Question Number	Scheme	Marks
9(a)	$\mathrm{f}(x)=\frac{1}{4}x^4-\frac{1}{3}x^3-2x^2+4x\ (+c)$	M1A1
	$x=-2\ \ y=-\frac{28}{3}\quad\Rightarrow c=0$	M1
	$\left(\mathrm{f}(x)=\frac{1}{4}x^4-\frac{1}{3}x^3-2x^2+4x\right)\quad\therefore C$ passes through O	A1 cso (4)
(b)(i)	$x=2\ \ \mathrm{f}'(x)=8-4-8+4=0$	M1
	$\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=3x^2-2x-4$	M1
	$x=2\quad\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=12-4-4>0\quad\therefore$ min at $x=2$	A1cso
	$x=1\ \ \mathrm{f}'(x)=1-1-4+4=0$	M1
	$x=1\quad\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=3-2-4<0\quad\therefore$ max at $x=1$	A1 cso
ALT	$\mathrm{f}'(x)=(x-2)(x-1)(x+2)\ \ (=0)$ factorise	M1
	$x=2,1,(-2)$ solve (solutions to be 2,1 (and another))	M1
	OR: $\mathrm{f}'(x)\ (=0)$ solved by calculator.	
	All 3 solutions needed (and correct) $=0$ not needed M2	
	$\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=3x^2-2x-4$ differentiate	M1
	$x=2\quad\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=12-4-4>0\quad\therefore$ min at $x=2$	A1cso
	$x=1\quad\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=3-2-4<0\quad\therefore$ max at $x=1$	A1cso
(ii)	$x=1\Rightarrow y=1\frac{11}{12}\qquad x=2\Rightarrow y=1\frac{1}{3}$	B1B1 (7)
(c)	$y'=(x-1)(x-2)(x+2)$	M1
(i)	$x=-2,\ y=-\frac{28}{3}$ or $\left(-2,-\frac{28}{3}\right)$	A1
(ii)	$x=-2\quad\frac{\mathrm{d}^2y}{\mathrm{d}x^2}=12+4-4>0\quad\therefore$ min point	A1cso (3)
		[14]

Question Number	Scheme	Marks
(a)M1	Attempt to integrate f'(x). The power of at least one x term must increase and none should decrease. c not needed	
A1	Correct integration, c not needed	
M1	Substitute the given coordinates to show c = 0. If c is not included (or assumed to be 0), then showing that substitution of x = -2 gives y = -28/3 is acceptable. Substitutions must be shown.	
A1cso	Correct conclusion from fully correct work. Accept eg $\mathrm{f}\left(0\right)=0\ \therefore$ shown	
(b)	Ignore labels (i) and (ii) when marking (b)	
(i)M1	Substitute x = 2 in the expression for f'(x) to show f'(x) = 0. Substitution must be shown	
M1	Differentiate the expression for f'(x). At least one power must decrease and none increase.	
A1cso	Show second derivative is > 0 at x = 2 and give the conclusion. No errors or omissions in the working.	
M1	Substitute x = 1 in the expression for f'(x) to show f'(x) = 0. Substitution must be shown	
A1cso	Show second derivative is < 0 at x = 1 and give the conclusion. No errors or omissions in the working.	
(ii)B1	For either y coordinate correct (and x coordinate correctly indicated; substitution shown indicates this)	
B1	For the second y coordinate correct	
(c)	(May have been seen in (b))	
M1	Factorise f'(x) completely – any valid method OR use the factor theorem to find x = -2	
(i)A1	Extract the x coordinate of the third turning point and obtain the corresponding y coordinate. May quote y coordinate from the question	
(ii)A1cso	Test the sign of the second derivative at this point and make the conclusion. All work in (c) and $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ (from (b)) must be completely correct for this mark to be awarded.	
	Alternative ways to determine the nature of the turning points:	
1.	If the change of sign of f'(x) is used then values of f'(x) either side of 1 and 2 must be calculated to provide evidence.	
2.	The continuity of a cubic function can be used to establish the nature of the turning points. If in doubt send to review.	