FREE SAMPLE: THE FIRST QUESTION

Question One (13 marks)

(a) A curve has the equation y = xe^(−2x) + 3.

Find the equation of the tangent to the curve at x = 1. Give the gradient and intercept to 3 significant figures.

[4 marks]

(b) Differentiate f(x) = ln(x² + 4x + 3) using the chain rule, and simplify your answer.

Hence find f'(1), correct to 3 significant figures.

[4 marks]

(c) Let f(x) = 2x + sin(x), where x is in radians.

(i) Find f'(x), and the gradient of the curve at x = $\frac{\pi}{2}$ (3 significant figures).

(ii) Find the number of stationary points of f in the interval 0 ≤ x ≤ 2π, and give their x-values to 3 significant figures.

[5 marks]

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THE WORKED ANSWER TO THAT QUESTION

Question 1 (13 marks) [Differentiation rules and tangents]

(a) A curve has the equation y = xe^(−2x) + 3. Find the equation of the tangent to the curve at x = 1. Give the gradient and intercept to 3 significant figures.

(a) Answer: y = −0.135x + 3.27

- Evidence level: Merit (differentiate with the appropriate rule, then use the point and gradient).
- dy/dx = (−2x + 1)e^(−2x).
- At x = 1: gradient m = −0.135 and y = 3.14.
- Tangent: y − 3.14 = −0.135(x − 1.00), so y = −0.135x + 3.27.

> **KEY TAKEAWAY**
> Tangent equation: the derivative gives the gradient at the given x; the curve gives the point; then $y - y_1 = m(x - x_1)$, keeping full calculator accuracy until the end.

(b) Differentiate f(x) = ln(x² + 4x + 3) using the chain rule, and simplify your answer. Hence find f'(1), correct to 3 significant figures.

(b) Answer: $f'(x) = 2\frac{x+2}{x^2+4x+3}$; f'(1) = 0.750

- Evidence level: Achieved (choose and apply the correct differentiation rule, then simplify).
- Identify the rule: f(x) is a function of a function, so use the chain rule.
- $f'(x) = 2\frac{x+2}{x^2+4x+3}$.
- Substitute x = 1: f'(1) = 0.750.

> **KEY TAKEAWAY**
> Differentiation rules: product (uv)' = u'v + uv'; quotient (u/v)' = (u'v − uv')/v²; chain d/dx[g(u)] = g'(u)u' — write down the derivative of each piece before combining.

(c) Let f(x) = 2x + sin(x), where x is in radians. (i) Find f'(x), and the gradient of the curve at $x = \frac{\pi}{2}$ (3 significant figures). (ii) Find the number of stationary points of f in the interval 0 ≤ x ≤ 2π, and give their x-values to 3 significant figures.

(c) Answer: (i) f'(x) = cos(x) + 2; gradient 2.00; (ii) 0 stationary points

- Evidence level: Merit (differentiate trigonometric functions, then solve a trig equation in an interval).
- (i) f'(x) = cos(x) + 2. At $x = \frac{\pi}{2}$: f' = 2.00.
- (ii) Stationary points need cos(x) + 2 = 0, which means cos(x) = −2; this value is outside −1 to 1, so there are none.
- Solutions in 0 ≤ x ≤ 2π: none.
- Number of stationary points = 0.

> **KEY TAKEAWAY**
> Trig derivatives: d/dx sin(bx) = b cos(bx); for stationary points set the derivative to zero and find ALL solutions of the trig equation inside the interval.

LOS: Differentiation rules and tangents (91578)

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