Question	Answer	Marks	Guidance
1	$7C5\ x^2(-2/x)^5$ soi	**B1**	Can appear in an expansion. Allow 7C2
	21×-32 soi	**B1**	Identified. Allow $(21x^2)\times(-32\ x^{-5})$. Implied by correct answer
	–672	**B1**	Allow $\dfrac{-672}{x^3}$. If 0/3 scored, 672 scores SCB1
		3	

Question	Answer	Marks	Guidance
2	$f'(x) = 3x^2 + 4x - 4$	**B1**	
	Factors or crit. values or sub any 2 values $(x \neq -2)$ into $f'(x)$ soi	**M1**	Expect $(x+2)(3x-2)$ or –2, ⅔ or any 2 subs (excluding $x = -2$).
	For $-2 < x < \frac{2}{3}$, $f'(x) < 0$; for $x > \frac{2}{3}$, $f'(x) > 0$ soi Allow $\leqslant, \geqslant$	**M1**	Or at least 1 specific value $(\neq -2)$ in each interval giving opp signs Or $f'(\frac{2}{3})=0$ and $f''(\frac{2}{3}) \neq 0$ (i.e. gradient changes sign at $x = \frac{2}{3}$)
	Neither www	**A1**	Must have 'Neither'
	ALT 1 At least 3 values of f(x)	**M1**	e.g. f(0) = 7, f(1) = 6, f(2) = 15
	At least 3 <u>correct</u> values of f(x)	**A1**	
	At least 3 <u>correct</u> values of f(x) spanning $x = \frac{2}{3}$	**A1**	
	Shows a decreasing and then increasing pattern. Neither www	**A1**	Or similar wording. Must have 'Neither'
	ALT 2 $f'(x) = 3x^2 + 4x - 4 = 3\left(x + \frac{2}{3}\right)^2 - \frac{16}{3}$	**B1B1**	Do not condone sign errors
	$f'(x) \geqslant -\frac{16}{3}$	**M1**	
	$f'(x) < 0$ for some values and > 0 for other values. Neither www	**A1**	Or similar wording. Must have 'Neither'
		4	

Question	Answer	Marks	Guidance
3(i)	0.8 oe	**B1**	
		1	
3(ii)	$BD = 5\sin \textit{their}\ 0.8$	**M1**	Expect 3.58(7). Methods using degrees are acceptable
	$DC = 5 - 5\cos \textit{their}\ 0.8$	**M1**	Expect 1.51(6)
	Sector = ½ × 5^2 × *their*0.8 OR Seg = ½ × 5^2 × [*their* 0.8 – sin*their* 0.8]	**M1**	Expect 10 for sector. Expect 1.03(3) for segment
	Trap = ½(5 + *theirDC*) × *theirBD* oe OR Δ*BDC* = ½*theirBD* × *theirCD*	**M1**	OR (for last 2 marks) if *X* is on *AB* and *XC* is parallel to *BD*:
	Shaded area = 11.69 – 10 OR 2.71(9) – 1.03(3) = 1.69 cao	**A1**	*BDCX* –(sector – Δ*AXC*) = 5.43(8) – [10 – 6.24(9)] = 1.69 cao M1A1
		5	

Question	Answer	Marks	Guidance
4(i)	Gradient, *m*, of *AB* = 3/4	**B1**	
	Equation of *BC* is $y-4=\frac{-4}{3}(x-3)$	**M1A1**	Line through (3, 4) with gradient $\frac{-1}{m}$ (M1). (Expect $y=\frac{-4}{3}x+8$)
	$x=6$	**A1**	Ignore any *y* coordinate given.
		4	

Question	Answer	Marks	Guidance
4(ii)	$(AC)^2 = 7^2 + 1^2 \rightarrow AC = 7.071$	**M1A1**	M mark for $\sqrt{(their\,6 +/ -1)^2 + 1}$.
		2	

Question	Answer	Marks	Guidance
5	$a + (n-1)3 = 94$	**B1**	
	$\frac{n}{2}[2a + (n-1)3] = 1420$ OR $\frac{n}{2}[a + 94] = 1420$	**B1**	
	Attempt elimination of *a* or *n*	**M1**	
	$3n^2 - 191n + 2840\ (= 0)$ OR $a^2 - 3a - 598\ (= 0)$	**A1**	3-term quadratic (not necessarily all on the same side)
	$n = 40$ (only)	**A1**	
	$a = -23$ (only)	**A1**	Award 5/6 if a 2nd pair of solutions (71/3, 26) is given in addition or if given as the only answer.
		6	

Question	Answer	Marks	Guidance
6	$(\mathbf{BO}) = -8\mathbf{i} - 6\mathbf{j}$	**B1**	OR **(OB)** = 8**i** + 6**j**
	$(\mathbf{BF}) = -6\mathbf{j} - 8\mathbf{i} + 7\mathbf{k} + 4\mathbf{i} + 2\mathbf{j} = -4\mathbf{i} - 4\mathbf{j} + 7\mathbf{k}$	**B1**	OR **(FB)** = 4**i** + 4**j** – 7**k**
	$(\mathbf{BF}.\mathbf{BO}) = (-4)(-8) + (-4)(-6)$	**M1**	OR **(FB.OB)** Expect 56. Accept one reversed but award final A0
	$\lvert\mathbf{BF}\rvert \times \lvert\mathbf{BO}\rvert = \sqrt{4^2+4^2+7^2} \times \sqrt{8^2+6^2}$	**M1**	Expect 90. At least one magnitude <u>methodically</u> correct
	Angle $OBF = \cos^{-1}\left(\frac{their\,56}{their\,90}\right) = \cos^{-1}\left(\frac{56}{90}\right)$ or $\cos^{-1}\left(\frac{28}{45}\right)$	**DM1A1**	Or equivalent 'integer' fractions. All M marks dependent on use of (±)**BO** and (±)**BF**. 3rd M mark dep on both preceding M marks
		6	

Question	Answer	Marks	Guidance
7(i)	$\frac{(\tan\theta+1)(1-\cos\theta)+(\tan\theta-1)(1+\cos\theta)}{(1+\cos\theta)(1-\cos\theta)}$ soi	**M1**	
	$\frac{\tan\theta - \tan\theta\cos\theta + 1 - \cos\theta + \tan\theta - 1 + \tan\theta\cos\theta - \cos\theta}{1-\cos^2\theta}$ www	**A1**	
	$\frac{2(\tan\theta-\cos\theta)}{\sin^2\theta}$ www **AG**	**A1**	
		3	

Question	Answer	Marks	Guidance
7(ii)	$(2)(\tan\theta - \cos\theta)\ (=0) \rightarrow (2)\left(\dfrac{\sin\theta}{\cos\theta} - \cos\theta\right)\ (=0)$ soi	M1	Equate numerator to zero and replace $\tan\theta$ by $\sin\theta/\cos\theta$
	$(2)\left(\sin\theta - \left(1-\sin^2\theta\right)\right)\ (=0)$	DM1	Multiply by $\cos\theta$ and replace $\cos^2\theta$ by $1-\sin^2\theta$
	$\sin\theta = 0.618(0)$ soi	A1	Allow $(\sqrt{5}–1)/2$
	$\theta = 38.2°$	A1	Apply penalty –1 for extra solutions in range
		4	

Question	Answer	Marks	Guidance
8(i)	$y = ⅓\ ax^3 + ½bx^2 - 4x\ \ (+c)$	B1	
	$11 = 0 + 0 + 0 + c$	M1	Sub $x = 0$, $y = 11$ into an integrated expression. c must be present
	$y = ⅓ax^3 + ½bx^2 - 4x + 11$	A1	
		3	
8(ii)	$4a + 2b - 4 = 0$	M1	Sub $x = 2$, $dy/dx = 0$
	$⅓(8a) + 2b - 8 + 11 = 3$	M1	Sub $x = 2$, $y = 3$ into an integrated expression. Allow if 11 missing
	Solve simultaneous equations	DM1	Dep. on both M marks
	$a = 3,\ b = –4$	A1A1	Allow if no working seen for simultaneous equations
		5	

Question	Answer	Marks	Guidance
9(i)	For *their* 3-term quad a recognisable application of $b^2 - 4ac$	M1	Expect $2x^2 - x(3+k) + 1 - k^2 \quad (=0)$ oe for the 3-term quad.
	$\left(b^2 - 4ac =\right)\ (3+k)^2 - 4(2)\left(1-k^2\right)$ oe	A1	Must be correct. Ignore any RHS
	$9k^2 + 6k + 1$	A1	Ignore any RHS
	$(3k+1)^2 \geqslant 0$ Do not allow > 0. Hence curve and line meet. **AG**	A1	Allow $(9)\left(k + \frac{1}{3}\right)^2 \geqslant 0$. Conclusion required.
	ALT Attempt solution of 3-term quadratic	M1	
	Solutions $x = k+1, \quad ½(1-k)$	A1A1	
	Which exist for all values of *k*. Hence curve and line meet. **AG**	A1	
		4	

Question	Answer	Marks	Guidance
9(ii)	$k = -1/3$	B1	**ALT** $dy/dx = 4x-3 \Rightarrow 4x-3=k$
	Sub (one of) *their* $k = -\frac{1}{3}$ into either line 1 $\rightarrow 2x^2 - \frac{8}{3}x + \frac{8}{9}\ (=0)$ Or into the derivative of line 1 $\rightarrow 4x\ -(3+k)(=0)$	M1	Sub $k = 4x-3$ into line 1 $\rightarrow 2x^2 - x(4x) + 1 - (4x-3)^2\ (=0)$
	x = 2/3 Do not allow unsubstantiated $\left(\frac{2}{3}, -\frac{1}{9}\right)$ following $k = -\frac{1}{3}$	A1	x = 2/3, y = –1/9 (both required) [from $-18x^2 + 24x - 8$ (=0) oe]
	y = –1/9 Do not allow unsubstantiated $\left(\frac{2}{3}, -\frac{1}{9}\right)$ following $k = -\frac{1}{3}$	A1	$k = -1/3$
		4	

Question	Answer	Marks	Guidance
10(i)	$V = 4(\pi)\int(3x-1)^{-2/3}\,dx \quad = 4(\pi)\left[\frac{(3x-1)^{1/3}}{1/3}\right][\div 3]$	M1A1A1	Recognisable integration of y^2 (M1) Independent A1, A1 for [ ] [ ]
	$4(\pi)[2-1]$	DM1	Expect $4(\pi)(3x-1)^{\frac{1}{3}}$
	4π or 12.6	A1	Apply limits ⅔ → 3. Some working must be shown.
		5	

Question	Answer	Marks	Guidance
10(ii)	$\mathrm{d}y/\mathrm{d}x = (-2/3)(3x-1)^{-4/3} \times 3$	B1	Expect $-2(3x-1)^{-4/3}$
	When $x = 2/3,\ y = 2$ soi $\mathrm{d}y/\mathrm{d}x = -2$	B1B1	2nd B1 dep. on correct expression for d*y*//d*x*
	Equation of normal is $y - 2 = \frac{1}{2}\left(x - \frac{2}{3}\right)$	M1	Line through (⅔, *their* 2) and with grad –1/*m*. Dep on *m* from diffn
	$y = \frac{1}{2}x + \frac{5}{3}$	A1	
		5	

Question	Answer	Marks	Guidance
11(i)	$[2]\left[(x-3)^2\right][-7]$	B1B1B1	
		3	
11(ii)	Largest value of *k* is 3. Allow (*k* =) 3.	B1	Allow $k \leqslant 3$ but not $x \leqslant 3$ as final answer.
		1	

Question	Answer	Marks	Guidance
11(iii)	$y = 2(x-3)^2 - 7 \rightarrow (x-3)^2 = ½(y+7)$ or with *x/y* transposed	**M1**	Ft *their a*, *b*, *c*. Order of operations correct. Allow sign errors
	$x = 3 \pm \sqrt{½(y+7)}$ Allow 3 + √ or 3 –√ or with *x/y* transposed	**DM1**	Ft *their a*, *b*, *c*. Order of operations correct. Allow sign errors
	$\mathrm{f}^{-1}(x) = 3 - \sqrt{½(x+7)}$	**A1**	
	(Domain is *x*) $\geqslant$ *their* -7	**B1FT**	Allow other forms for interval but if variable appears must be *x*
		4	
11(iv)	$x + 3 \leqslant 1$. Allow *x* + 3 = 1	**M1**	Allow $x + 3 \leqslant k$
	largest *p* is -2 . Allow (*p* =) –2	**A1**	Allow $p \leqslant -2$ but not $x \leqslant -2$ as final answer.
	$\mathrm{fg}(x) = \mathrm{f}(x+3) = 2x^2 - 7$ cao	**B1**	
		3	