Differentiation 1 MS

Q1.

10 $y = \frac{1}{6}(2x-3)^3 - 4x$		
(i) $\frac{dy}{dx} = \frac{1}{6} \times 3 \times (2x-3)^2 \times 2 - 4$	B2,1	Everything but the "×2"
	B1	For the "×2", even if B0 given above.
	[3]	
(ii) $x = 0,\ y = -\frac{27}{6}$,	B1	For correct y value
$y + \frac{27}{6} = 5x \rightarrow 2y + 9 = 10x$	M1 A1	Must be using calculus for m. co.
	[3]	(ok unsimplified)
(iii) $(2x-3)^2 - 4 \quad (> 0)$	M1	Links $\frac{dy}{dx}$ with 0
$\rightarrow x = 2½$ or ½	DM1	Method for quadratic – lead to 2 answers
$\rightarrow x > 2½,\ x < ½.$	A1	Correct set of values.
	[3]	

Q2.

5 $\frac{dy}{dx} = \frac{6}{\sqrt{3x-2}}$		
(i) $x = 2$, tangent has gradient 3	M1	Use of $m_1 m_2 = -1$ with dy/dx
$\rightarrow$ normal has gradient $-\frac{1}{3}$	M1 A1	Correct form of line eqn. for normal
$\rightarrow y - 11 = -\frac{1}{3}(x-2)$	[3]	
(ii) Integrate $\rightarrow 6\frac{\sqrt{3x-2}}{\frac{1}{2}} \div 3$	B1	Without the ÷3
	B1	For ÷3, even if B0 above
$\rightarrow y = 4\sqrt{3x-2} + c$ through (2,11)	M1	Using (2, 11) for c
$\rightarrow y = 4\sqrt{3x-2} + 3$	A1	co
	[4]	

Differentiation 1 MS

Q3.

8	**(i)** $2x+2y+\frac{\pi x}{2}=60$	M1		Linking 60 with sum of at least 4 sides and use of radians
	$\rightarrow y=30-x-\frac{\pi x}{4}$	A1	[2]	co
	(ii) $A=xy+\frac{\pi x^2}{4}$			
	$=x\,(30-x-\frac{\pi x}{4})+\frac{\pi x^2}{4}$	M1		Subs "y" into area eqn and use $\frac{1}{2}r^2\theta$
	$=30x-x^2$	A1	[2]	co.
	(iii) $\frac{dA}{dx}=30-2x$			Knowing to differentiate
	$=0$ when $x=15$ cm	M1 A1	[2]	Sets differential to 0 + solution. co.
	(iv) Max.	M1 A1	[2]	Any valid method. co.

Q4.

10	$y=4x-x^2+3$			
	(i) $\frac{dy}{dx}=4-2x$	B1		co
	At $x=3$, $m=-2$			
	Gradient of normal $=\frac{1}{2}$	M1		Use of $m_1m_2=-1$
	Eqn of normal $y-6=\frac{1}{2}(x-3)$	M1 A1		Use of $y-k=m(x-h)$ or $y=mx+c$
	$\rightarrow 2y=x+9$		[4]	(where m is gradient of normal)
	(ii) Meets axes at $(0, \frac{9}{2})$ and $(-9, 0)$	M1		Sets x and y to 0 + midpoint formula.
	Mid-point is $\left(\frac{-9}{2},\frac{9}{4}\right)$	A1	[2]	co.
	(iii) $2y=x+9$, $y=4x-x^2+3$			
	$\rightarrow 2x^2-7x+3=0$ oe	M1 A1		Eliminates x completely. Correct eqn.
	$\rightarrow$ (½, 4¾)	M1 A1	[4]	Solution of quadratic. co

Differentiation 1 MS

Q5.

11	$y = \dfrac{9}{2-x}$			
	(i) $\dfrac{dy}{dx} = -9(2-x)^{-2} \times -1$	B1 B1		Without the "× −1" Indep. With the "×−1". Indep.
	$\dfrac{9}{(2-x)^2} \neq 0$. No turning points.	B1√	[3]	√ provided of form $k \div (2-x)^2$.

Q6.

3	**(i)** $(k(2t-1)^{-1/2}$ $0.7(2t-1)^{-1/2}$	M1 A1	[2]	$k \neq 1$ oe
	(ii) Sub $t = 5$ into *their* deriv 0.23(3)	M1 A1	[2]	Ignore units

Q7.

5	**(i)** $\dfrac{dy}{dx} = \dfrac{-1}{(x-3)^2} + 1$	B1		oe
	$\dfrac{d^2y}{dx^2} = \dfrac{2}{(x-3)^3}$	B1	[2]	oe
	(ii) $(x-3)^2 = 1 \Rightarrow x - 3 = \pm 1$	M1		Set $\dfrac{dy}{dx} = 0$ & reasonable attempt to solve
	$x = 4, 2$ $y = 5, 1$	A1 A1		
	When $x = 4$ $\dfrac{d^2y}{dx^2} > 0 (= 2) \Rightarrow$ min	M1		Investigate signs of f″ at a point or other method
	When $x = 2$ $\dfrac{d^2y}{dx^2} < 0 (= -2) \Rightarrow$ max	A1	[5]	

Q8.

6	**(i)** $(3x+5)(x-1)(> 0)$ $-5/3, 1$ $x < -5/3, x > 1$	M1 A1 A1	[3]	Attempt at factorisation Both required Ignore any words between answers Condone ‹ ›

Differentiation 1 MS

Q9.

2	$\left(\frac{dv}{dr}=\right)4\pi r^2$	M1	
	$=4\pi\times10^2$	A1	SOI at any point
	$\frac{dr}{dt}=\frac{\frac{dv}{dt}}{\frac{dv}{dr}}$ **OE** used	M1	Correct link between differentials with $\frac{dr}{dt}$ finally as subject
	$\frac{50}{4\pi\times10^2}=\frac{1}{8\pi}$ or 0.0398	A1 [4]	Allow $\frac{50}{400\pi}$. Non-calculus methods $\frac{0}{4}$

Q10.

4	$y=\frac{4}{3x-4}$		
	(i) $\frac{dy}{dx}=-4(3x-4)^{-2}\quad\times\quad3$	B1 B1	Correct without ×3. For ×3.
	If $x=2$, $m=-3$ Eqn of tangent $y-2=-3(x-2)$	M1 A1 [4]	Correct line eqn. co (for normal M0A0)
	(ii) $\tan\theta=\pm(-3)$ $\rightarrow\quad\theta=\pm108.4^\circ$ (or $\pm71.6^\circ$)	M1 A1√ [2]	Correct link with (± his gradient) co (accept acute or obtuse) or -71.6° or radians
	or scalar product, $\tan\theta=y$-step ÷ x-step **or** use of tan $(A-B)$ M1A1 for each		

Differentiation 1 MS

Q11.

9	$\frac{dy}{dx} = \frac{2}{\sqrt{x}} - 1 \quad P(9, 5)$		
	(i) $y = 4\sqrt{x} - x(+c)$ Uses (9, 5) in an integrated expression $\rightarrow c = 2$	B1 B1 M1 A1 [4]	Ignore + c. Substitution of point after integration. co.
	(ii) $\frac{dy}{dx} = 0 \rightarrow x = 4, y = 6$	M1 A1 A1 [3]	Attempt to solve $dy/dx = 0$. x correct. y correct.
	(iii) $\frac{d^2y}{d^2x} = -x^{\frac{-3}{2}} \rightarrow$ –ve $\rightarrow$ Max	B1 B1√ [2]	co. √ for correct deduction.
	(iv) $\frac{dy}{dx} = -\frac{1}{3}$ Perpendicular $m = 3$ $\tan\theta = 3$ Angle is $\tan^{-1}3$ $k = 3$	M1 A1 [2]	Use of $m_1m_2 = -1$ Needs $k = 3$

Q12.

2	$\frac{\delta y}{\delta x} = 9x^2 - 12x + 4$	M1A1		
	$(3x-2)^2 \geq 0$	A1	[3]	