FREE SAMPLE: THE FIRST QUESTION

Question One (9 marks)

(a) A curve has the equation $y = x^2 - 6x - 3$.

Find the coordinates of the point on the curve where the gradient is -4.

[3 marks]

(b) For the function $f(x) = -x^3 + 12x^2 - 45x$, find the values of x for which the function is decreasing.

[3 marks]

(c) The curve $y = 2x^3 - 3x^2 - 4x - 1$ has a tangent at the point where $x = 1$.

Find the equation of this tangent, in the form $y = mx + c$.

[3 marks]

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THE WORKED ANSWER TO THAT QUESTION

Question 1 (9 marks) [Gradients, tangents and graphs]

(a) A curve has the equation $y = x^2 - 6x - 3$. Find the coordinates of the point on the curve where the gradient is -4.

(a) Answer: (1, −8)

- Evidence level: Achieved (differentiate, set the gradient equal to the given value, solve, then find y).
- Differentiate: $dy/dx = 2x - 6$.
- Set the gradient equal to -4: $2x - 6 = -4$, so $x = 1$.
- Substitute into the curve: $y = -8$.
- The point is $(1, -8)$.

> **KEY TAKEAWAY**
> Gradient at a point: differentiate to get dy/dx, set it equal to the required gradient to find x, then substitute back into the ORIGINAL equation for y.

(b) For the function $f(x) = -x^3 + 12x^2 - 45x$, find the values of x for which the function is decreasing.

(b) Answer: $x < 3$ or $x > 5$

- Evidence level: Merit (use the sign of the derivative).
- $f'(x) = -3x^2 + 24x - 45 = -3(x - 5)(x - 3)$.
- $f'(x) = 0$ at $x = 3$ and $x = 5$. This is a downward-opening parabola in f', so $f'(x)$ is negative outside these values and positive between them.
- The function is decreasing where $f'(x) < 0$, that is $x < 3$ or $x > 5$.

> **KEY TAKEAWAY**
> Increasing means $f'(x) > 0$ and decreasing means $f'(x) < 0$: find where $f' = 0$, then use the shape of f' to decide the sign on each interval.

(c) The curve $y = 2x^3 - 3x^2 - 4x - 1$ has a tangent at the point where $x = 1$. Find the equation of this tangent, in the form $y = mx + c$.

(c) Answer: $y = -4x - 2$

- Evidence level: Merit (find the gradient with a derivative, then build the tangent line).
- Differentiate: $dy/dx = 6x^2 - 6x - 4$.
- At $x = 1$ the gradient is $m = -4$.
- The point on the curve is $(1, -6)$ because $y = -6$.
- Use $y - (-6) = -4(x - 1)$: $y = -4x - 2$.
- The tangent is $y = -4x - 2$.

> **KEY TAKEAWAY**
> A tangent has the same gradient as the curve at the point: use the derivative for m, the curve for the point, then $y - y_1 = m(x - x_1)$.

LOS: Gradients, tangents and graphs (91262)

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