Assessment Schedule – 2025

Calculus: Apply differentiation methods in solving problems (91578)

Evidence Statement

	Expected coverage	Achievement (u)	Achievement with Merit (r)	Achievement with Excellence (t)
ONE (a)	$f'(x) = 5(5x^3 - 2x + 1)^4 \times (15x^2 - 2)$	• Correct derivative.		
(b)	$\frac{dC}{dt} = -30t^{-\frac{3}{2}} + \frac{5}{2}t^{-\frac{1}{2}}$ $\frac{dC}{dt} = \frac{-30}{t^{\frac{3}{2}}} + \frac{5}{2t^{\frac{1}{2}}}$ $t = 4$ gives $\frac{dC}{dt} = \frac{-30}{4^{\frac{3}{2}}} + \frac{5}{2 \times 4^{\frac{1}{2}}}$ $\frac{dC}{dt} = \frac{-5}{2} = -2.5$	• Correct rate of change, with evidence of derivative.		
(c)	$\frac{dy}{dx} = 3(\sin x)^2 \times \cos x \times \cos x - (\sin x)^3 \times \sin x$ $\frac{dy}{dx} = 3\sin^2 x \times \cos^2 x - \sin^4 x$ $x = \frac{\pi}{4}$ gives $\frac{dy}{dx} = 3 \times \frac{1}{2} \times \frac{1}{2} - \frac{1}{4}$ $\frac{dy}{dx} = \frac{3}{4} - \frac{1}{4}$ $\frac{dy}{dx} = \frac{1}{2}$ Then gradient of normal $= -2$	• Correct derivative.	• Finds the correct gradient of the normal, with evidence of derivative.	
(d)	$f'(x) = 2x + 2e^{2x}$ $x = 1$ gives $f(x) = 1 + e^2 = 8.389$ $x = 1$ gives $f'(x) = 2 + 2e^2 = 16.778$ Equation of tangent is: $y - 1 - e^2 = (2 + 2e^2)x - 2 - 2e^2$ $y = 16.779x - 8.389$ $y = 0$ gives $x = \frac{1 + e^2}{2 + 2e^2} = 0.5$ i.e. crosses x-axis at $x = 0.5$	• Correct derivative for $f'(x)$, **evaluated** when $x = 1$.	• Correct coordinates for P, with correct derivative.	

(e)	$x = 3t^2 + 6t + 1 \Rightarrow \frac{dx}{dt} = 6t + 6$ $y = 2t^3 \Rightarrow \frac{dy}{dt} = 6t^2$ $\frac{\mathrm{d}y}{\mathrm{d}x} = 6t^2 \times \frac{1}{6t+6} = \frac{t^2}{t+1}$ $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = \frac{2t(t+1) - t^2}{(t+1)^2} \times \frac{1}{6t+6}$ $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = \frac{t^2+2t}{6(t+1)^3}$ For points of inflection: $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = \frac{t^2+2t}{6(t+1)^3} = 0$ $t^2 + 2t = 0$ $t = 0$ or $t = -2$ $t = 0 \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = 0$ i.e. stationary inflection $t = -2 \Rightarrow \frac{\mathrm{d}y}{\mathrm{d}x} = -4$ i.e. non-stationary inflection – not required $t = 0 \Rightarrow x = 1$ and $y = 0$ i.e. required point is $(1, 0)$ Accept alternative method if candidate finds any stationary points, and then tests these to see if they are inflection points.	• Correct expression for $\frac{\mathrm{d}y}{\mathrm{d}x}$.	Correct expression for for $\frac{\mathrm{d}y}{\mathrm{d}x}$ and $\frac{\mathrm{d}^2y}{\mathrm{d}x^2}$ AND Solved $\frac{\mathrm{d}^2y}{\mathrm{d}x^2} = 0$ equation for the two values of t.	**E7** Correct solution but with one minor error. OR Correct solution but with one minor error. **E8** Finds the single required coordinate (1,0), with full justification.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE partial solution.	1u	2u	3u	1r	2r	1t	2t

	Expected coverage	Achievement (u)	Achievement with Merit (r)	Achievement with Excellence (t)
TWO (a)	$f'(x) = -7x^{-2} - \dfrac{9x^2 - 4x}{3x^3 - 2x^2 + 5}$ $f'(x) = \dfrac{-7}{x^2} - \dfrac{9x^2 - 4x}{3x^3 - 2x^2 + 5}$	• Correct derivative.		
(b)	$\dfrac{dP}{dt} = (30 - 10t)e^{-t} + (30t - 5t^2) \times -e^{-t}$ $t = 2$ gives $\dfrac{dP}{dt} = -4.06$ As $\dfrac{dP}{dt} < 0$, so depth of the water is decreasing.	• Correct decision of decreasing, with correct derivative.		
(c)	$\dfrac{dy}{dx} = \dfrac{2x(x+4) - x^2}{(x+4)^2}$ $\dfrac{dy}{dx} = \dfrac{x^2 + 8x}{x^2 + 8x + 16}$ Gradient of curve = Gradient of tangent $\dfrac{x^2 + 8x}{x^2 + 8x + 16} = -3$ $x^2 + 8x = -3(x^2 + 8x + 16)$ $4x^2 + 32x + 48 = 0$ $(x+2)(x+6) = 0$ $x = -2$ and $x = -6$ $y = 2$ and $y = -18$ $(-2, 2)$ and $(-6, -18)$	• Correct derivative.	• Both coordinates found, with evidence of derivative.	
(d)	$\dfrac{dx}{dt} = 2\sec t \tan t$ $\dfrac{dy}{dt} = 5\sec^2 t$ $\dfrac{dy}{dx} = \dfrac{5\sec t}{2\tan t} = \dfrac{5}{2\sin t}$ $t = \dfrac{\pi}{6}$ gives $\dfrac{dy}{dx} = 5,\ x = \dfrac{4}{\sqrt{3}} = 2.3094,\ y = \dfrac{5}{\sqrt{3}} = 2.8868$ Equation of tangent is: $\sqrt{3}y - 5\sqrt{3}x + 15 = 0$ Or $1.732y - 8.66x + 15 = 0$ Or equivalent.	• Finds $\dfrac{dy}{dx}$. (Does not need to be simplified.)	• Correct equation of tangent found.	

(e)	$\frac{dy}{dx} = 2(\cos 2x)(-2\sin 2x)$ $\frac{dy}{dx} = -4\cos 2x \sin 2x$ OR $-2\sin 4x$ $\frac{d^2y}{dx^2} = -4 \times -\sin 2x \times 2 \times \sin 2x - 4\cos 2x \times \cos 2x \times 2$ $\frac{d^2y}{dx^2} = 8\sin^2 2x - 8\cos^2 2x$ OR $-8\cos 4x$ $x = \frac{\pi}{3}$ gives $p = \frac{\left(1+(\sqrt{3})^2\right)^{\frac{3}{2}}}{4}$ $p = \frac{(4)^{\frac{3}{2}}}{4}$ $p = \frac{8}{4} = 2$	• Correct expression for $\frac{dy}{dx}$.	• Correct expression for $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$	**E7** Correct solution, but with one minor error. **E8** Correct value of $p = 2$ found, with evidence of a calculus method.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE partial solution.	1u	2u	3u	1r	2r	1t	2t

	Expected coverage	Achievement (u)	Achievement with Merit (r)	Achievement with Excellence (t)
THREE (a)(i) (ii) (iii)	$x = -6$ and $x = -2$ and $x = 3$ $x < -6$ and $x = -4$ and $x = 6$ $f(x) = 2$	• Two out of three correct responses.		
(b)	$\frac{dy}{dx} = \frac{\frac{1}{x} \times 2x - \ln x \times 2}{(2x)^2}$ $\frac{dy}{dx} = \frac{2 - 2\ln x}{4x^2}$ For stationary points $\frac{dy}{dx} = 0$ $\frac{2 - 2\ln x}{4x^2} = 0$ $2 - 2\ln x = 0$ $\ln x = 1$ $x = e^1 = e = 2.718$	• Correct x-value found, with evidence of derivative.		
(c)	$V = \frac{4}{3}\pi r^3 \Rightarrow \frac{dV}{dr} = 4\pi r^2$ $\frac{dr}{dt} = -0.05$ and $r = 6$ We require $\frac{dV}{dt} = \frac{dV}{dr} \times \frac{dr}{dt}$ $\frac{dV}{dt} = 4\pi r^2 \times -0.05$ $\frac{dV}{dt} = 4\pi \times 6^2 \times -0.05$ $\frac{dV}{dt} = -7.2\pi = -22.62 \text{ cm}^3/\text{sec}$ Units not necessary. Do not penalise missing minus sign.	• Correct derivatives for $\frac{dV}{dr}$ and $\frac{dr}{dt}$ found.	• Correct value for $\frac{dV}{dt} = -22.62$ found, with evidence of derivatives.	
(d)	$\frac{dx}{dt} = -10e^{-2t}$ $\frac{dy}{dt} = 10e^{2t}$ $\frac{dy}{dx} = 10e^{2t} \times \frac{1}{-10e^{-2t}} = -e^{4t}$ Gradient $= -2$ $-e^{4t} = -2$ $e^{4t} = 2$ $4t = \ln 2$ $t = \frac{\ln 2}{4} = 0.173$ $\Rightarrow x = \frac{5}{\sqrt{2}}(3.54) \Rightarrow y = 5\sqrt{2}(7.071)$ i.e. required point is $(3.54, 7.071)$	• $\frac{dy}{dx}$.	• Coordinates of required point (3,54,7.071) found, with evidence of derivative.	

(e)	$y=(16x-x^2)^{\frac{1}{2}}$ Area = AD × AB Let A = $(x, 0)$ Area = $(16-2x)(16x-x^2)^{\frac{1}{2}}$ $\frac{dA}{dx}=-2(16x-x^2)^{\frac{1}{2}}+(16-2x)$ $\times\frac{1}{2}(16x-x^2)^{-\frac{1}{2}}\times(16-2x)$ $\frac{dA}{dx}=-2(16x-x^2)^{\frac{1}{2}}+\frac{(8-x)(16-2x)}{(16x-x^2)^{\frac{1}{2}}}$ $\frac{dA}{dx}=0$ $2(16x-x^2)^{\frac{1}{2}}=\frac{(8-x)(16-2x)}{(16x-x^2)^{\frac{1}{2}}}$ $16x-x^2=(8-x)(8-x)$ $16x-x^2=64-16x+x^2$ $2x^2-32x+64=0$ $x=2.343$ and $x=13.657$ Then length AD = $16-2\times2.343$ AD = 11.314 units	• Correct $\frac{dA}{dx}$ from a model with a minor error.	• $\frac{dA}{dx}$ found.	**E7** Finding the value(s) of x. OR Correct solution but with one minor error. **E8** Correct length of AD found, with full and clear calculus justification.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	ONE partial solution.	1u	2u	3u	1r	2r	1t	2t

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 19	20– 24