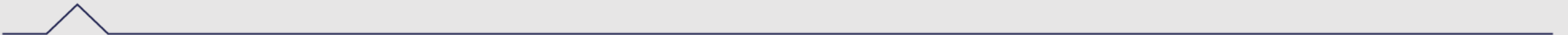

Visualizing Mathematical Modelling: Using Online Graphical Calculators

John Gough

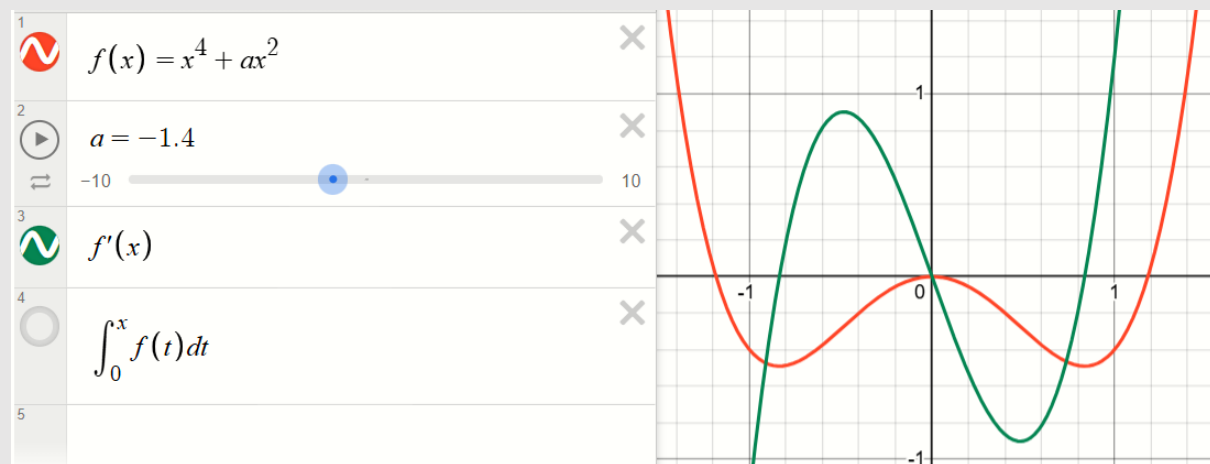
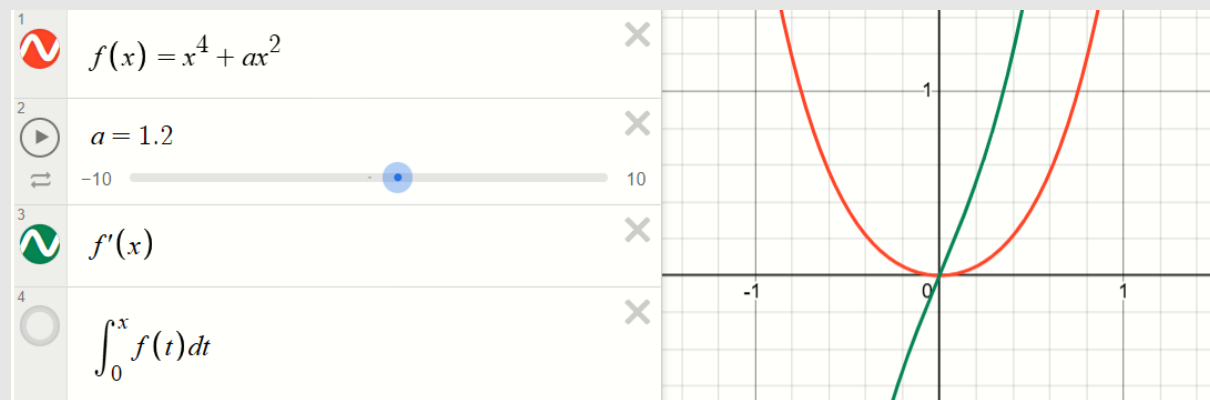


Desmos

- Free online graphing calculator <https://www.desmos.com/calculator>
- Already seeing first year students who have had exposure to it at school
- Set up an individual account to save work
- Allows exploration (adjustment of parameters)
- Animations!
- Growing community of users publishing

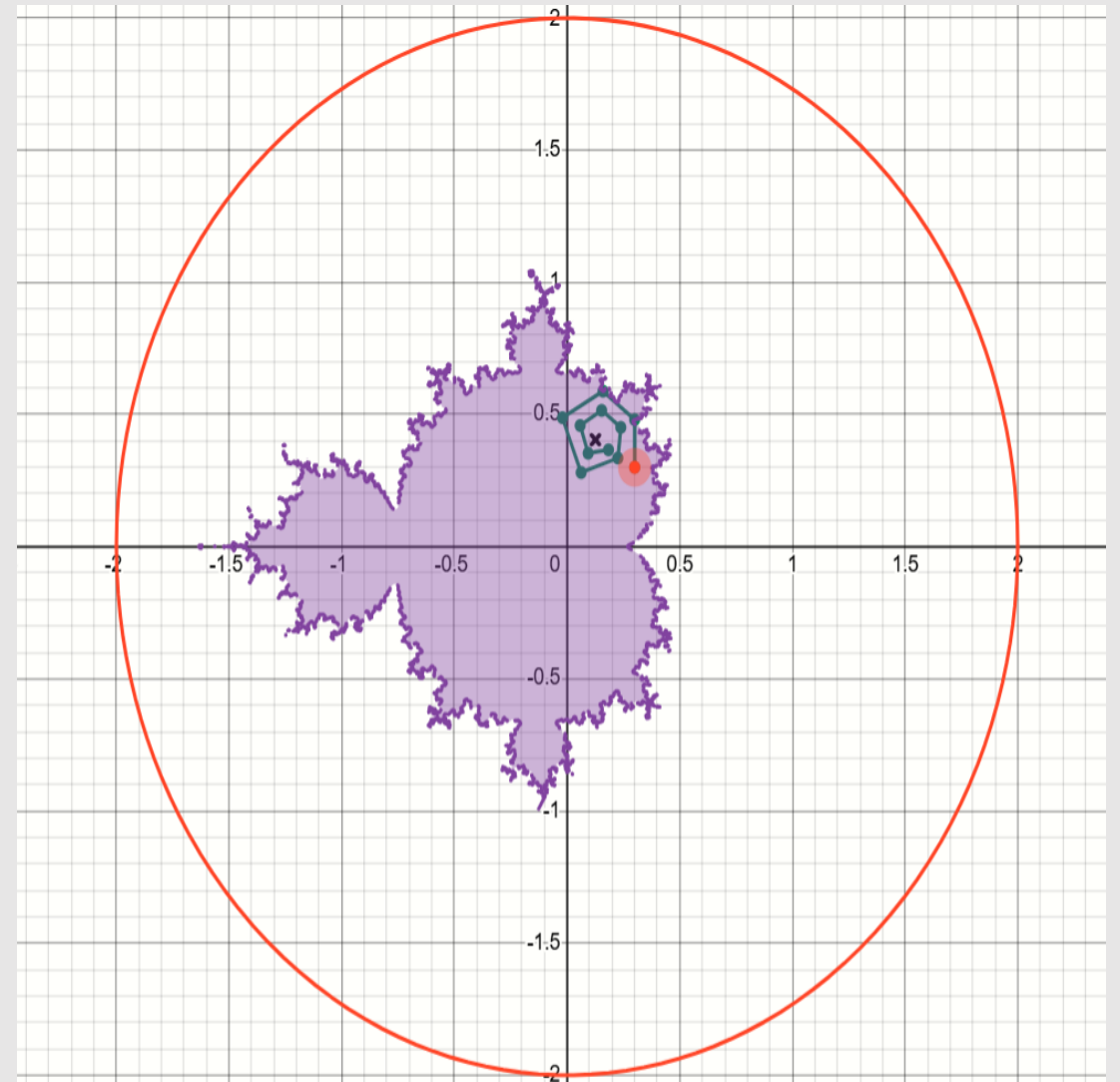


Phase Transition



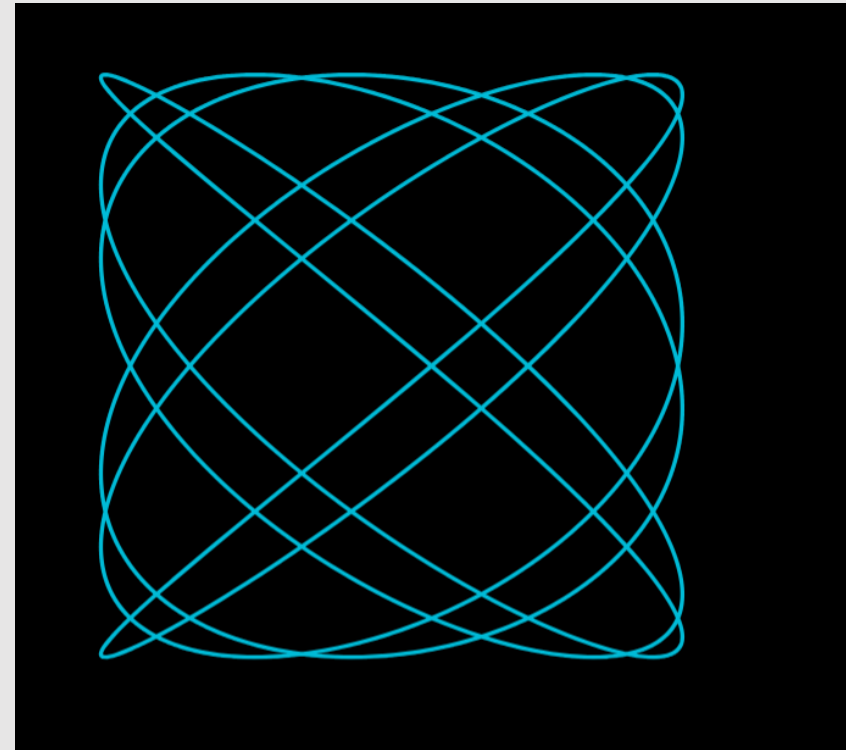
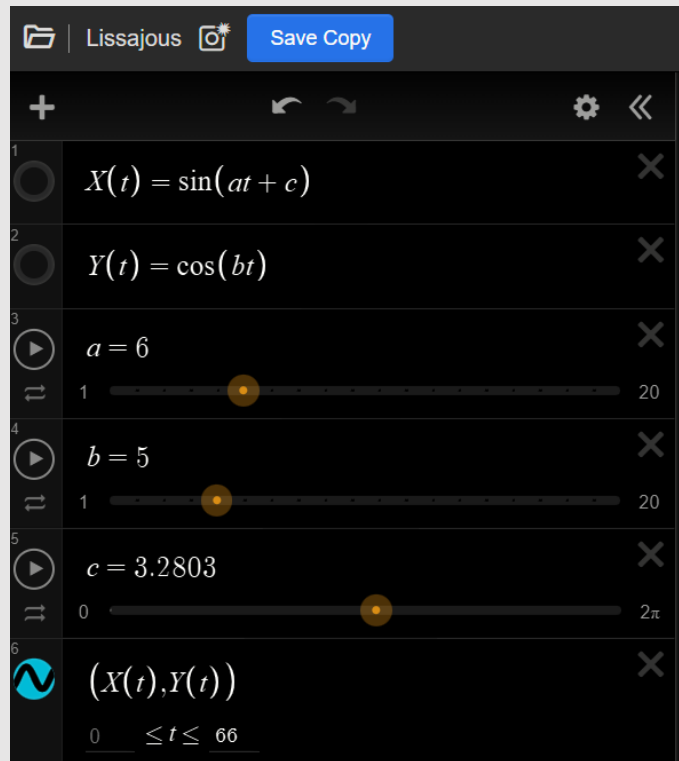
Mandelbrot Set

<https://www.desmos.com/calculator/4lkb52boy>





Lissajous Figures

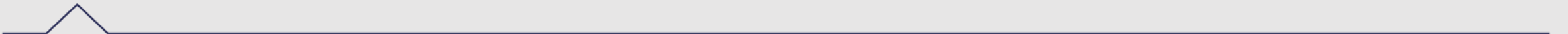
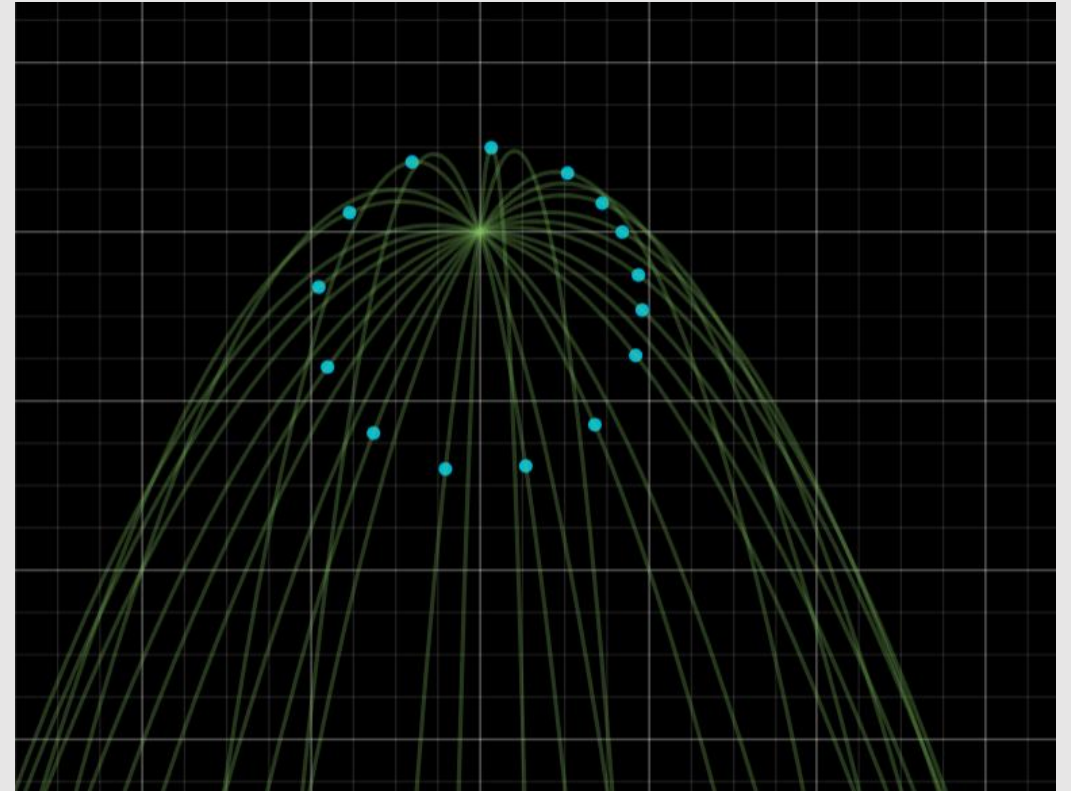
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Fireworks

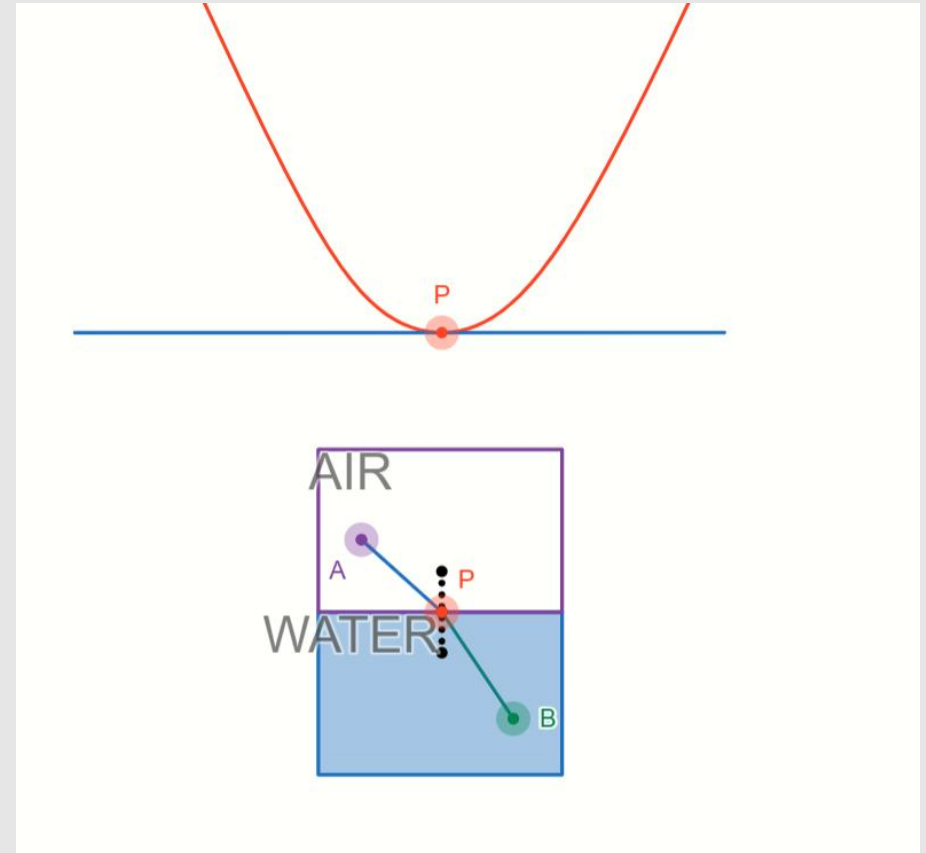
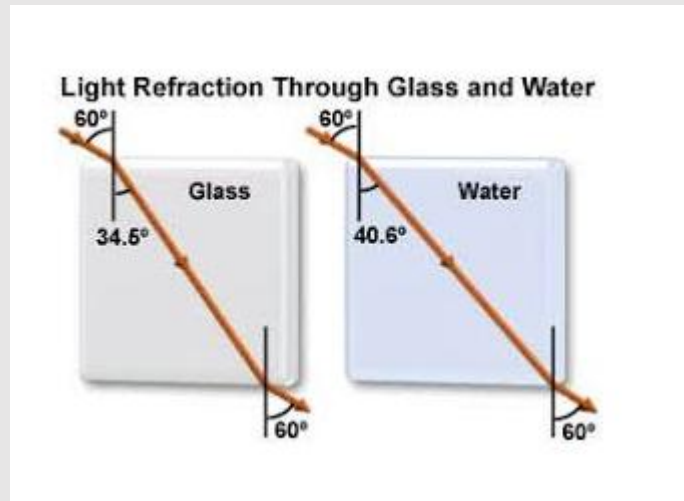
<https://www.desmos.com/calculator/70yefvfzug>

8		$y = -\frac{g}{2u^2 \cos^2(l)}x^2 + x \tan(l)$
9		$x^2 + \left(y + \frac{g}{2}t^2\right)^2 = (ut)^2$

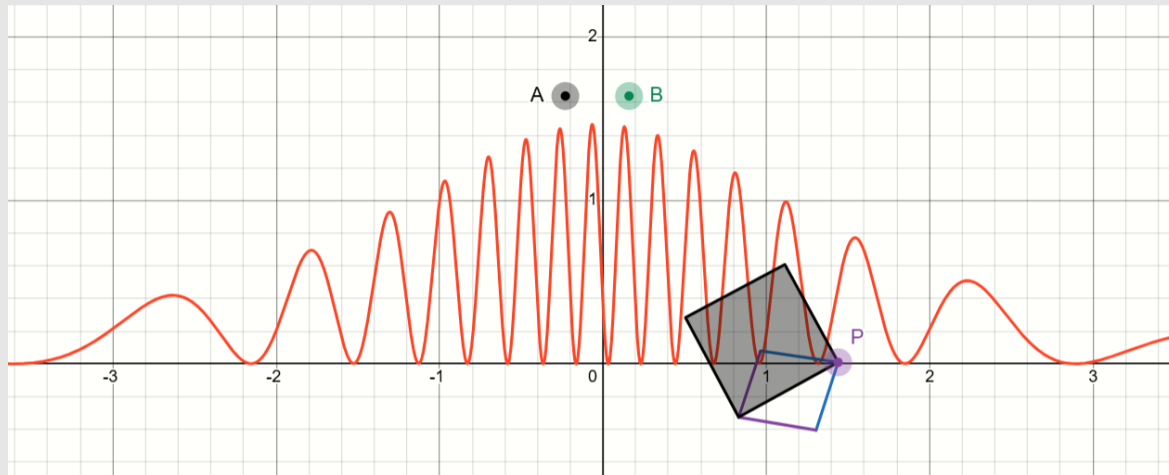


Fermat's Principle

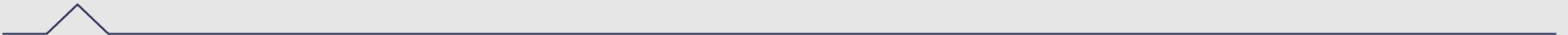
<https://www.desmos.com/calculator/c40sdqcntm>



Two Slit Experiment




<https://www.desmos.com/calculator/glq4ezmt0v>



Worked Example

<https://www.desmos.com/calculator/kqyjfozuo3>


1



$$f(x) = \left(\frac{1}{\sqrt{2}} \sin(2\pi x) - \sum_{k=0}^n \frac{\sqrt{32} (-1)^k}{\pi((2k+1)^2 - 4)} \sin((2k+1)\pi x) \right) \{0 < x < 1\}$$


×

2




$n = 1$

×




0



20

3



$\sqrt{2} \sin(2\pi x) \left\{ 0 < x < \frac{1}{2} \right\}$

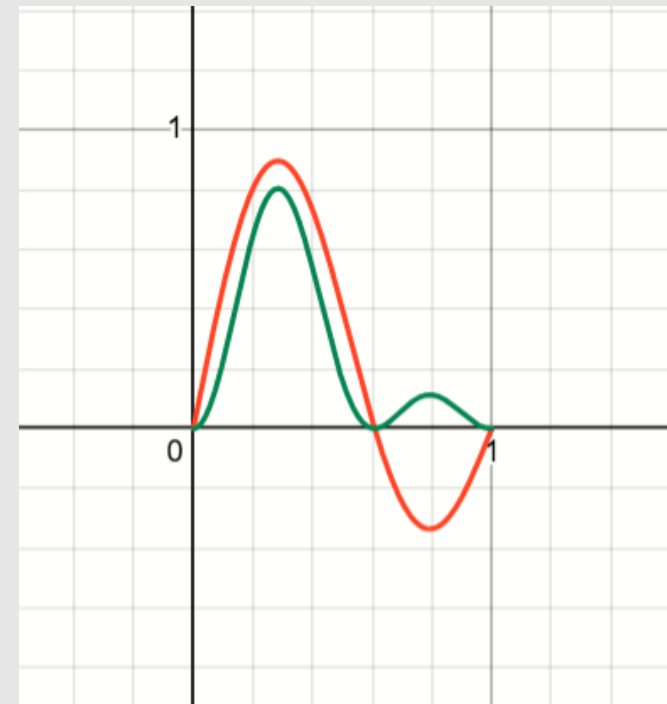
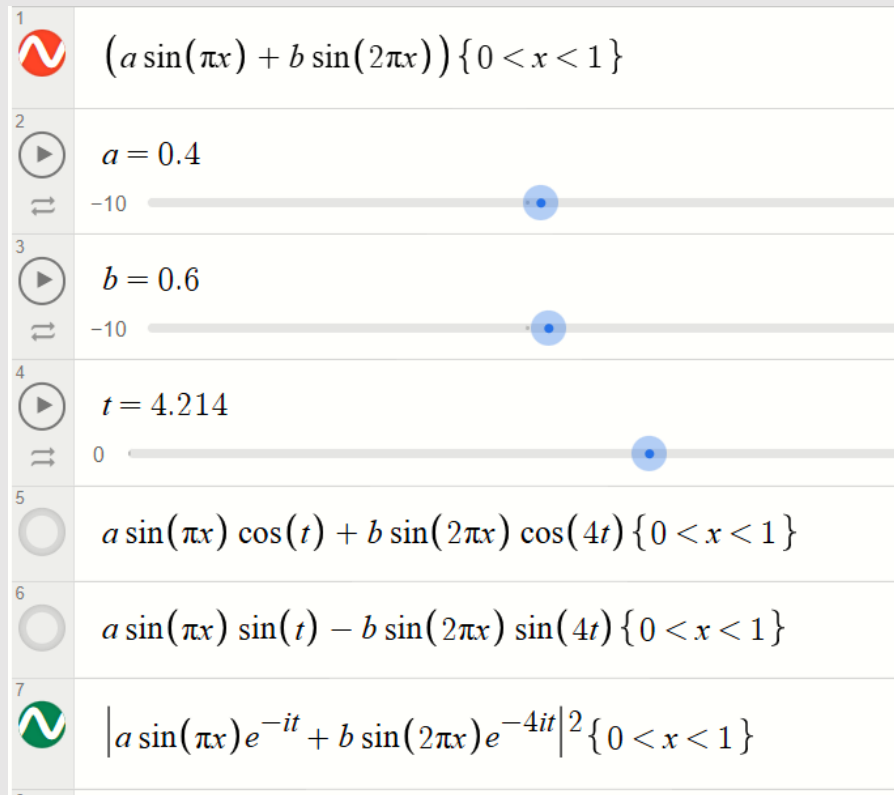
×

4



Two Modes

www.desmos.com/calculator/g8bjcql01l





Banana skins!

FROM THE MAKERS OF WOLFRAM LANGUAGE AND MATHEMATICA



Include a parameter t

MatrixExp({{0,1},{-1,0}})

 NATURAL LANGUAGE  MATH INPUT



Input

$\exp\left(\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\right)$ (matrix exponential)

Result

$\begin{pmatrix} \cos(1) & \sin(1) \\ -\sin(1) & \cos(1) \end{pmatrix}$

MatrixExp(t{{0,1},{-1,0}})

 NATURAL LANGUAGE  MATH INPUT

Input



$\exp\left(t \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\right)$

Exact result

$\{\{1, e^t\}, \{e^{-t}, 1\}\}$

$\begin{pmatrix} 1 & e^t \\ e^{-t} & 1 \end{pmatrix}$

MatrixExp({t{0,1},t{-1,0}})

 NATURAL LANGUAGE  MATH INPUT

Input

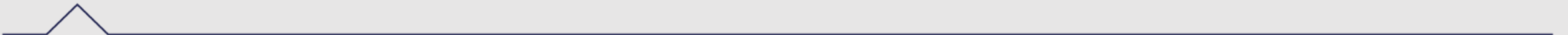
$\exp(\{t \{0, 1\}, t \{-1, 0\}\})$ (matrix e

Result

$\begin{pmatrix} \cos(t) & \sin(t) \\ -\sin(t) & \cos(t) \end{pmatrix}$

Outlook

- Transferrable Skills
 1. Mathematical Understanding
 2. Checking & Reflection
 3. Coding
 4. Typesetting (uses the same syntax as Latex)
- Encourages investigation
- Responsible approach needed





PRIFYSGOL

ABERYSTWYTH
UNIVERSITY