**Y13 A level Mathematics**

**30 Further Differentiation 2 weeks**

## Teaching objectives

**a** Understand and use the derivative of Sin x and Cos x

**b** Differentiate ekx and akx, Sin kx, Cos kx, Tan kx and related sums, differences and constant multiples

**c** Differentiate simple functions and relations defined implicitly

**Resources for advance preparation:**

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|  | **Starter** | **Main teaching**Including key questions, key teaching points, models and resources | **Notes**Including Support and Extension | **Consolidation/Plenary**Including key questions and homework |
| **1** | [Slippery slopes](https://undergroundmathematics.org/calculus-meets-functions/slippery-slopes) | **Understand and use the derivative of Sin x and Cos x** * Graph of [differential function](https://drive.google.com/file/d/0B4bEjiUzbc3cdmk0M0dnaUdOYTA/view?usp=sharing) of Sin x using technology
* Algebraic proof of differential of Sin x
* Graphical derivative of Cos x
* Using derivatives of Sin x and Cos x to [solve problems](https://drive.google.com/file/d/0B4bEjiUzbc3cNWYwN09vYW12WFk/view?usp=sharing)
 | Link back to (23 – Trigonometry) Radian measure.Alternatively, *use* differentiating trig functions to *introduce* radians, ideally using a graph plotter. | [Practice questions](https://cdn.kutasoftware.com/Worksheets/Calc/03%20-%20Chain%20Rule%20with%20Trig.pdf)[More practice questions](https://drive.google.com/file/d/0B4bEjiUzbc3cR3FFeC1FOGF2QVk/view?usp=sharing) |
| **2** |  |  **DifferentiateSin kx, Cos kx, Tan kx and related sums, differences and constant multiples*** Derivatives of related sums, differences and multiples
 | For differentiation (or integration) to be correct angles must be in **radians**[Finding gradient of sin, cos by considering rotation round a unit circle](https://undergroundmathematics.org/calculus-trig-log/rotating-derivatives) | [Link to PhysicsandMathsTutor.com](https://www.physicsandmathstutor.com/a-level-maths-papers/c3-by-topic/)7 sets of past exam questions on differentiation of trig, ln, e functions in MEI section |
| **3** | Use technology to find e (where graph of y = ax function is same as its derivative function). | **Differentiate ekx and akx** * Exploring derivatives of y = e2x, y = e3x, [reinforcing chain rule](https://cdn.kutasoftware.com/Worksheets/Calc/03%20-%20Chain%20Rule%20with%20Logs%20Exponentials.pdf)
 | [Finding ax by first principals](https://undergroundmathematics.org/calculus-trig-log/to-the-limit/gradient-a-to-x)Make sure students don’t think ln / e are functions rather than operators | **See above** |
|  | **Starter** | **Main teaching**Including key questions, key teaching points, models and resources | **Notes**Including Support and Extension | **Consolidation/Plenary**Including key questions and homework |
| **4** | [Differentiation Rules OK(risp)](http://www.s253053503.websitehome.co.uk/risps/risp38.html)Use as starter and use exp(y) = … to lead in | * Find derivative of ln x
* Use chain rule to find derivative of functions involving ln e.g. ln (x2+x)
 | Links back to integration of 1/x[Advanced Arithmagons (risp)](http://www.s253053503.websitehome.co.uk/risps/risp21.html) | [Trig and log gradients match](https://undergroundmathematics.org/calculus-trig-log/trig-gradient-match) |
| **5** | [Gradient of a circle](https://undergroundmathematics.org/chain-rule/implicit-circles) | **Differentiate simple functions and relations defined implicitly*** Considering **chain rule** to find d/dx f(y)
* Using **product rule (then chain)** to find d/dx f(x,y)
 | Students can get confused when x and y are on the same side of the equation.e.g. x2+y2=4xdy/dx = 2x+2y +4[The Two Special Cubes(risp)](http://www.s253053503.websitehome.co.uk/risps/risp7.html) | Using these derivatives to solve problems[Set 1](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%201%20QP.pdf), [Set 2](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%202%20QP.pdf), [Set 3](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%203%20QP.pdf), [Set 4](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%204%20QP.pdf), [Set 5](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%205%20QP.pdf)and solutions[Set 1](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%201%20MS.pdf), [Set 2](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%202%20MS.pdf), [Set 3](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%203%20MS.pdf), [Set 4](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%204%20MS.pdf), [Set 5](https://pmt.physicsandmathstutor.com/download/Maths/A-level/C3/Topic-Qs/OCR-MEI/C3%20Differentiation%20-%20Implicit%205%20MS.pdf) |