

FOURIER SERIES: BUILDING BLOCKS

YU / HUGHES

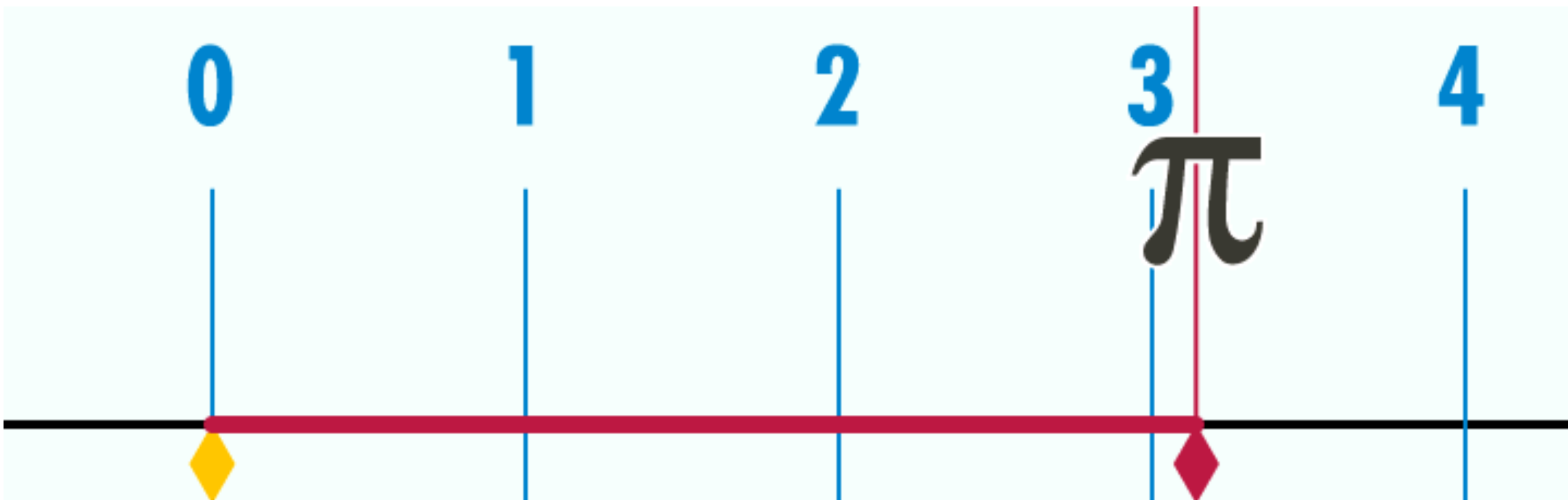
SEPTEMBER 14-16, 20-21



UMASS
AMHERST

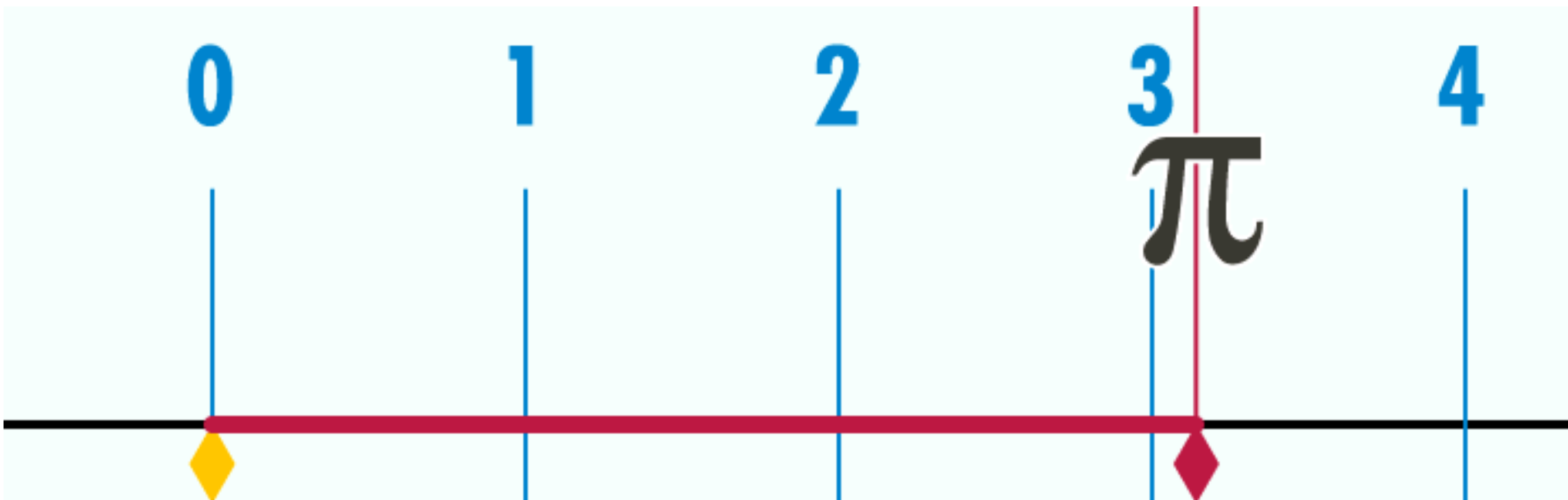
COOL TRIGONOMETRIC ANIMATED GIFS

WHAT IS PI?



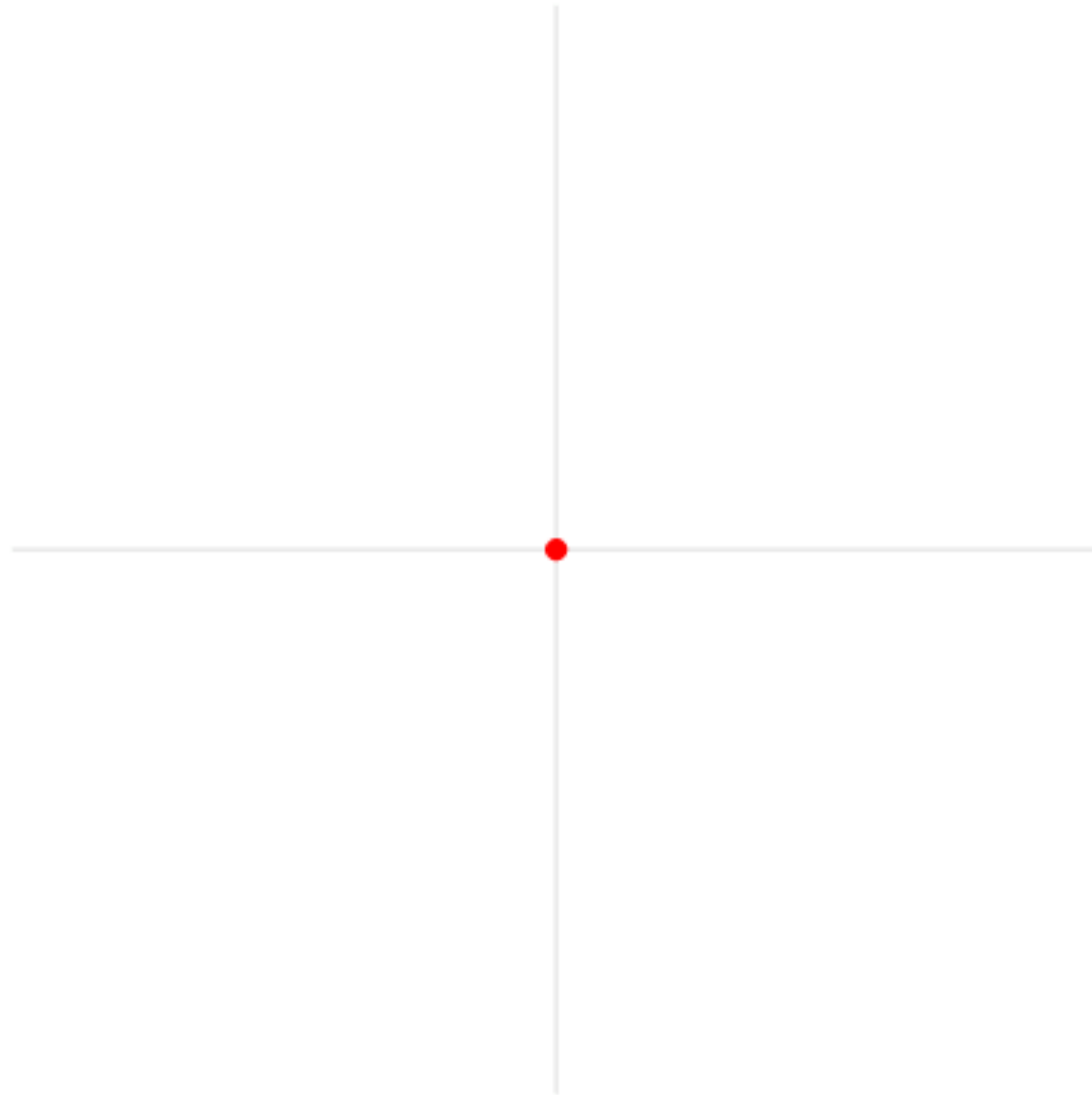
<https://upload.wikimedia.org/wikipedia/commons/2/2a/Pi-unrolled-720.gif>

WHAT IS PI?



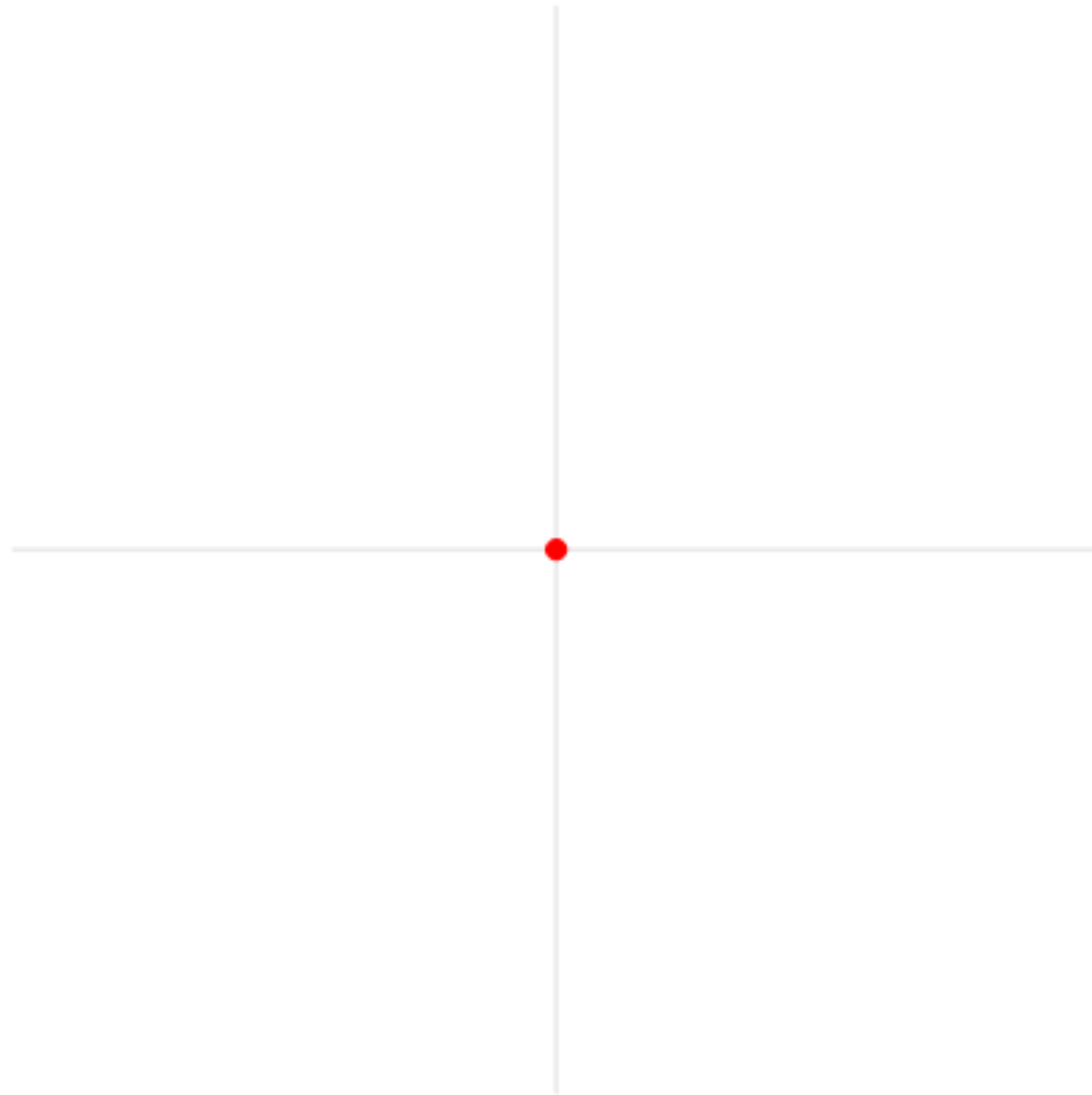
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ANGULAR FREQUENCY AND RADIANS



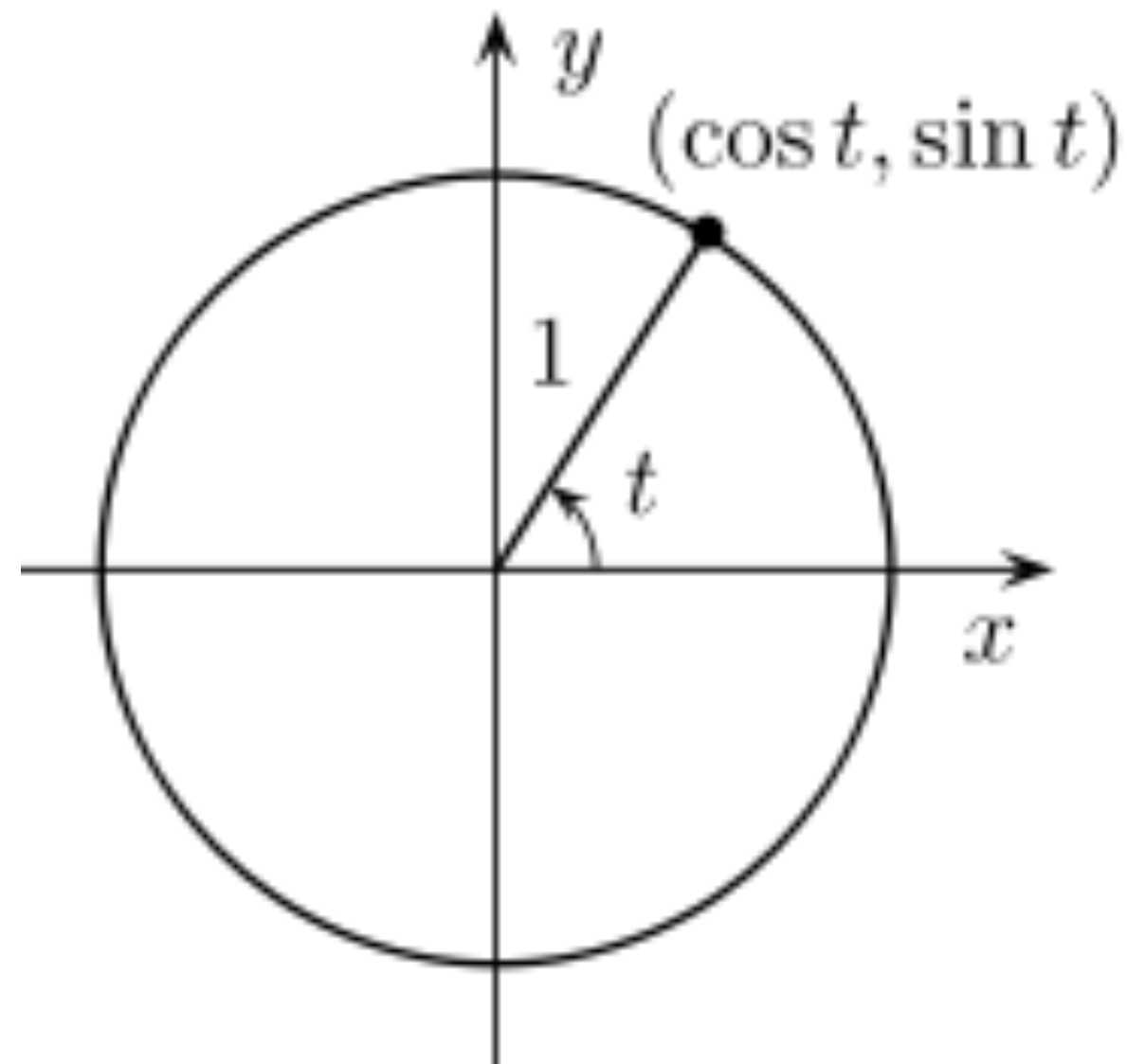
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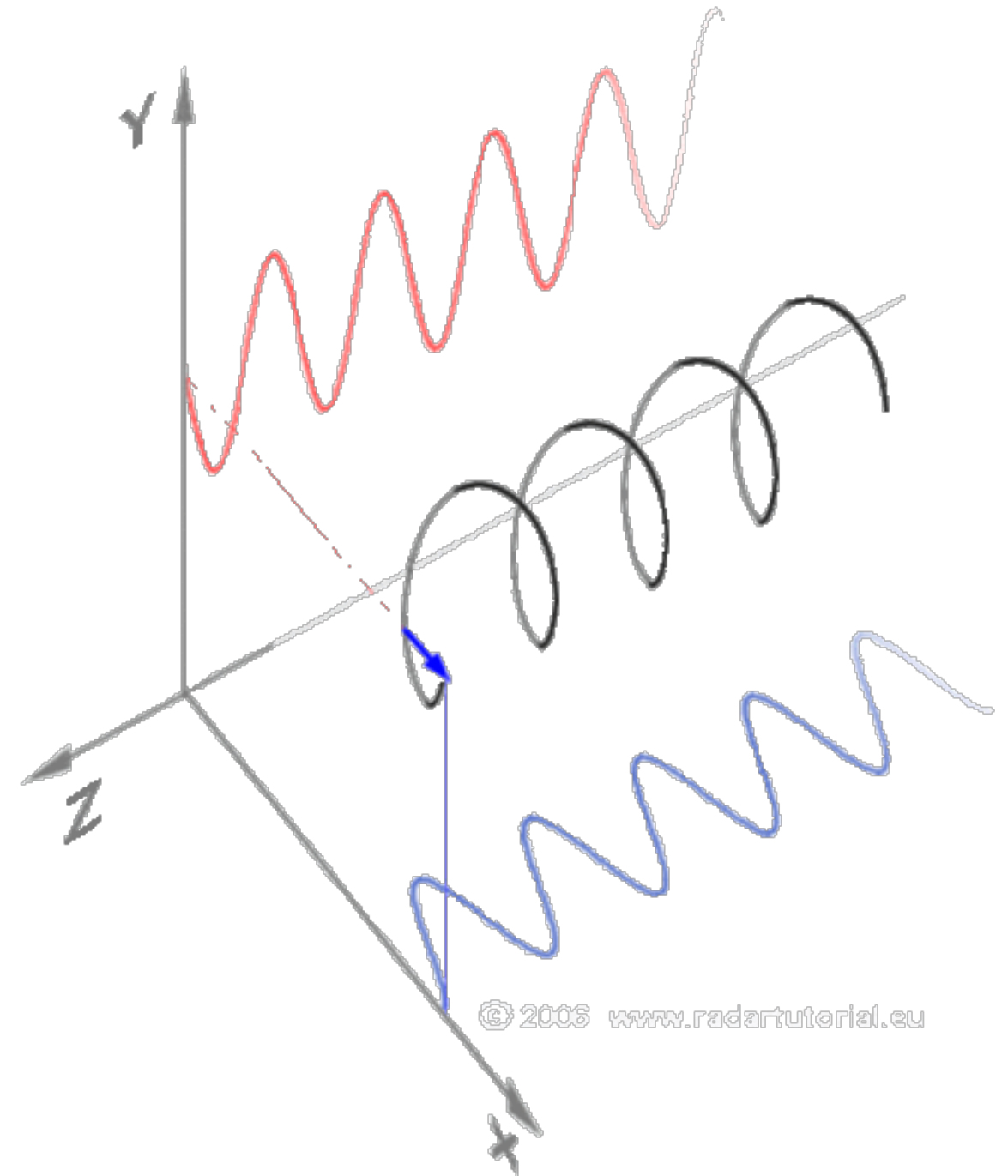
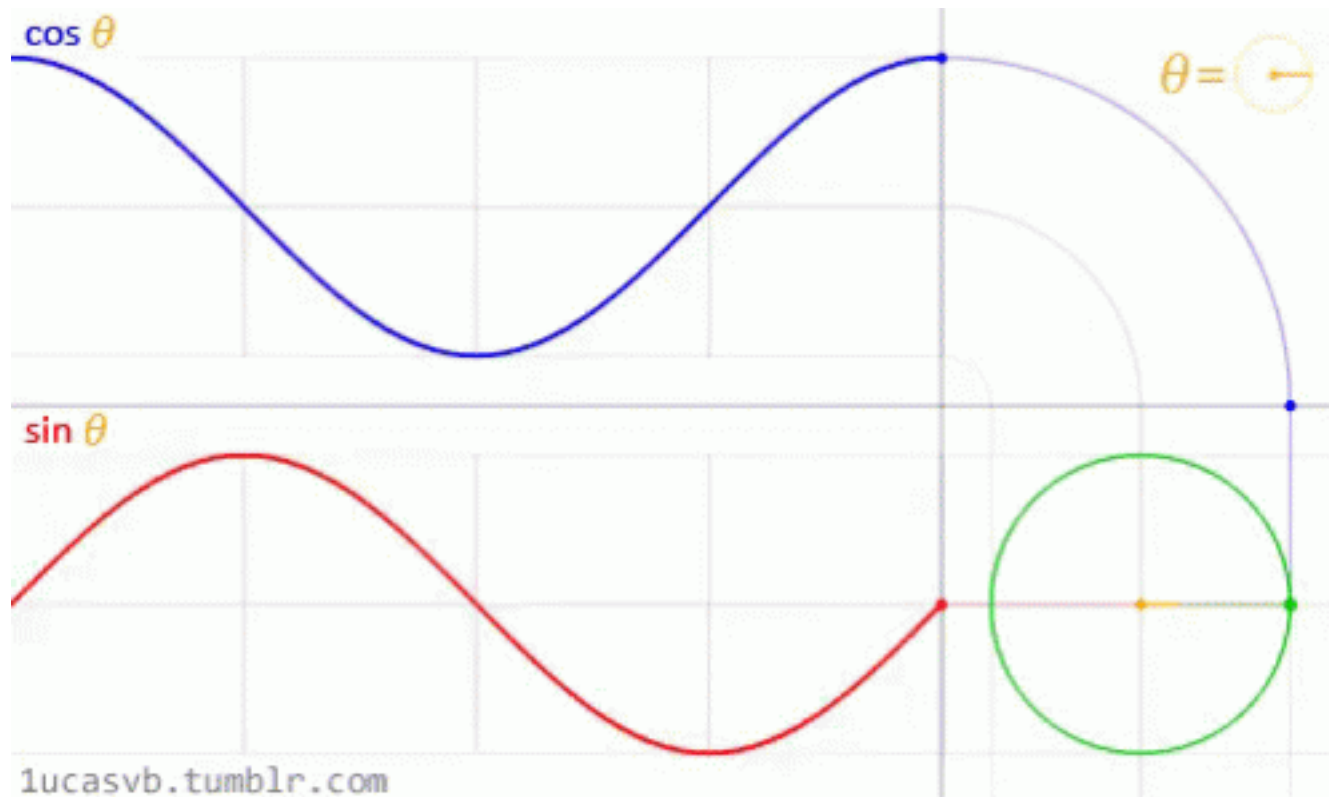
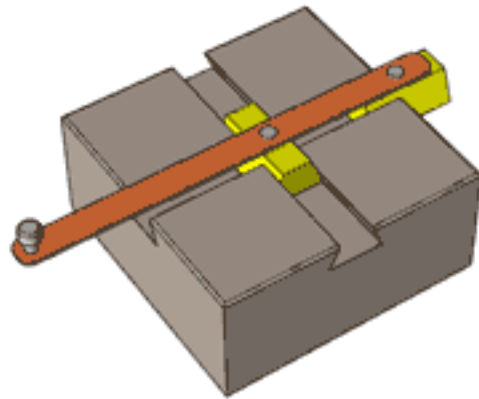


https://upload.wikimedia.org/wikipedia/commons/4/4e/Circle_radians.gif

SINE, COSINE, AND THE UNIT CIRCLE

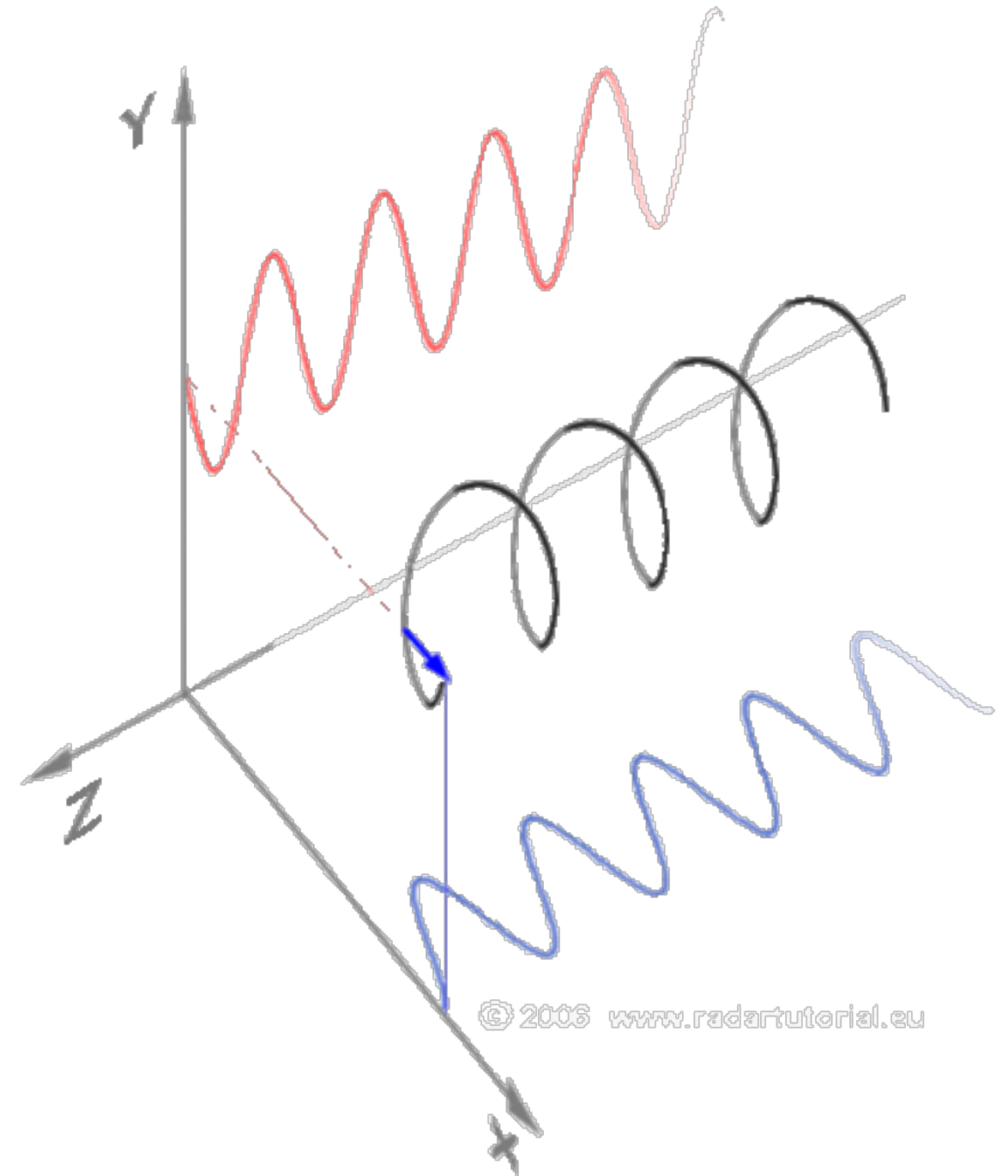
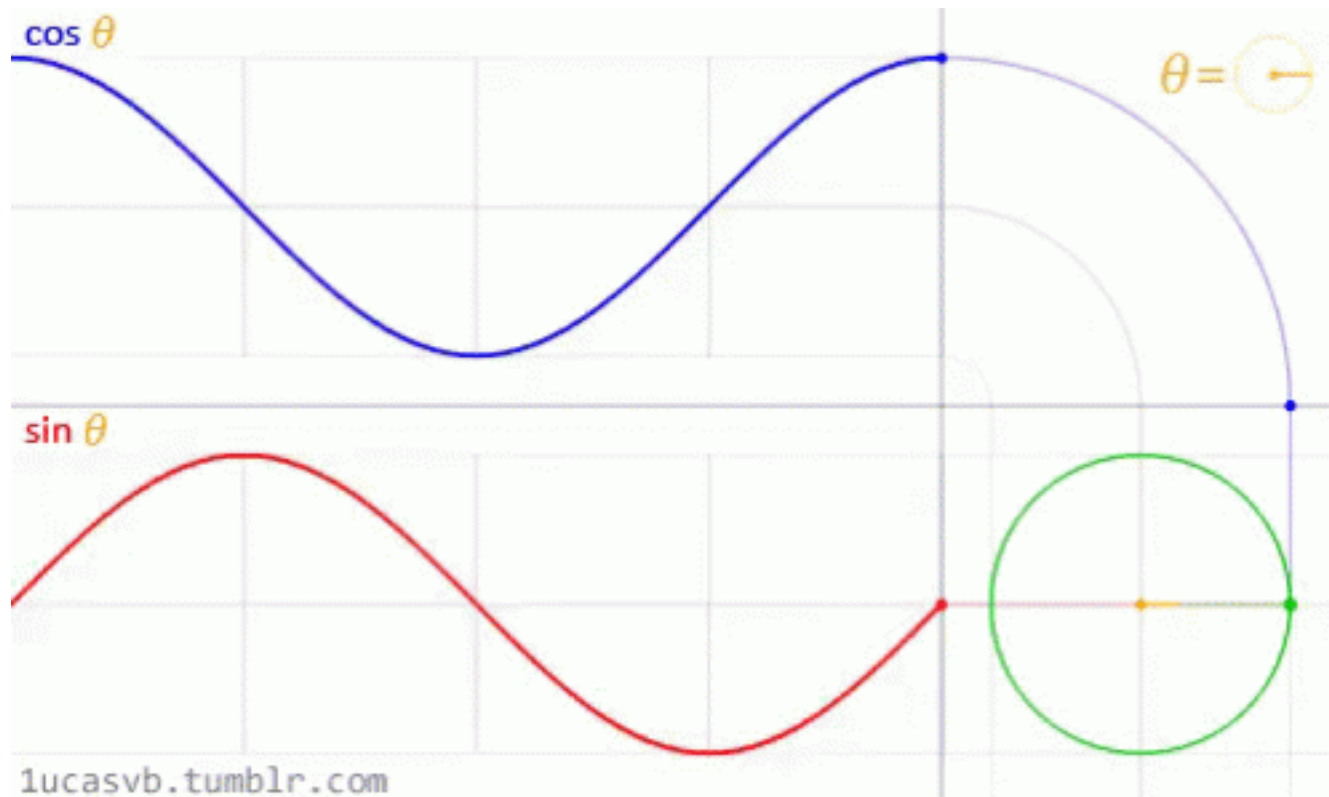
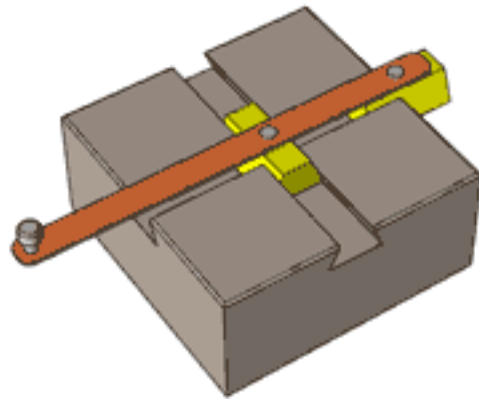


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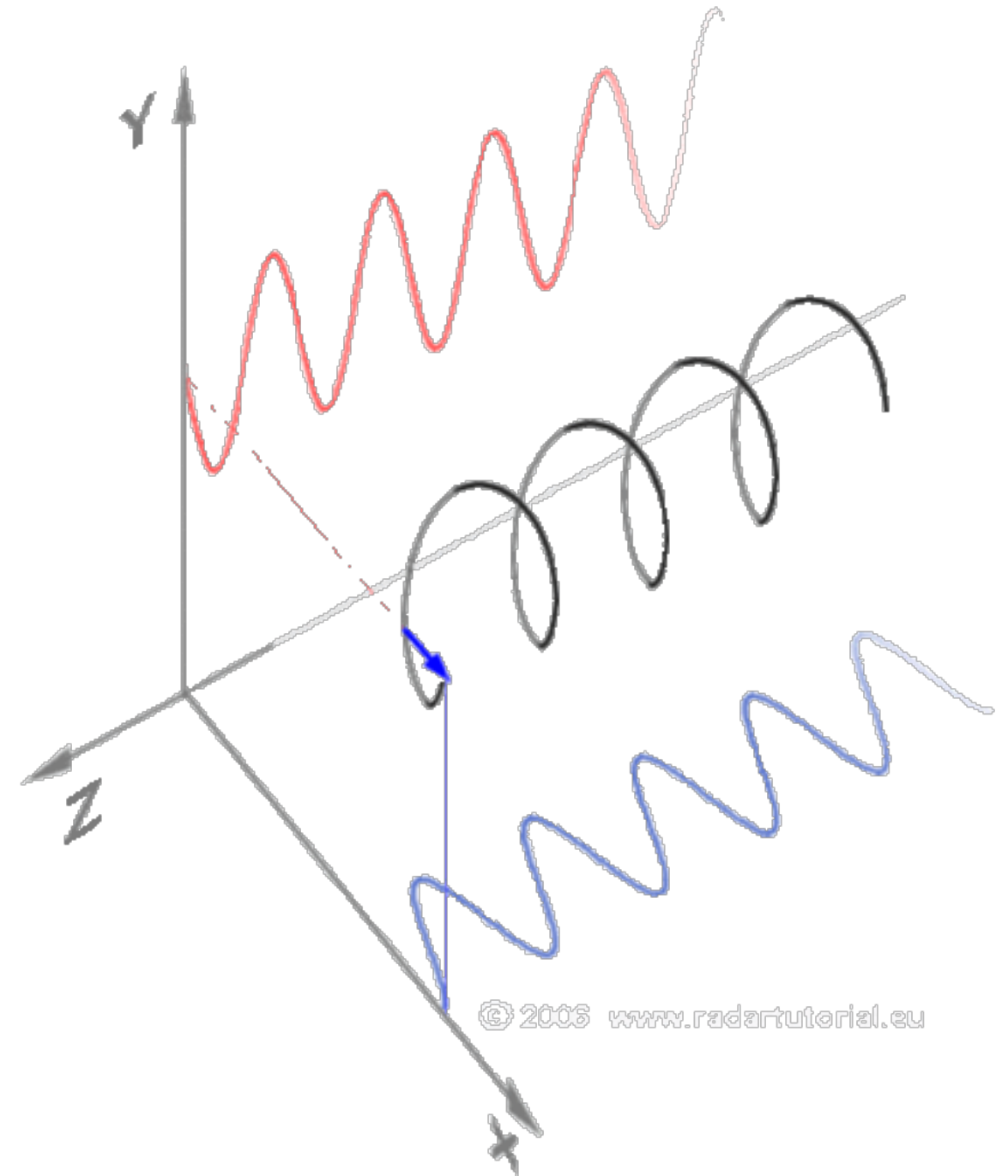
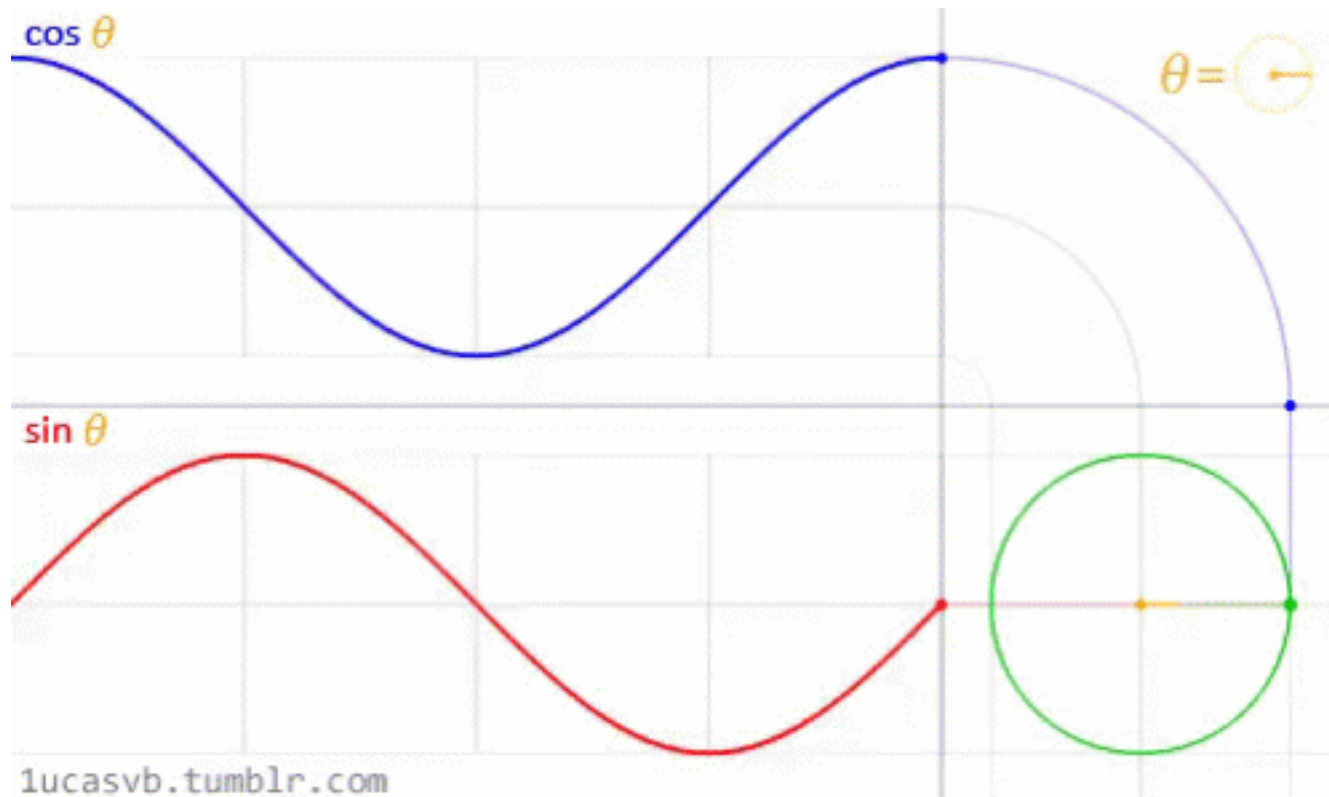
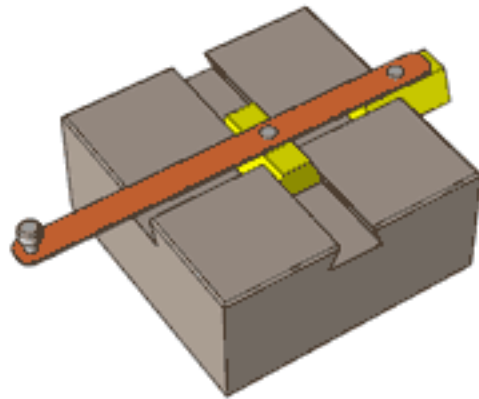
<http://www.businessinsider.com/7-gifs-trigonometry-sine-cosine-2013-5>
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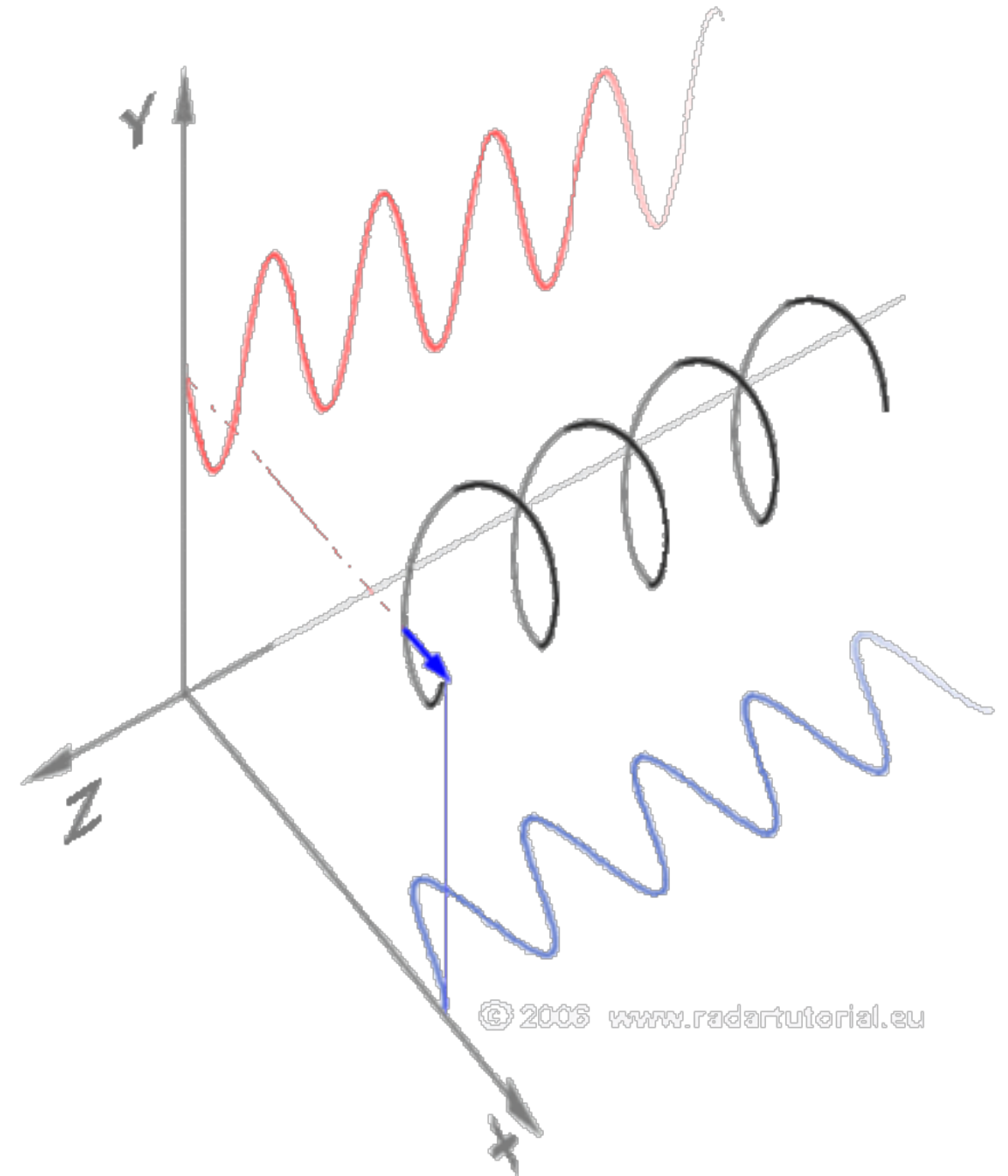
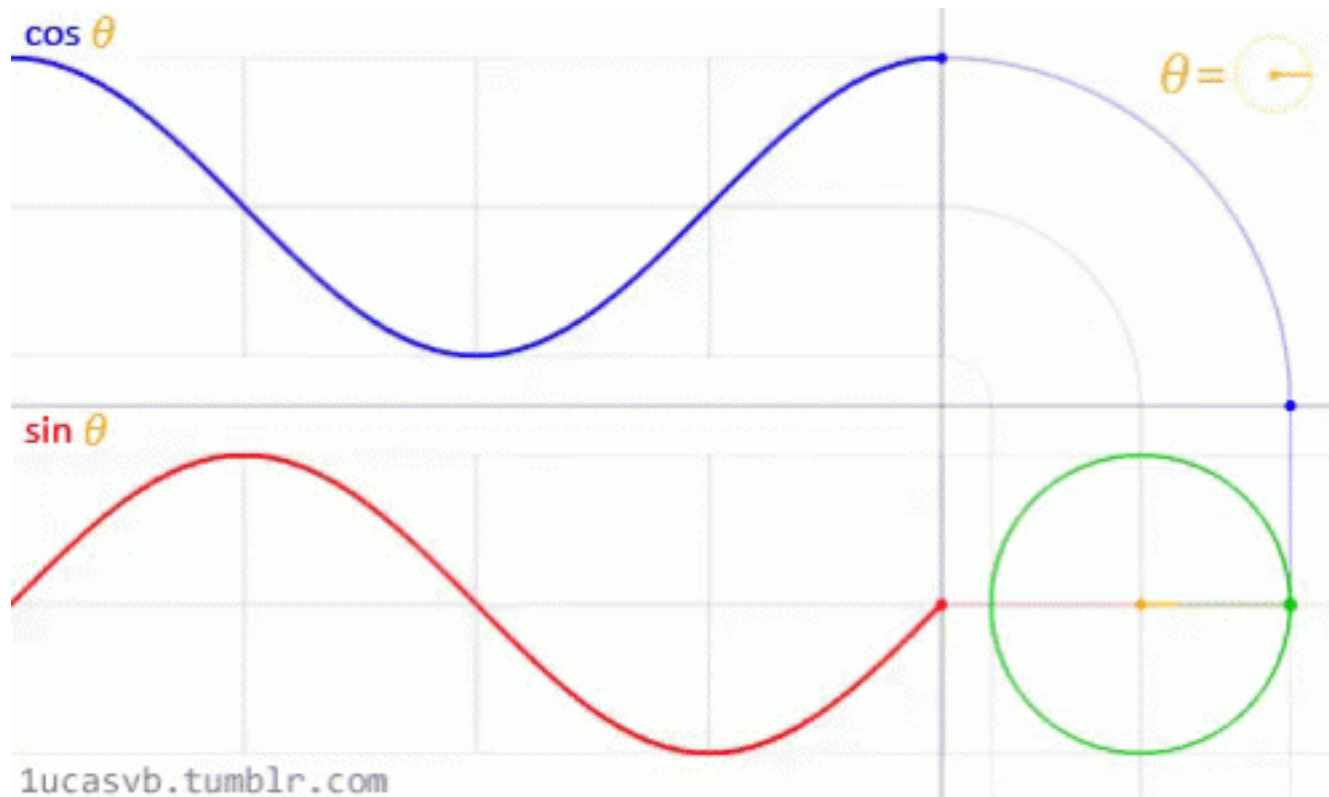
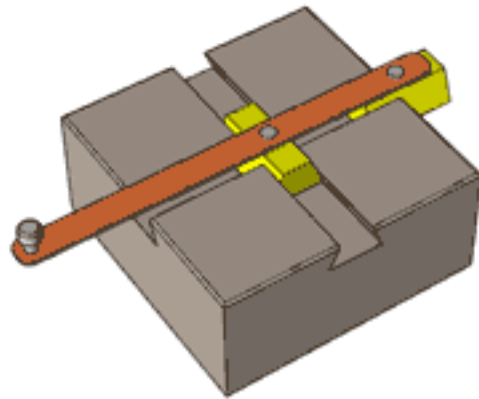
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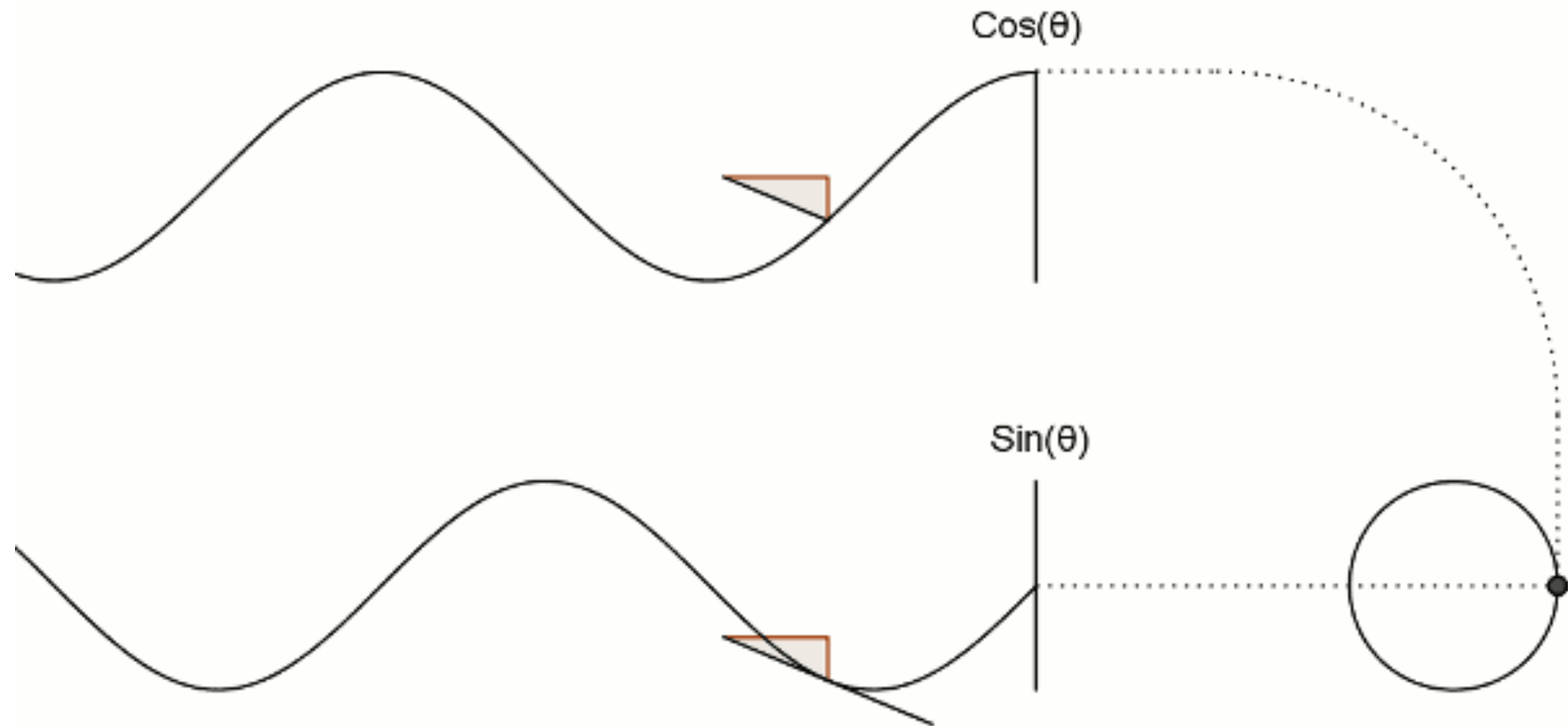
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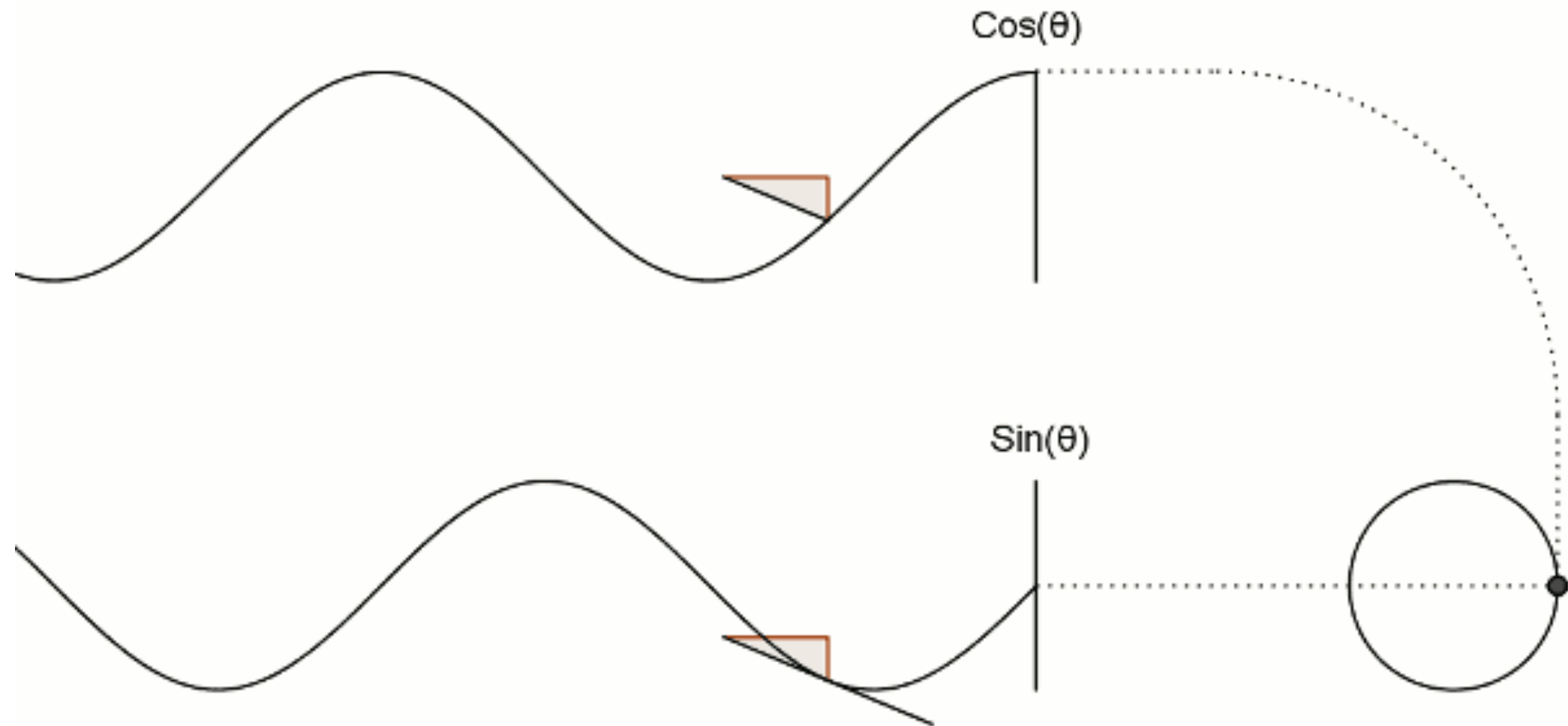


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SINUSOIDS, CIRCLES, AND TRIANGLES



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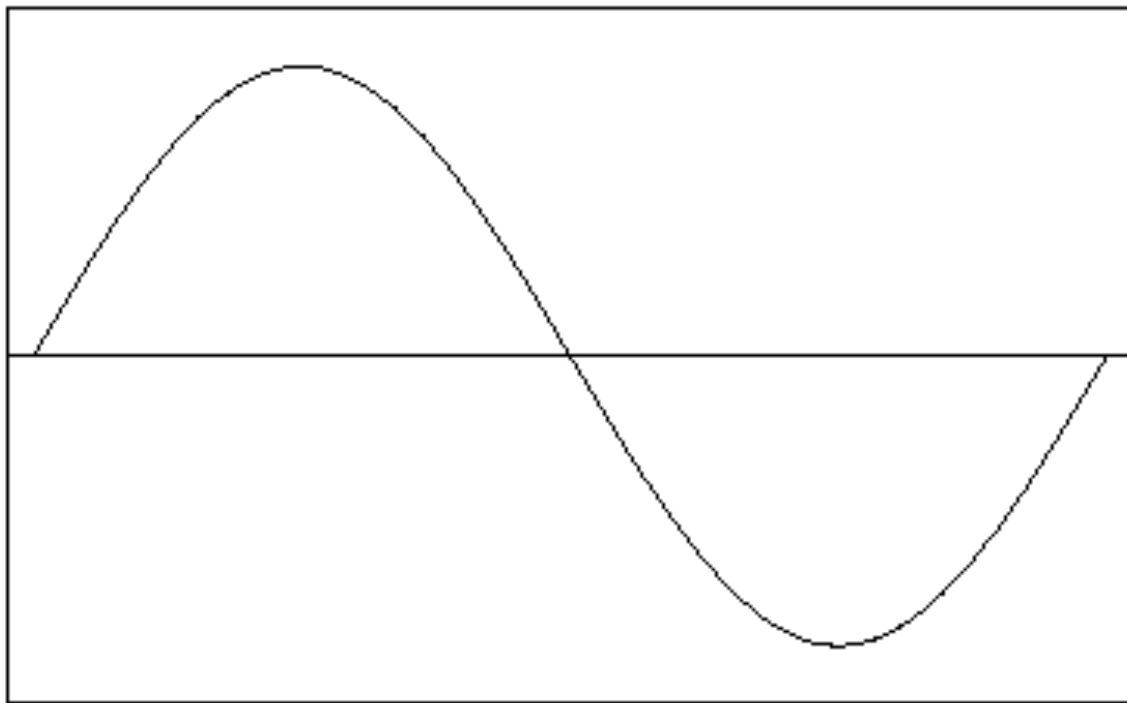


FOURIER SERIES

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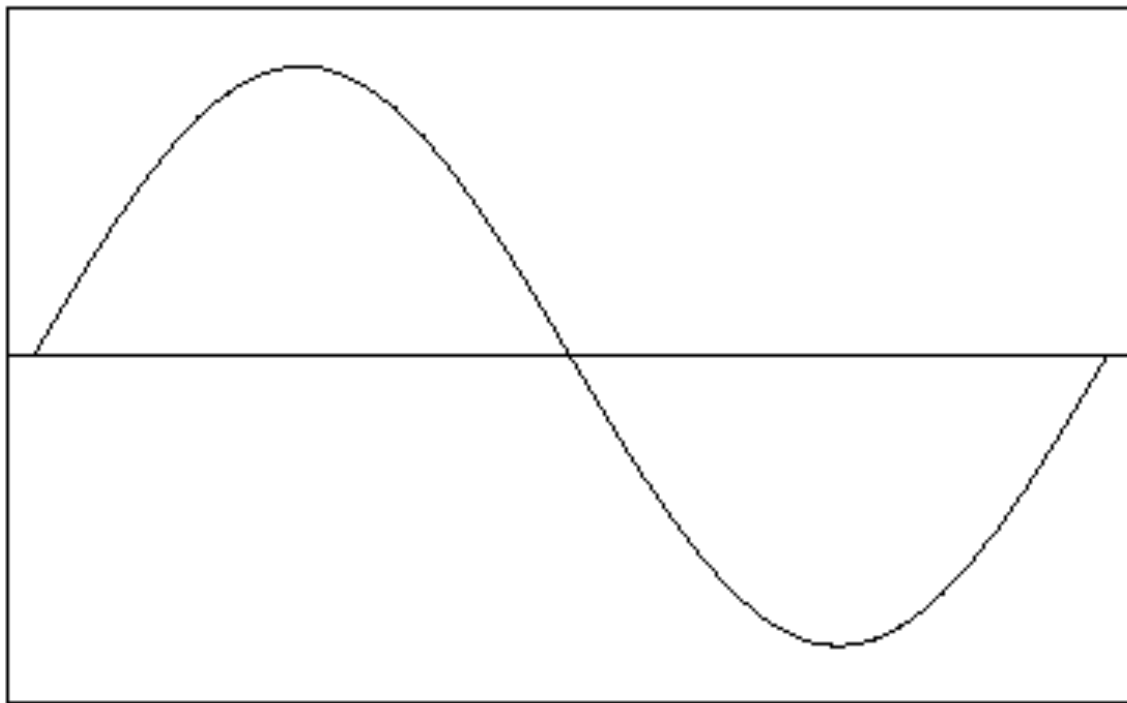
**Read “Who is Fourier” Ch. 1 and 2
for a review! (See slack for link)**

FOURIER SERIES OF A SQUARE WAVE



<https://sites.google.com/a/georgiasouthern.edu/julia-inozemtseva/teaching-math-animations-and-pics?tmpl=%2Fsystem%2Fapp%2Ftemplates%2Fprint%2F&showPrintDialog=1#TOC-Fourier-Series>

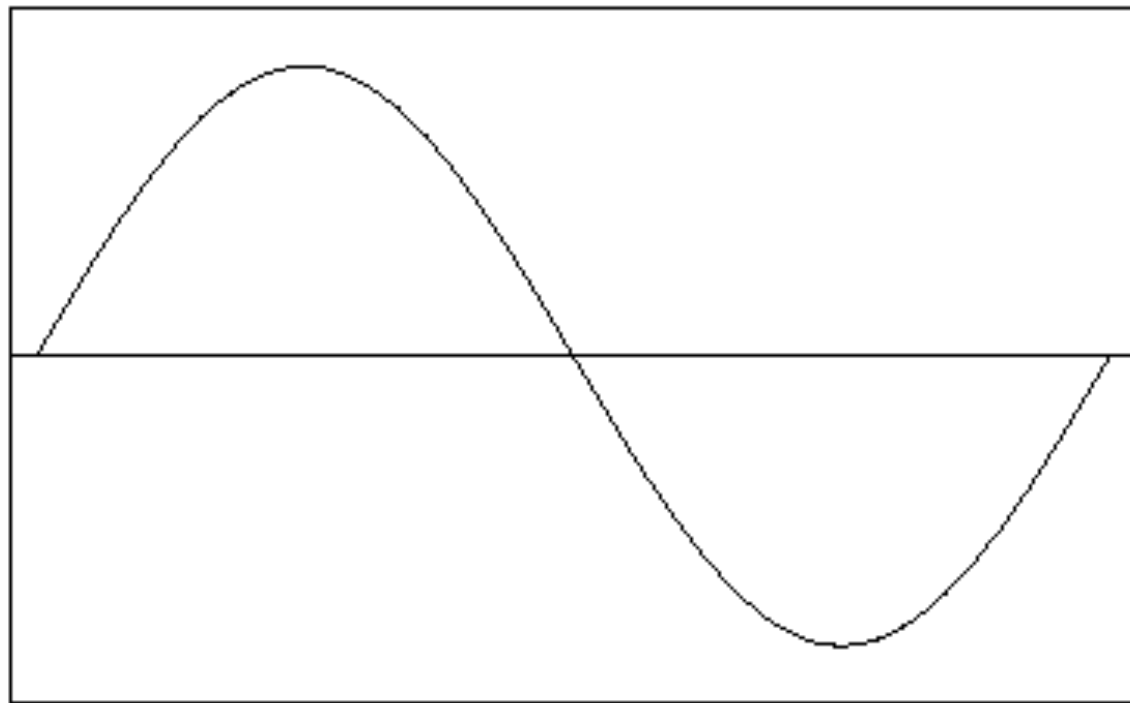
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And preview of spectrum!

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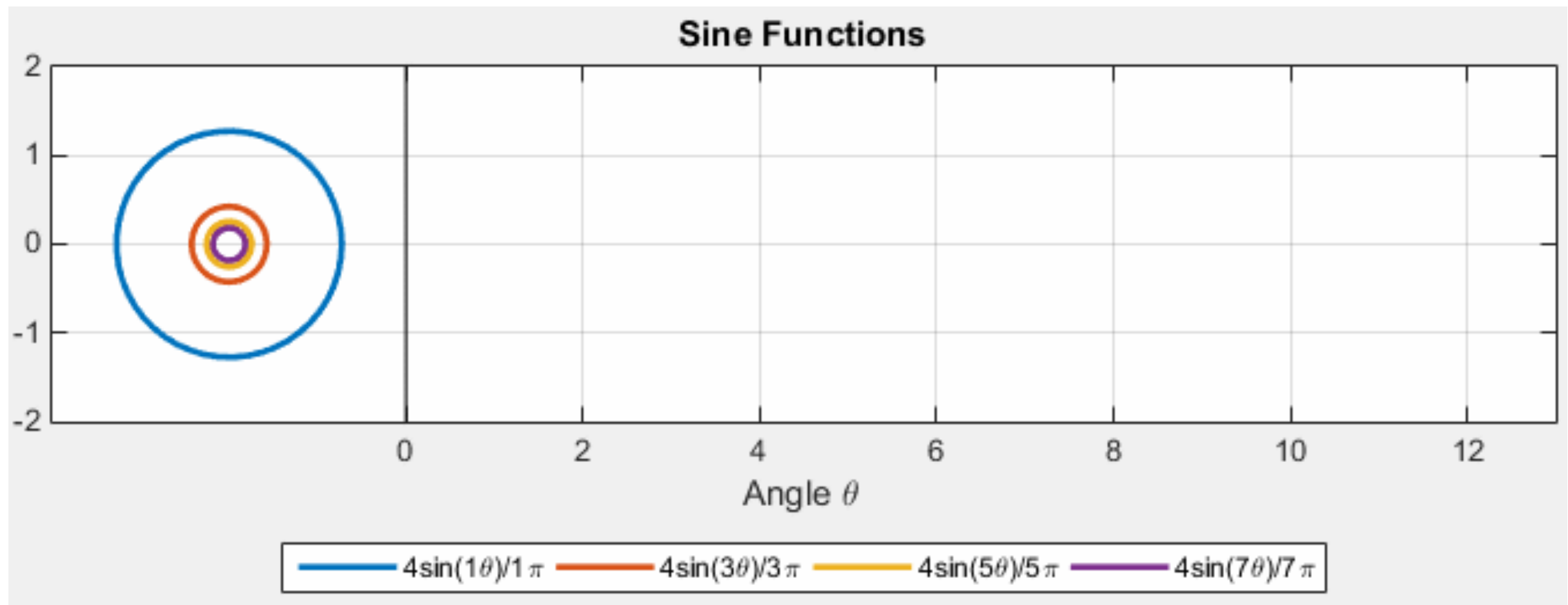


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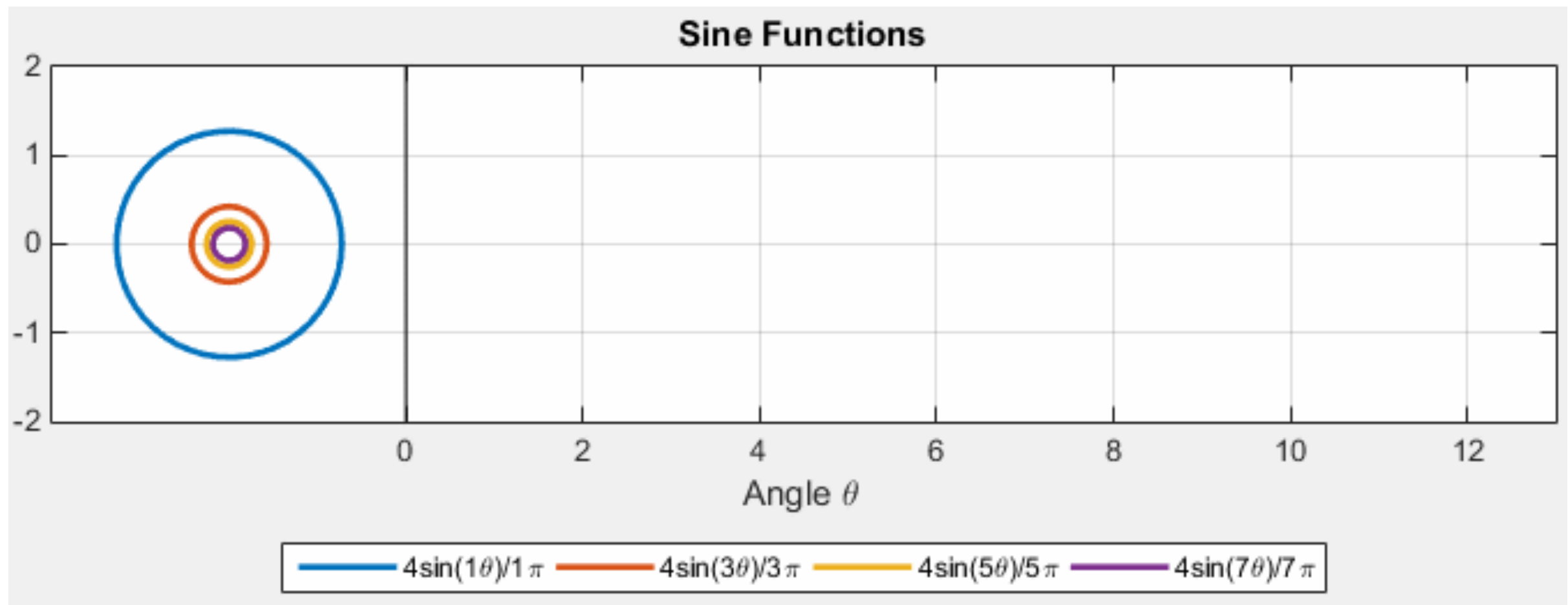


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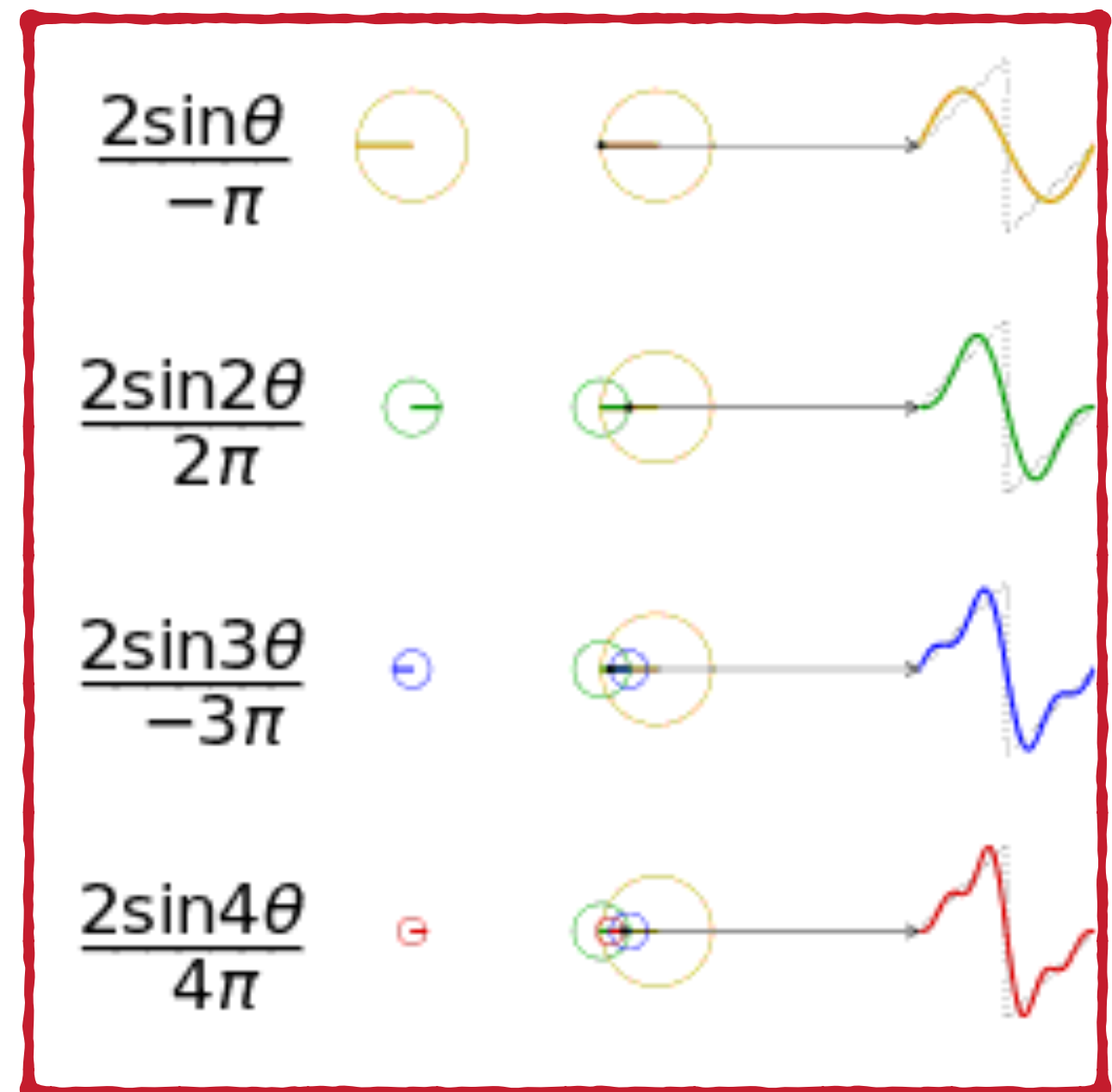
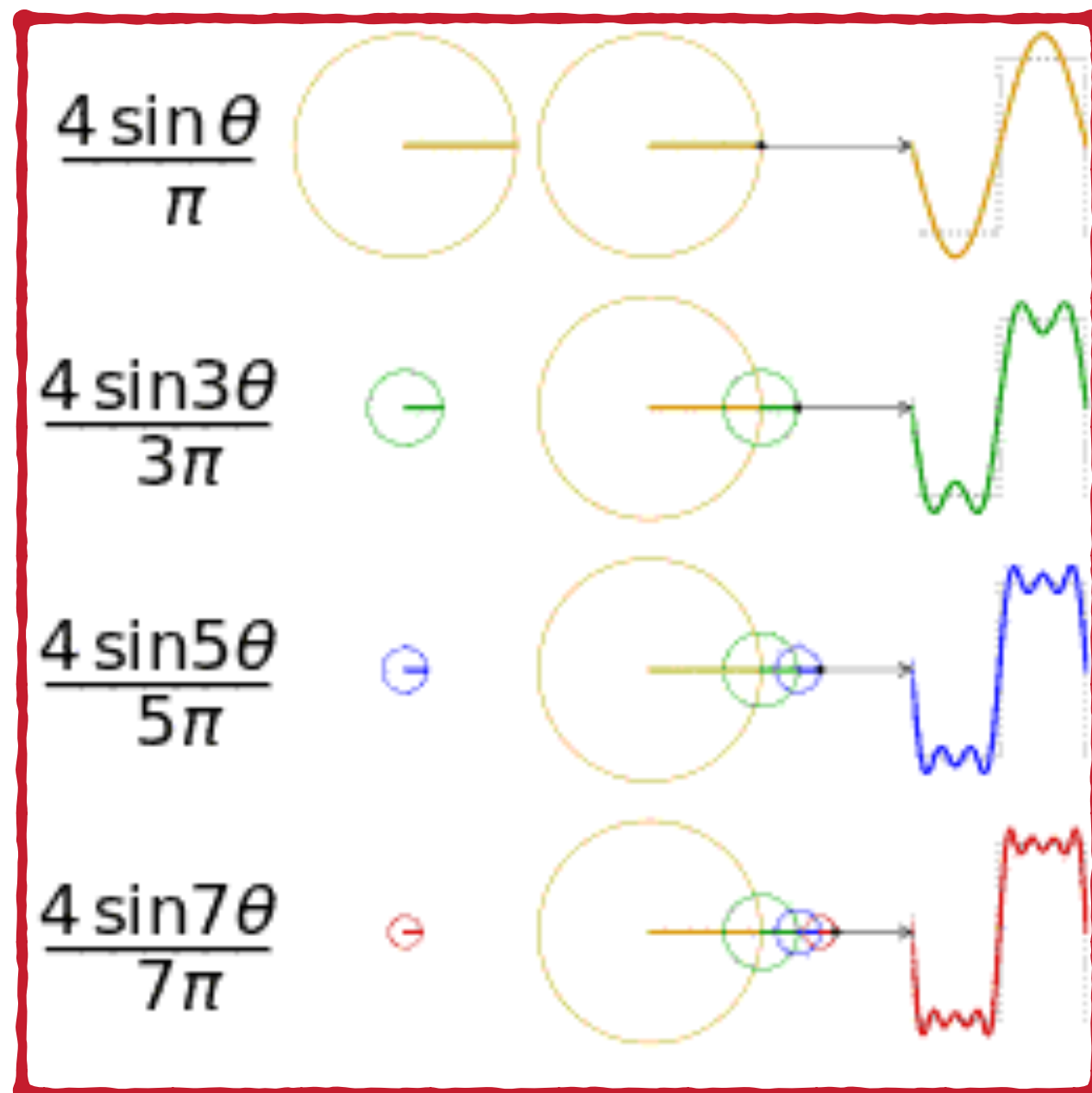
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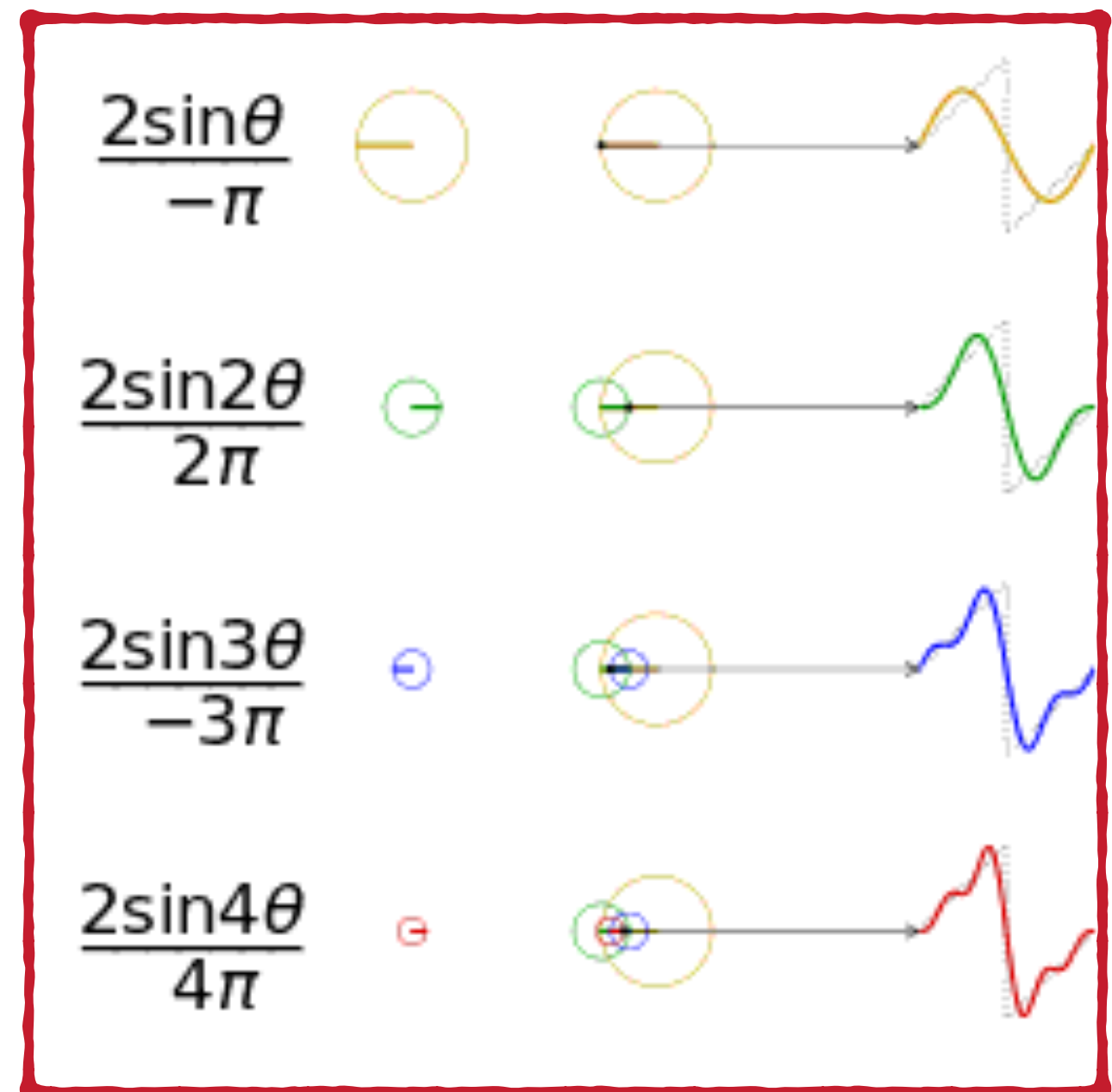
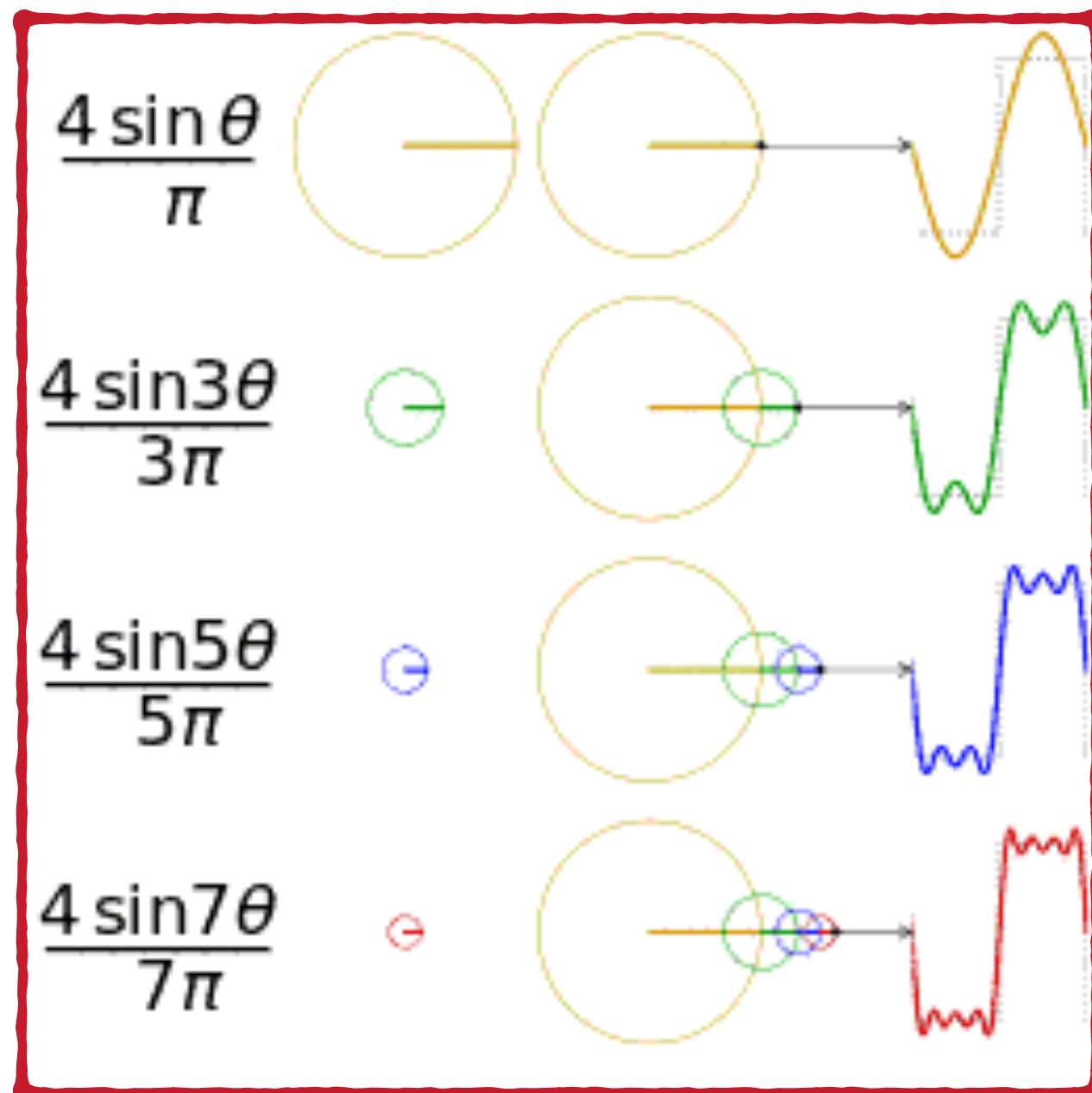


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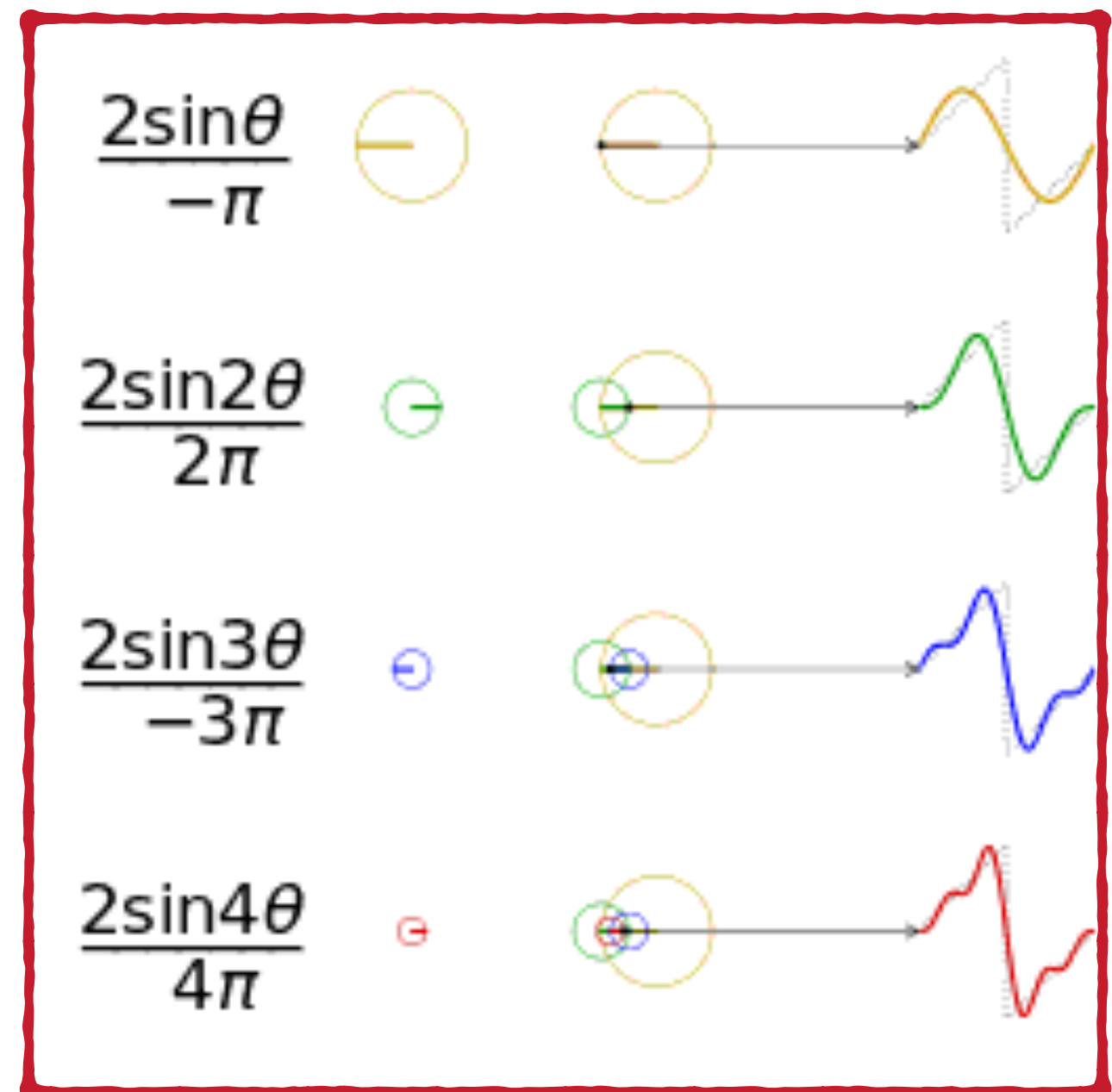
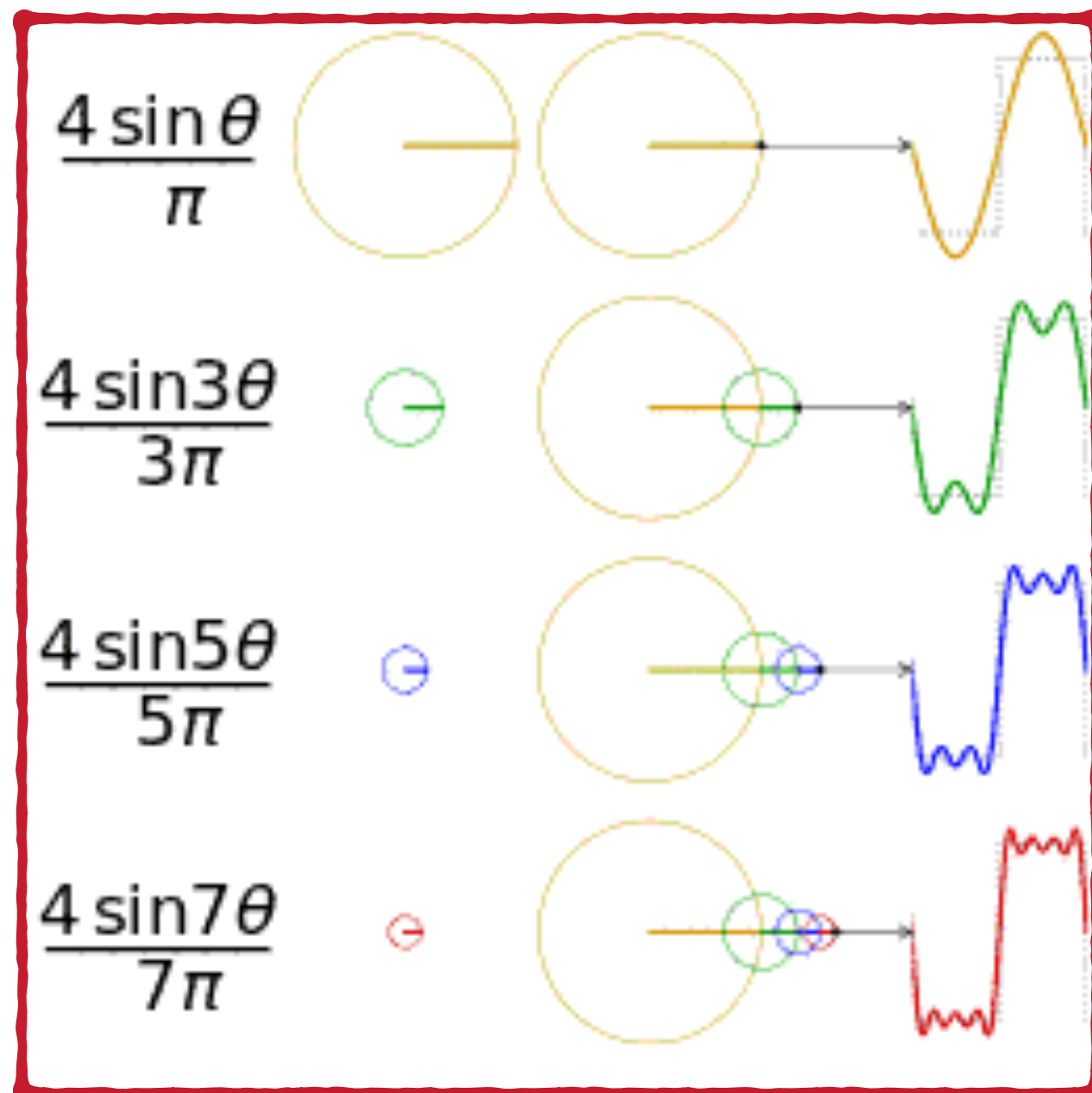
FOURIER SERIES: SQUARE/SAWTOOTH WAVES



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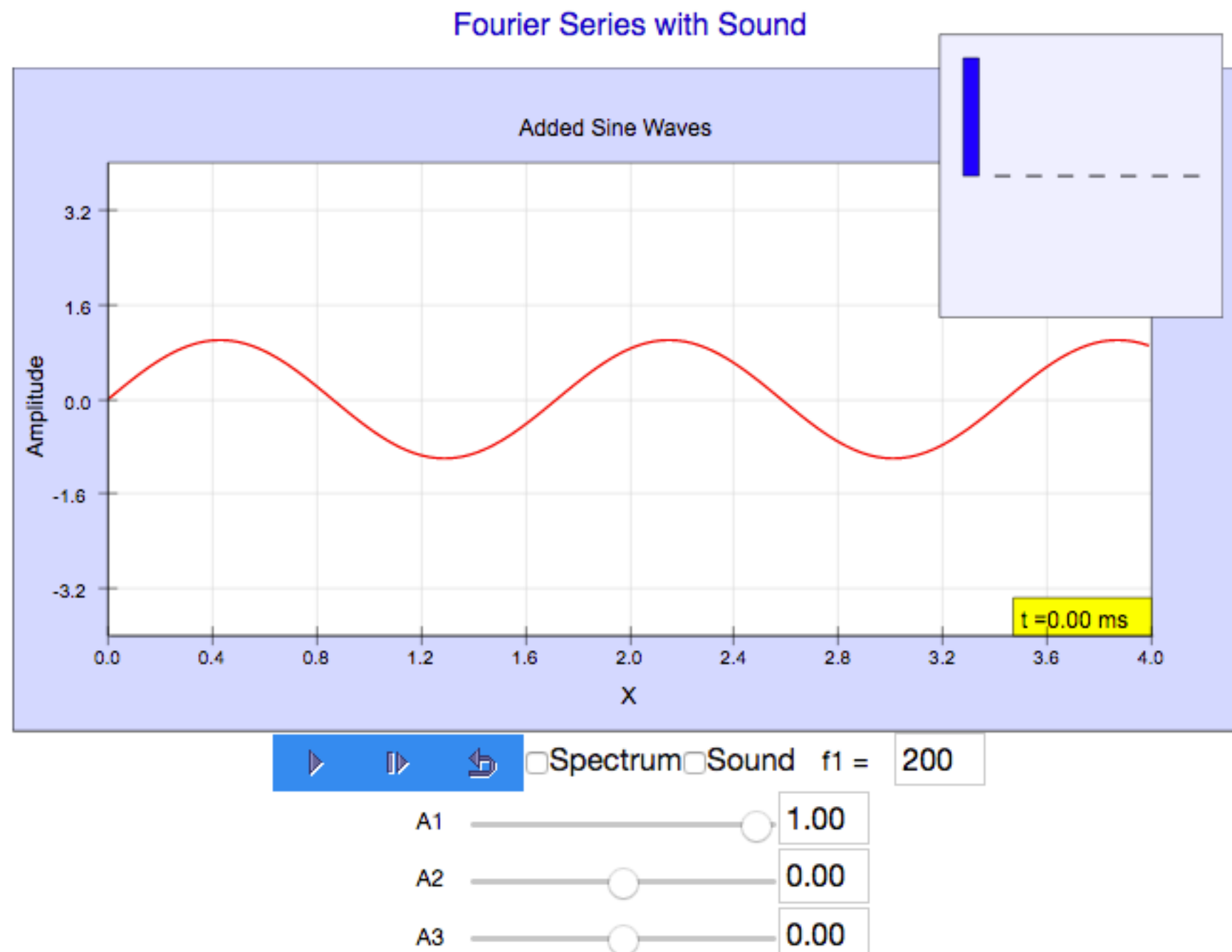


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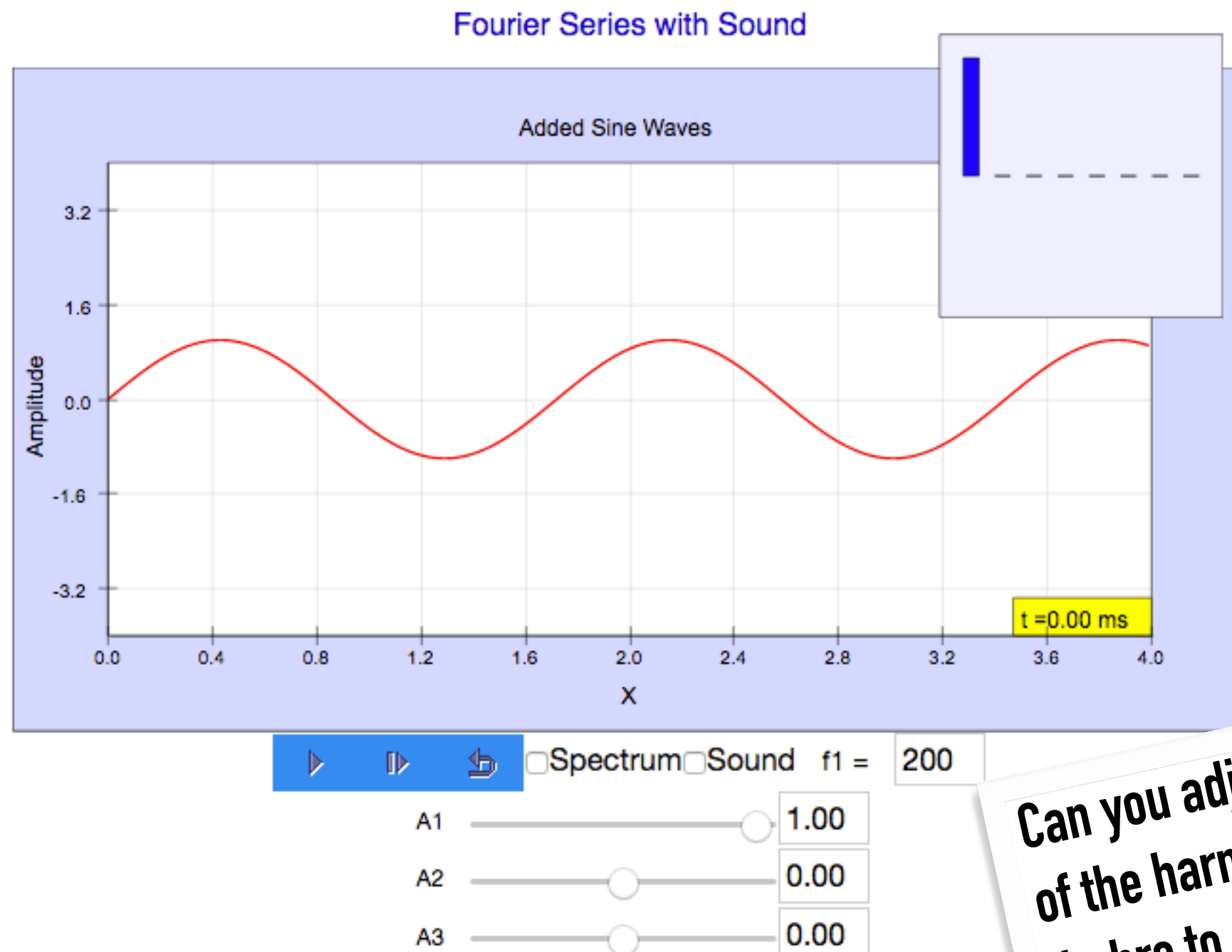
COMPLEX WAVES: REVIEW

EXERCISE: SOUND OF ADDING IN HARMONICS



https://soundphysics.ius.edu/?page_id=949

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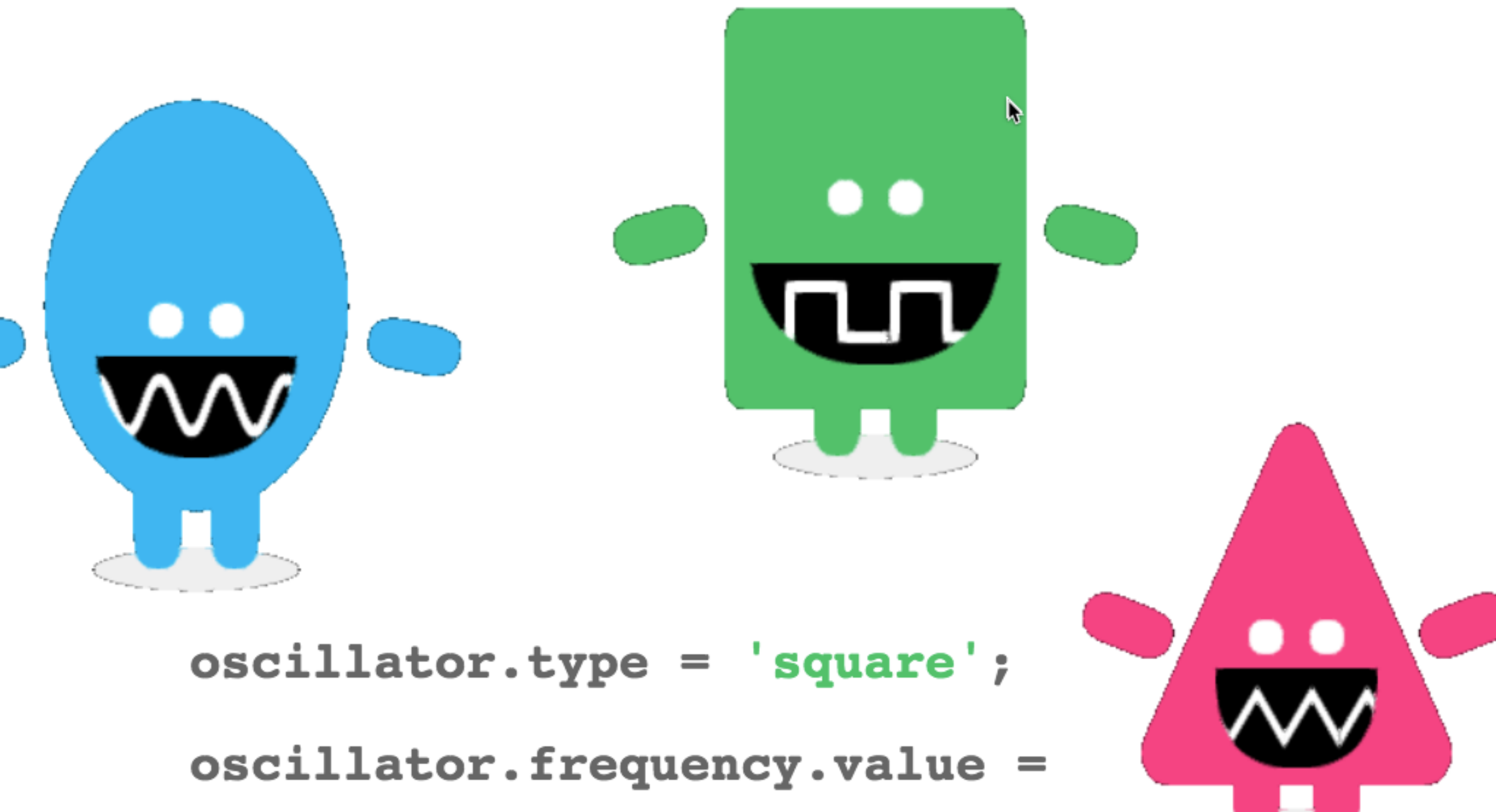


Can you adjust the amplitudes of the harmonics to get the timbre to sound like some instrument you like?

https://soundphysics.ius.edu/?page_id=949

DEMO: COMPLEX WAVES

<https://musiclab.chromeexperiments.com/Oscillators>



```
oscillator.type = 'square';  
oscillator.frequency.value =
```

BUILDING UP A SQUARE WAVE WITH SINES



$N = 0$

BUILDING UP A SQUARE WAVE WITH SINES



$N = 0$

BUILDING UP A SQUARE WAVE



BUILDING UP A SQUARE WAVE



TWO REPRESENTATIONS OF SQUARE WAVE



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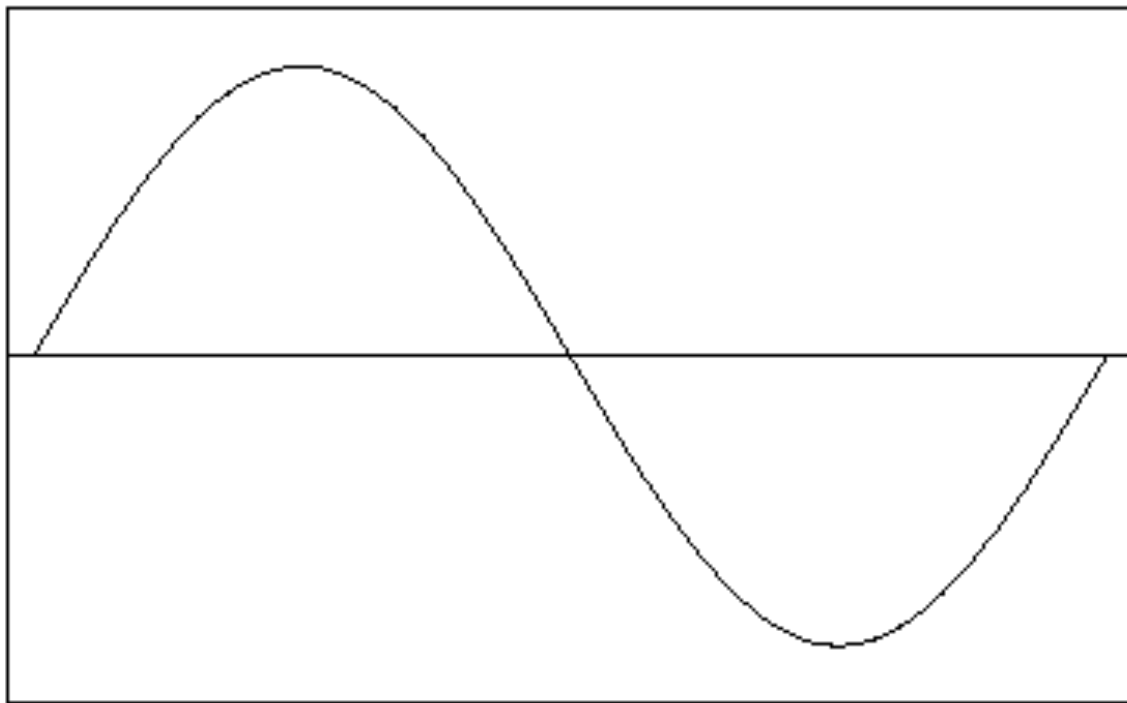


**Time domain:
waveform**

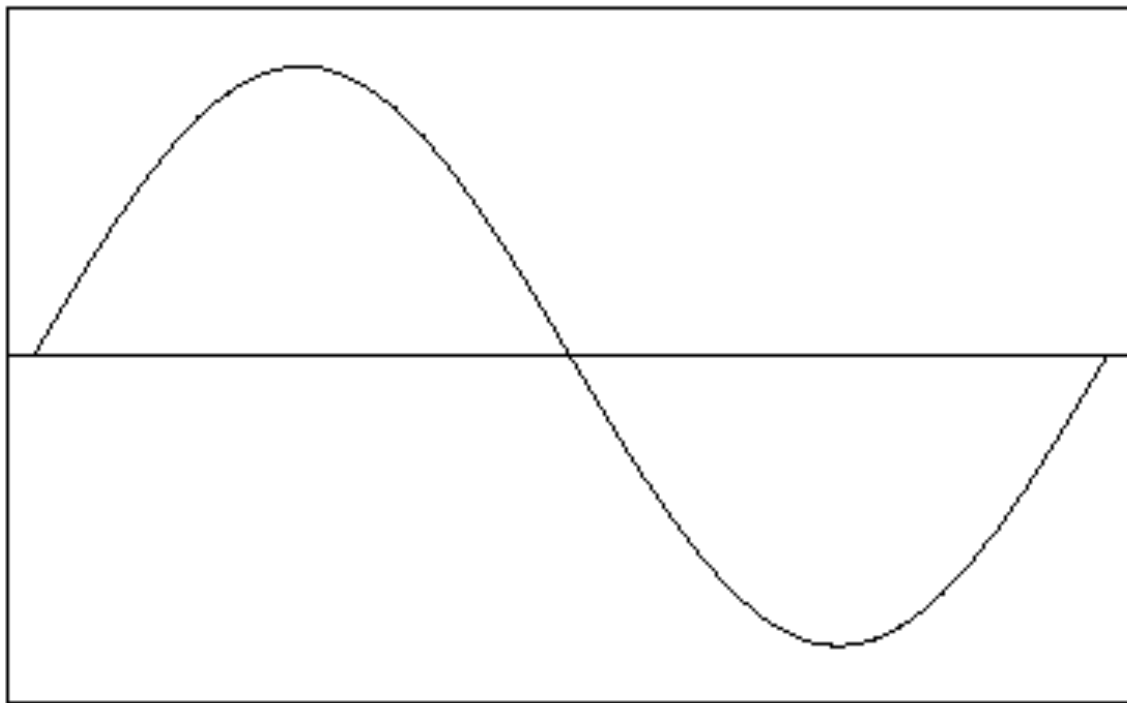


**Frequency domain:
spectrum**

HARMONIC AMPLITUDES



HARMONIC AMPLITUDES



BUILDING UP A TRIANGLE WAVE WITH SINES



$N = 0$

BUILDING UP A TRIANGLE WAVE WITH SINES



$N = 0$

FOURIER SERIES IN PYTHON