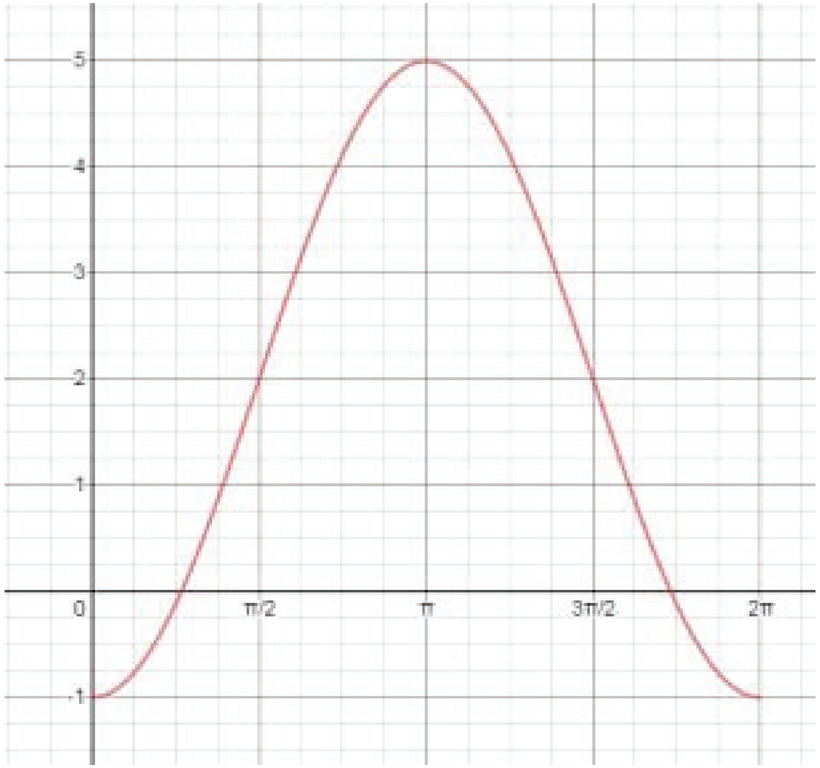
Question	Answer	Marks	Guidance
6(i)	LHS $=\left(\frac{1}{c}-\frac{s}{c}\right)^2=\frac{(1-s)(1-s)}{c^2}=\frac{(1-s)(1-s)}{1-s^2}$	B1	Expresses tan in terms of sin and cos
		B1	correctly $1-s^2$ as the denominator
	$=\frac{(1-s)(1-s)}{(1-s)(1+s)}$	M1	Factors and correct cancelling www
	$\frac{1-\sin x}{1+\sin x}$ AG	A1	
		4	

Question	Answer	Marks	Guidance
6(ii)	Uses part **(i)** to obtain $\frac{1-\sin 2x}{1+\sin 2x} = \frac{1}{3} \rightarrow \sin 2x = ½$	**M1**	Realises use of $2x$ and makes $\sin 2x$ the subject
	$x = \frac{\pi}{12}$	**A1**	Allow decimal (0.262)
	(or) $x = \frac{5\pi}{12}$	**A1**	**FT** for ½π – 1st answer. Allow decimal (1.31) $\frac{\pi}{12}$ and $\frac{5\pi}{12}$ only, and no others in range. SC $\sin x = ½ \rightarrow \frac{\pi}{6}\ \frac{5\pi}{6}$ B1
		3	

Question	Answer	Marks	Guidance
7(i)	$\overrightarrow{AM} = 1.5\mathbf{i} + 4\mathbf{j} + 5\mathbf{k}$ $\overrightarrow{GM} = 6.5\mathbf{i} - 4\mathbf{j} - 5\mathbf{k}$	**B3,2,1**	Loses 1 mark for each error.
		3	
7(ii)	$\overrightarrow{AM} . \overrightarrow{GM} = 9.75 - 16 - 25 = -31.25$	**M1**	Use of $x_1x_2 + y_1y_2 + z_1z_2$ on AM and GM
	$\overrightarrow{AM} . \overrightarrow{GM} = \sqrt{(1.5^2+4^2+5^2)} \times \sqrt{(6.5^2+4^2+5^2)} \cos GMA$	**M1 M1**	M1 for product of 2 modulii M1 all correctly connected
	Equating → Angle $GMA = 121°$	**A1**	
		4	

Question	Answer	Marks	Guidance
8(a)	$ar^2 = 48$, $ar^3 = 32$, r = ⅔ **or** $a = 108$	**M1**	Solution of the 2 eqns to give r (or a). A1 (both)
	r = ⅔ **and** $a = 108$	**A1**	
	$S\infty = \dfrac{108}{\frac{1}{3}} = 324$	**A1**	**FT** Needs correct formula and r between −1 and 1.
		3	
8(b)	Scheme A $a = 2.50$, $d = 0.16$ $S_n = 12(5 + 23\times0.16)$	**M1**	Correct use of either AP S_n formula.
	$S_n = 104$ tonnes.	**A1**	
	Scheme B $a = 2.50$, $r = 1.06$	**B1**	Correct value of r used in GP.
	$= \dfrac{2.5\left(1.06^{24} - 1\right)}{1.06 - 1}$	**M1**	Correct use of either S_n formula.
	$S_n = 127$ tonnes.	**A1**	
		5	

Question	Answer	Marks	Guidance
9(i)	$-1 \leqslant f(x) \leqslant 5$ or $[-1, 5]$ (may use y or f instead of f(x))	**B1 B1**	$-1 < f(x) \leqslant 5$ or $-1 \leqslant x \leqslant 5$ or $(-1,5)$ or $[5,-1]$ B1 only
		2	

Question	Answer	Marks	Guidance
9(ii)		*B1	Start and end at –ve y, symmetrical, centre +ve.
	$g(x) = 2 - 3\cos x$ for $0 \leqslant x \leqslant p$	DB1	Shape all ok. Curves not lines. One cycle $[0,2\pi]$ Flattens at each end.
		2	

Question	Answer	Marks	Guidance
9(iii)	(greatest value of $p =$) π	B1	
		1	
9(iv)	$x = 2 - 3\cos x \rightarrow \cos x = ⅓(2 - x)$	M1	Attempt at $\cos x$ the subject. Use of cos^{-1}
	$g^{-1}(x) = \cos^{-1}\dfrac{2-x}{3}$ (may use 'y =')	A1	Must be a function of x,
		2	

Question	Answer	Marks	Guidance
10(i)	integrating $\rightarrow \dfrac{dy}{dx} = x^2 - 5x\ (+c)$	B1	
	$= 0$ when $x = 3$	M1	Uses the point to find c after $\int = 0$.
	$c = 6$	A1	
	integrating again $\rightarrow\ y = \dfrac{x^3}{3} - \dfrac{5x^2}{2} + 6x\quad (+d)$	B1	**FT** Integration again FT if a numerical constant term is present.
	use of (3, 6)	M1	Uses the point to find d after $\int = 0$.
	$d = 1½$	A1	
		6	

Question	Answer	Marks	Guidance
10(ii)	$\frac{dy}{dx} = x^2 - 5x + 6 = 0 \rightarrow x = 2$	B1	
		1	
10(iii)	$x = 3$, $\frac{d^2y}{dx^2} = 1$ and/or +ve Minimum. $x = 2$, $\frac{d^2y}{dx^2} = -1$ and/or −ve Maximum	B1	www
	May use shape of '$+x^3$' curve or change in sign of $\frac{dy}{dx}$	B1	www SC: $x = 3$, minimum, $x = 2$, maximum, B1
		2	

Question	Answer	Marks	Guidance
11(i)	$3 \times -\frac{1}{2} \times (1+4x)^{-\frac{3}{2}}$	B1	
	$\frac{dy}{dx} = 3 \times -\frac{1}{2} \times (1+4x)^{-\frac{3}{2}} \times 4$	B1	Must have '× 4'
	If $x = 2$, $m = -\frac{2}{9}$, Perpendicular gradient $= \frac{9}{2}$	M1	Use of $m_1.m_2 = -1$
	Equation of normal is $y - 1 = \frac{9}{2}(x-2)$	M1	Correct use of line eqn (could use y=0 here)
	Put $y = 0$ or on the line before $\rightarrow \frac{16}{9}$	A1	AG
		5	

Question	Answer	Marks	Guidance
11(ii)	Area under the curve = $\int_0^2 \frac{3}{\sqrt{1+4x}}\,dx = \frac{3\sqrt{1+4x}}{\frac{1}{2}} \div 4$	B1 B1	Correct without '÷4'. For 2nd B1, ÷4'.
	Use of limits 0 to 2 → 4½ − 1½	M1	Use of correct limits in an integral.
	3	A1	
	Area of the triangle = ½ × 1 × $\frac{2}{9}$ = $\frac{1}{9}$ or attempt to find $\int_{16/9}^{2}\left(\frac{9}{2}x-8\right)dx$	M1	Any correct method.
	Shaded area = 3 − $\frac{1}{9}$ = $2\frac{8}{9}$	A1	
		6	