Question Number	Scheme	Marks
10.	(a) $\frac{\mathrm{d}y}{\mathrm{d}x} = 4x^3 - 12x^2 - 4x + 13$	M1 A1
	at R, $\frac{\mathrm{d}y}{\mathrm{d}x} = 4 - 12 - 4 + 13 = 1$	
	l_1 has equation $y - 13 = 1(x-1)$ $\quad [y = x + 12]$	M1 A1
	(b) $4x^3 - 12x^2 - 4x + 13 = 1$	
	$4x^3 - 12x^2 - 4x + 12 = 0$	M1
	$4(x-1)(x^2 - 2x - 3) = 0$	
	$4(x-1)(x+1)(x-3) = 0$	M1
	$x = -1,\ x = 1,\ x = 3$	
	At P, $x = -1$, $y = 1 + 4 - 2 - 13 + 5 = -5$ so $P(-1,-5)$	A1
	At Q, $x = 3$, $y = 81 - 108 - 18 + 39 + 5 = -1$ so $Q(3,-1)$	A1
	(c) Gradient of $PQ = \frac{-5+1}{-1-3} = 1$	
	Equation of l_2 is $y + 1 = 1(x-3)$ $\quad [y = x - 4]$	M1 A1
	or $y + 5 = 1(x+1)$	
	(d) Gradient of l_2 = gradient of C at P = gradient of C at Q [= 1]	B1
	[Since l_2 passes through P and Q with the same gradient as the curve at these points, it must be a tangent to C at P and at Q.]	
	(e) Normal at R has equation $y - 13 = -1(x-1)$	
	At intersection with l_2, $(x-4) - 13 = -1(x-1)$ or $y - 13 = -1(y + 4 - 1)$	M1
	$\Rightarrow 2x = 18$ or $2y = 10$	M1
	$\Rightarrow x = 9$ and $y = 5$	A1
	$RS^2 = (13-5)^2 + (1-9)^2$	M1
	$RS = \sqrt{64+64} = 8\sqrt{2}$	A1
	(f) $PQ = \sqrt{(-1-3)^2 + (-5+1)^2} = \sqrt{16+16} = 4\sqrt{2}$	
	Area $PQR = \frac{1}{2} \times 8\sqrt{2} \times 4\sqrt{2} = 32$	M1 A1 (18)
	alternative	
	(f) Area $PQR = \frac{1}{2}\begin{vmatrix} -1 & 3 & 1 & -1 \\ -5 & -1 & 13 & -5 \end{vmatrix} = \frac{1}{2}\left[(1 + 39 - 5) - (-15 - 1 - 13)\right]$ M1	
	$= \frac{1}{2}(35 + 29) = 32$ A1	

Notes

(a)

M1 for an attempt at differentiation (usual rules – reducing the power of at least one term, the disappearance the constant is insufficient for this mark)

A1 for a complete correct differentiated expression

M1 for finding and using a numerical value of the gradient, derived only from using $\frac{dy}{dx}$ into either $y - 13 =$ (their m) $(x - 1)$, or by applying $y = mx + c$ including finding a value for c

A1 for any correct equation $y - 13 = 1(x - 1)$ $\left[y = x + 12,\ \ y - x - 12 = 0\right]$ etc

(b)

M1 for setting their $\frac{dy}{dx} = 1$ and re-arranging to give a cubic equation (=0)

M1 for factorising their equation leading to three values of x

A1 for either of the correct coordinates $(-1, -5)$ **or** $(3, -1)$ ($x = -1$, $y = -5$ **or** $x = 3, y = -1$)

A1 for both $(-1, -5)$ **and** $(3, -1)$ correct , ($x = -1$, $y = -5$ **and** $x = 3, y = -1$)

(c)

M1 for finding the numerical gradient of l_2 using their coordinates of P and Q, and attempting to form an equation using their gradient and the points P or Q

A1 for a correct equation eg $y + 5 = 1(x + 1)$ or $y + 1 = 1(x - 3)$ $[y = x - 4]$

(d)

B1 please refer to ms

(e)

M1 for forming the equation of the normal at R. They must use a numerical gradient derived from their gradient of the tangent in part (a) using the rule $m_t \times m_n = -1$, and use the given coordinate of R. $y - 13 = -1(x - 1)$ oe ($y = -x + 14$)

M1 for finding the point of intersection of the Normal at R and l_2, by any acceptable method eg., simultaneous equations

A1 for the point of intersection of S, either $x = 9$ and $y = 5$, or gives coords (9, 5)

M1 for using Pythagoras with point R and their S

A1 for $8\sqrt{2}$, $\sqrt{128}$ oe exact answer only

(f)

M1 for any method to find the area of triangle PQR ft their P and Q

A1 for area $PQR = 32$ (units^2)