Differentiation (AS)

G1 Understand and use the derivative of as the gradient of the tangent to the graph of at a general point (x, y); the gradient of the tangent as a limit; interpretation as a rate of change; sketching the gradient function for a given curve; second derivatives; differentiation from first principles for small positive integer powers of x. Understand and use the second derivative as the rate of change of gradient.

G2 Differentiate x^n for rational values of n, and related constant multiples, sums and differences.

G3 Apply differentiation to find gradients, tangents and normals, maxima and minima and stationary points. Identify where functions are increasing or decreasing.

For a brief commentary on this content go to the MEI outline SoW.

Pre-requisites

- GCSE: Rules of indices.
- AS Equations of straight lines.

Common student errors

- Assuming that at a point where $\frac{dy}{dx} = 0$ and $\frac{d^2y}{dx^2} = 0$ there must be a point of inflection.
- Not understanding differentiation from first principles, especially when the question guides the student through it.
- Difficulty in seeing the link from $\frac{dy}{dx}$, via gradients, to equations of tangents and normals.

Teaching it!

- A series of eight videos designed to support students on this topic.
- Card Sort: Derivative Match: Desmos Classroom activity matching functions & derivatives.
- Tangents to a polynomial: A GeoGebra file exploring a series of tangents to a curve.
- Differentiation from 1st principles: A GeoGebra file exploring the idea of a series of chords.
- Tangent or normal?: An Underground Mathematics resource which will make students think.
- Two problems which can be solved with or without calculus.
- Gradient on a curve (student task): Autograph, Casio, Desmos, GeoGebra
- Stationary points (student task): Autograph, Casio, Desmos, GeoGebra

Getting them thinking

- How would you explain the role of chords in differentiation from first principles?
- Give me an example of a curve with a maximum point at $(-2,2)$.
- Prove that for a rectangle enclosed by a piece of string of fixed length the area is maximised when the rectangle is a square.
- Prove that the cubic $y = \frac{1}{3}x^3 + bx$ is an increasing function if and only if $b \geq 0$.