ERGs

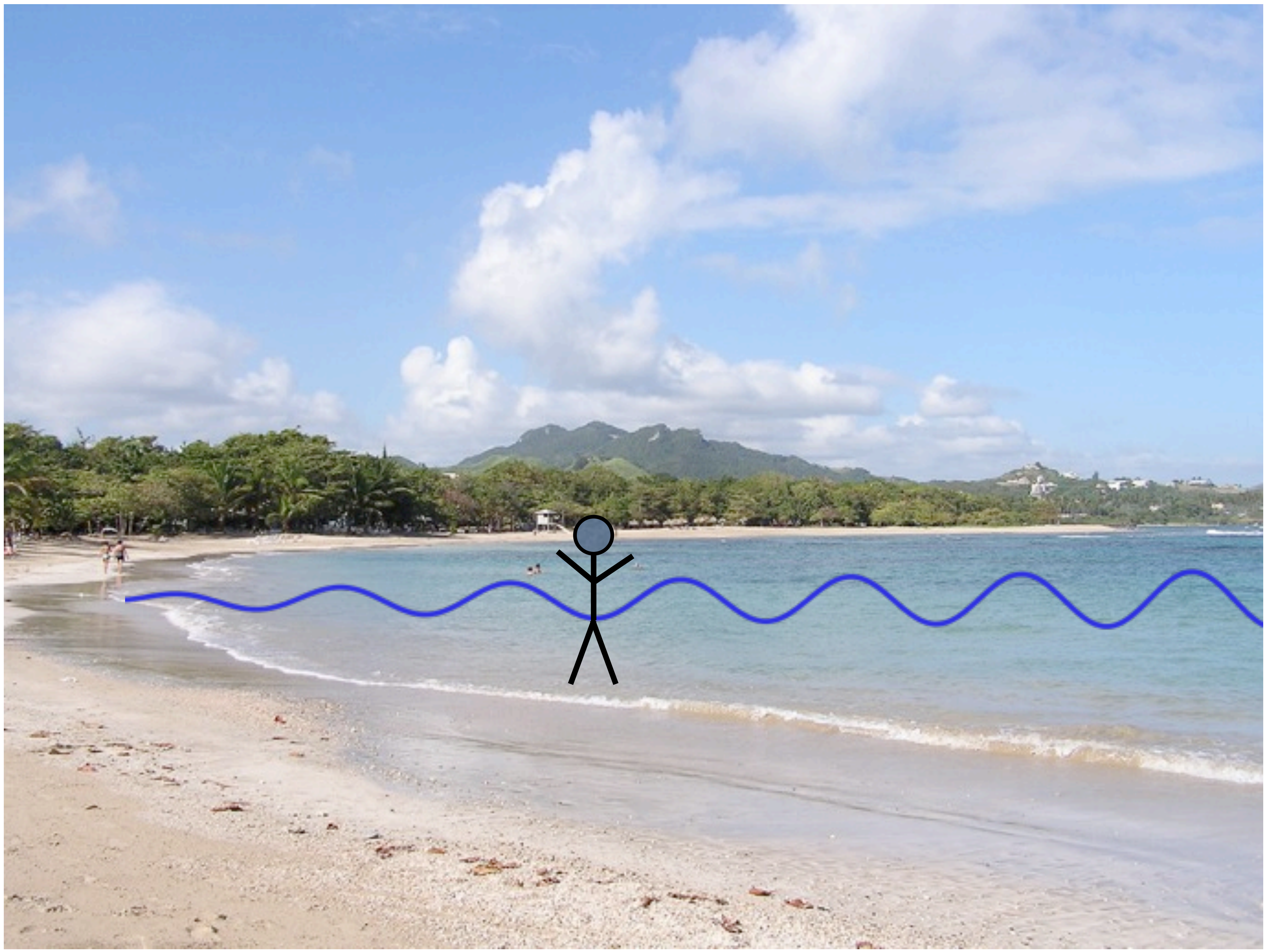
PART 1

Summary

- Hello, I'm a wave
- The unit circle and the Pythagorean theorem
- The sine wave
- Period and frequency
- The Phase Angle
- The Harmonics
- Building a square wave
- The Spectrum

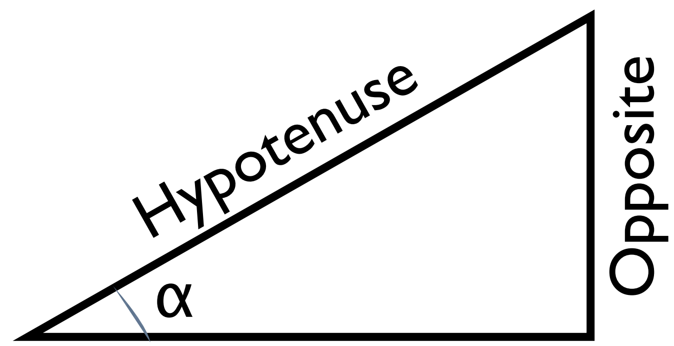
Hello, I'm a wave

Hello, I'm a wave

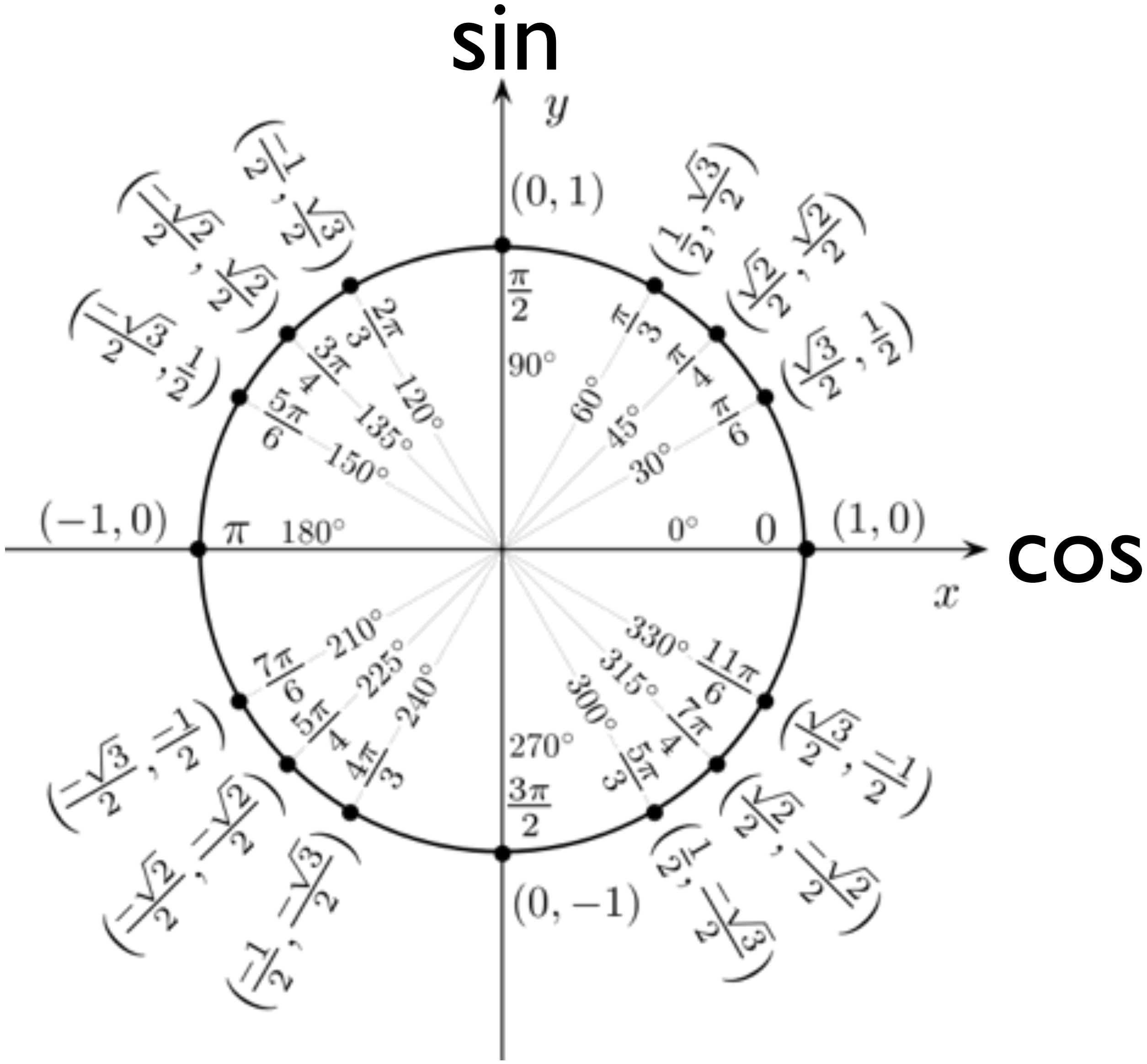


The unit circle

and the Pythagorean theorem



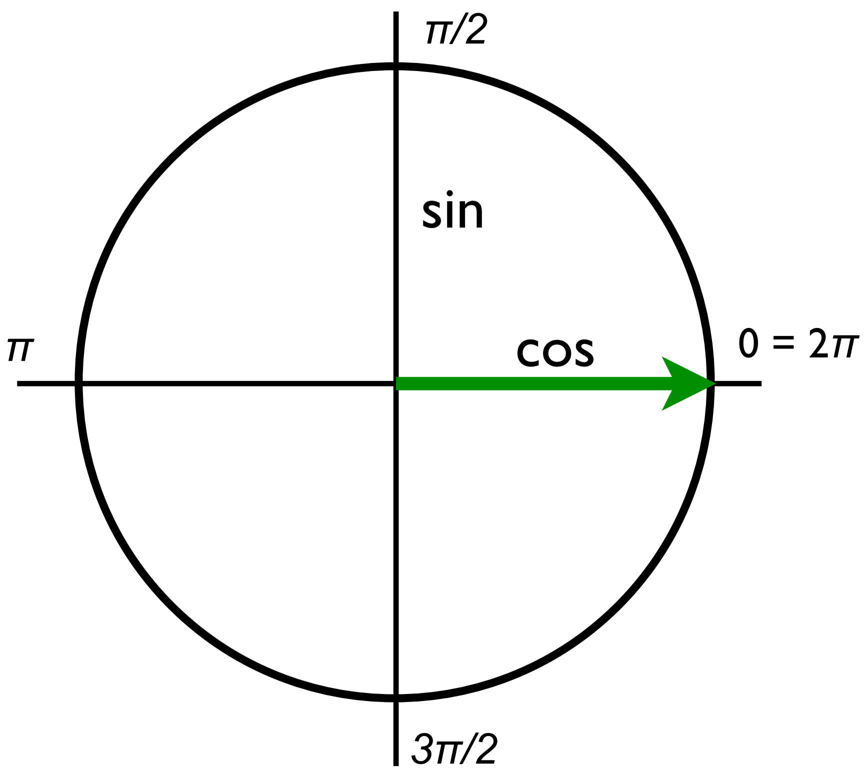
$$\sin(\alpha) = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

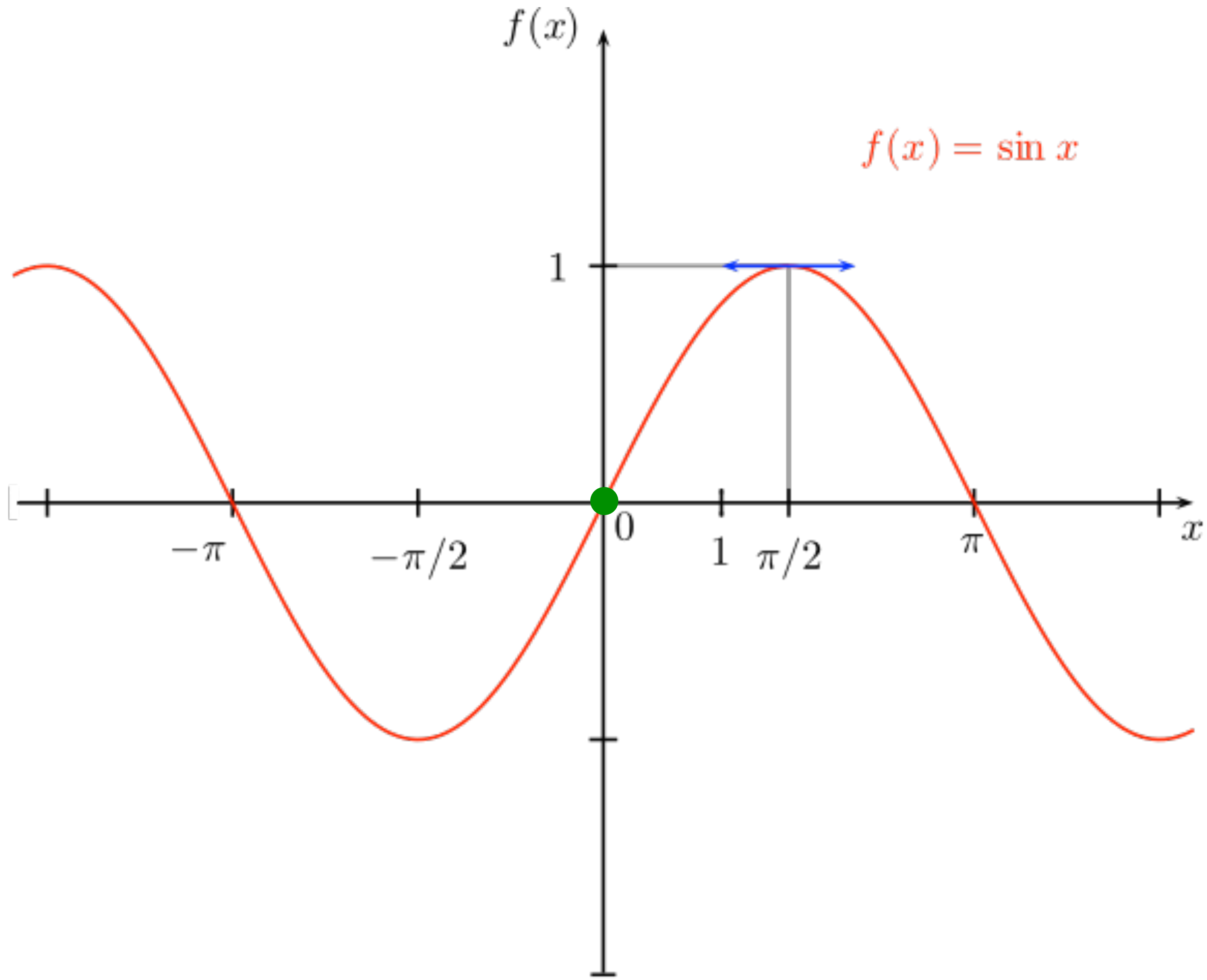


http://en.wikipedia.org/wiki/File:Unit_circle_angles.svg

Angle	0	π/6 30°	π/4 45°	π/3 60°	π/2 90°
sin	$\frac{\sqrt{0}}{2} = 0$	$\frac{\sqrt{1}}{2} = \frac{1}{2}$	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{4}}{2} = 1$

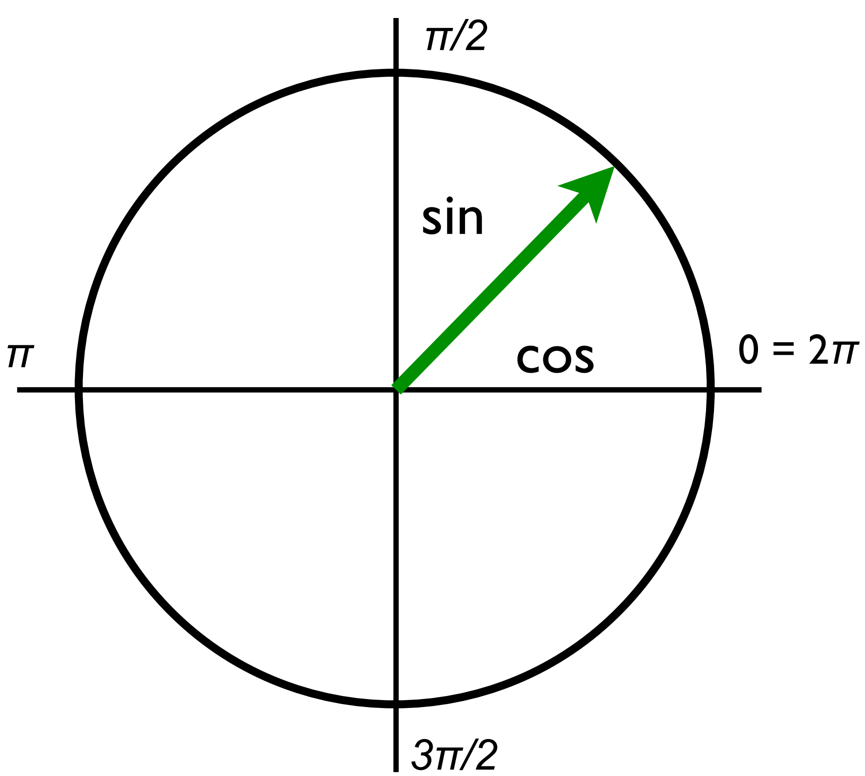
The sine wave





$\pi + \pi/2 = 2\pi/2 + \pi/2 = 3\pi/2$

The sine wave



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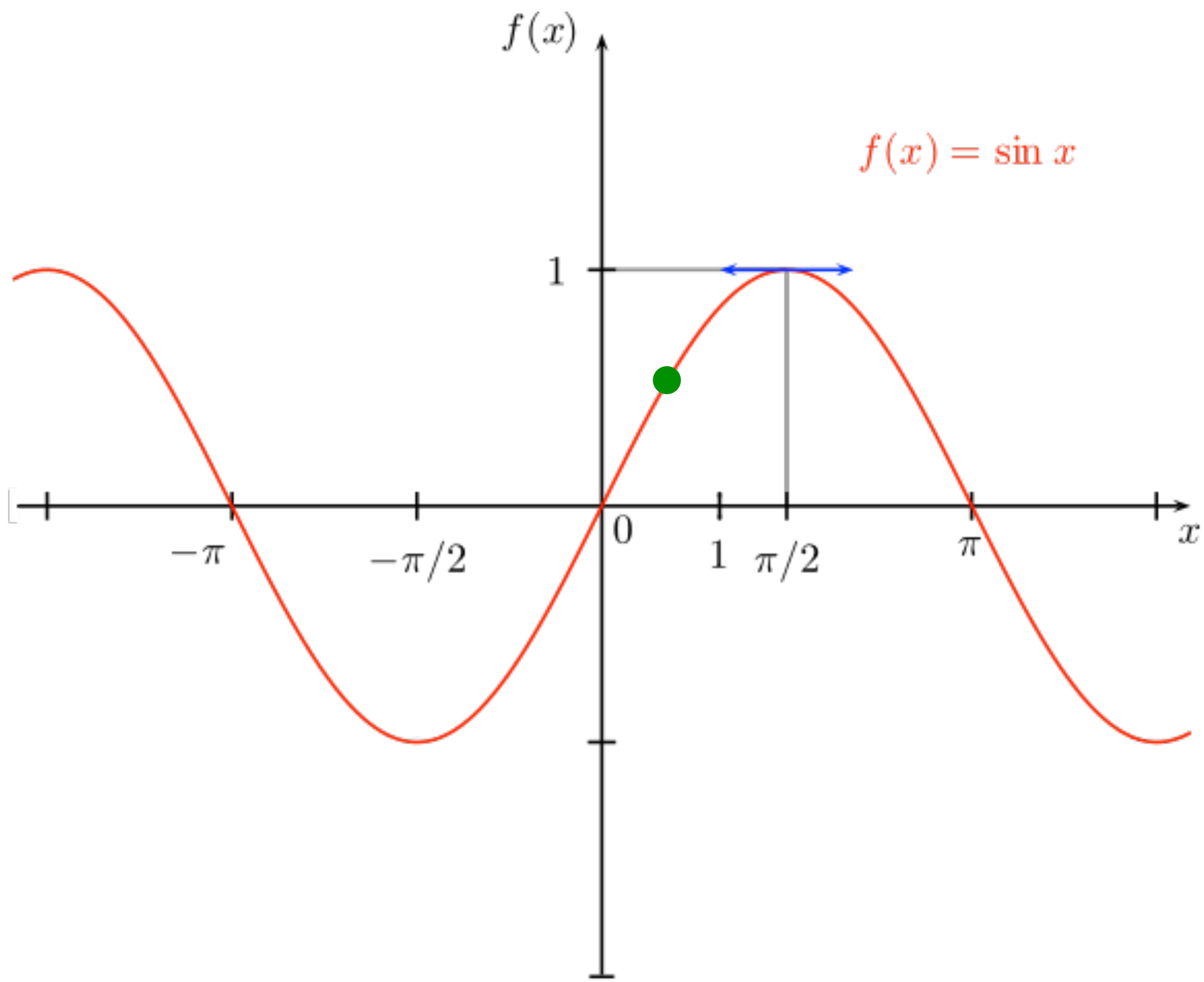

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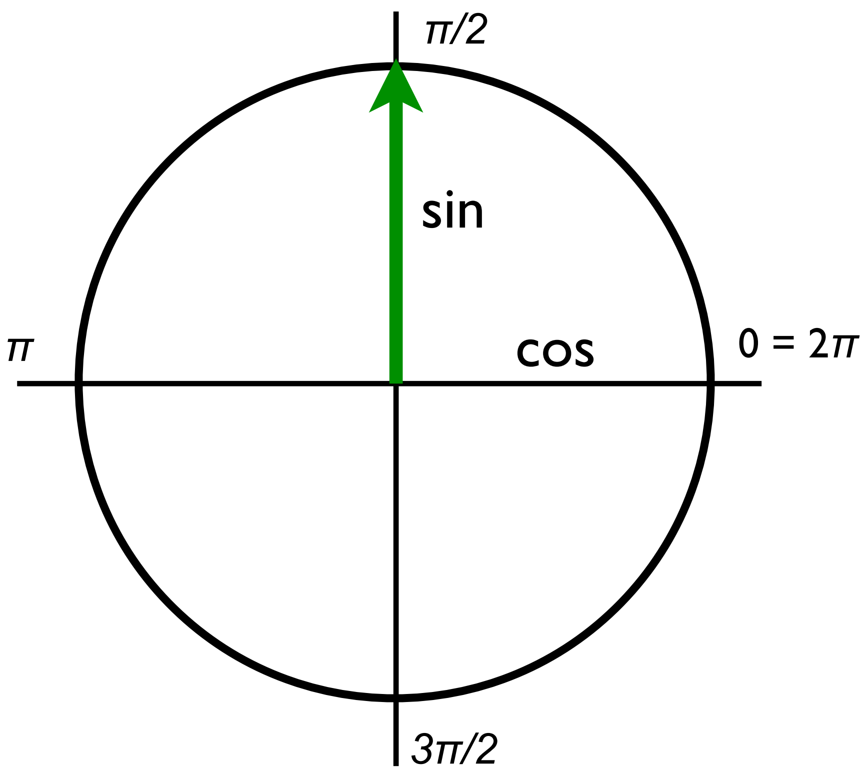

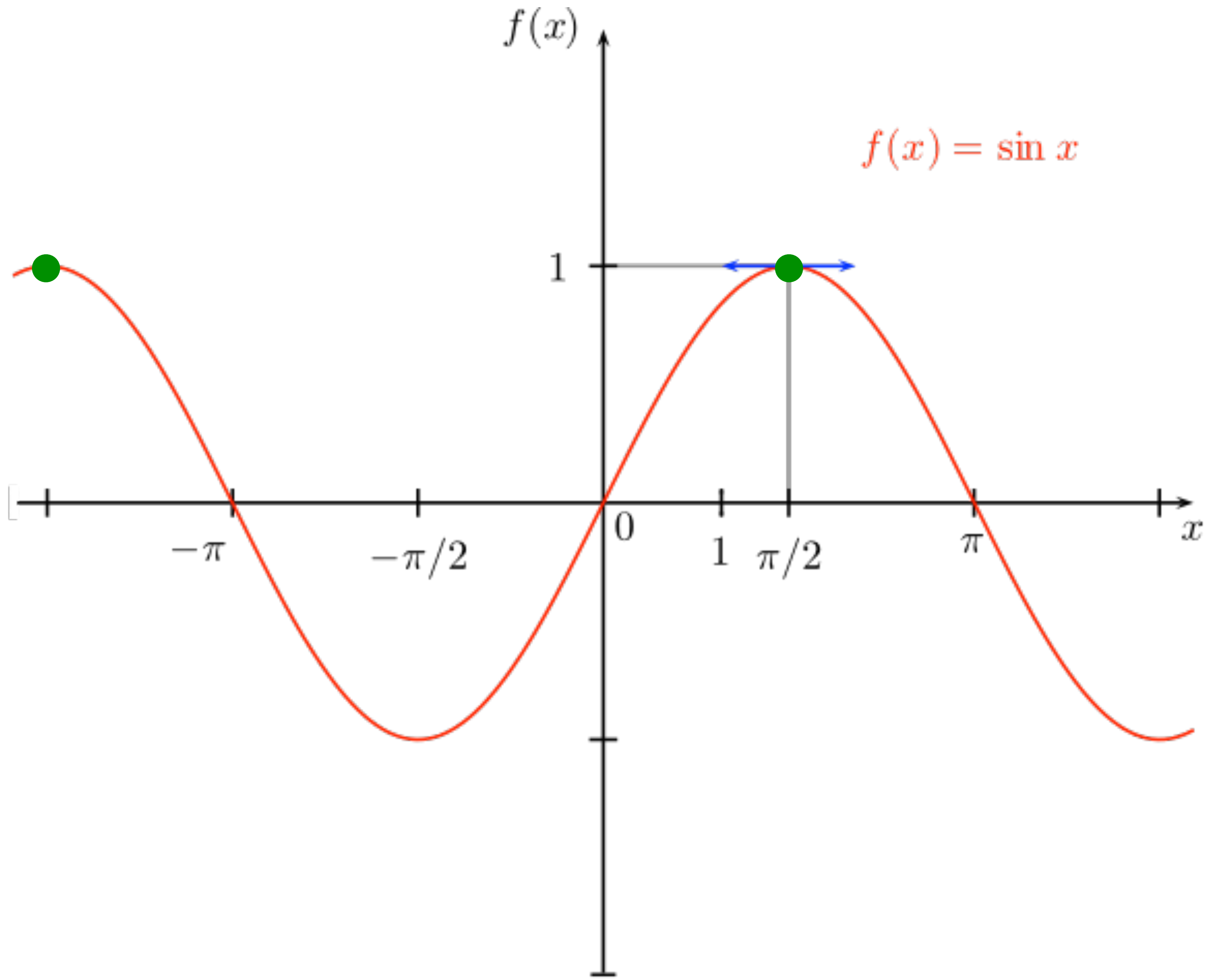

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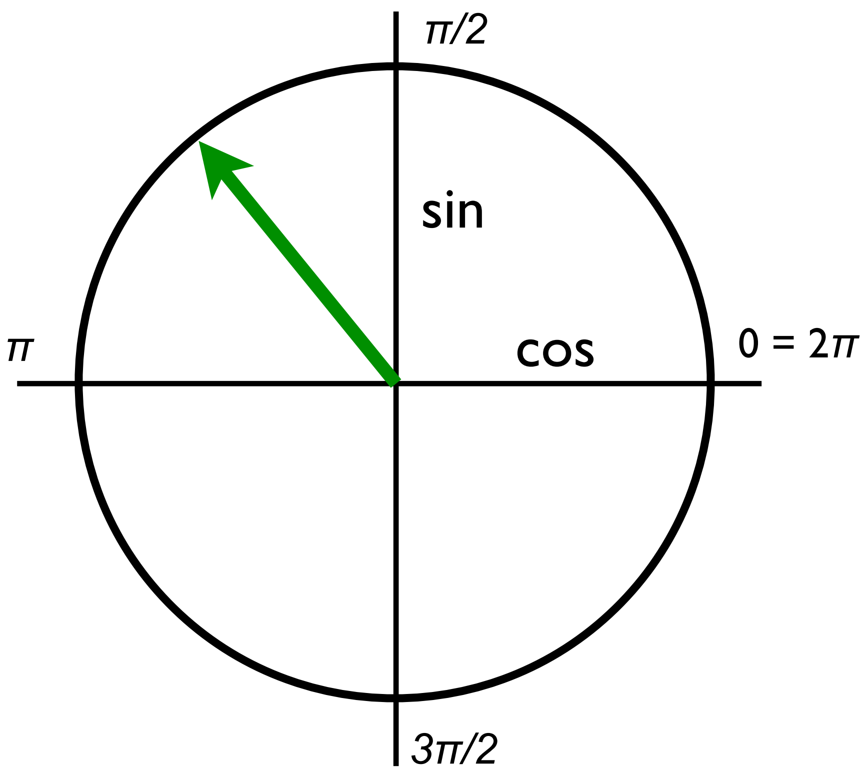
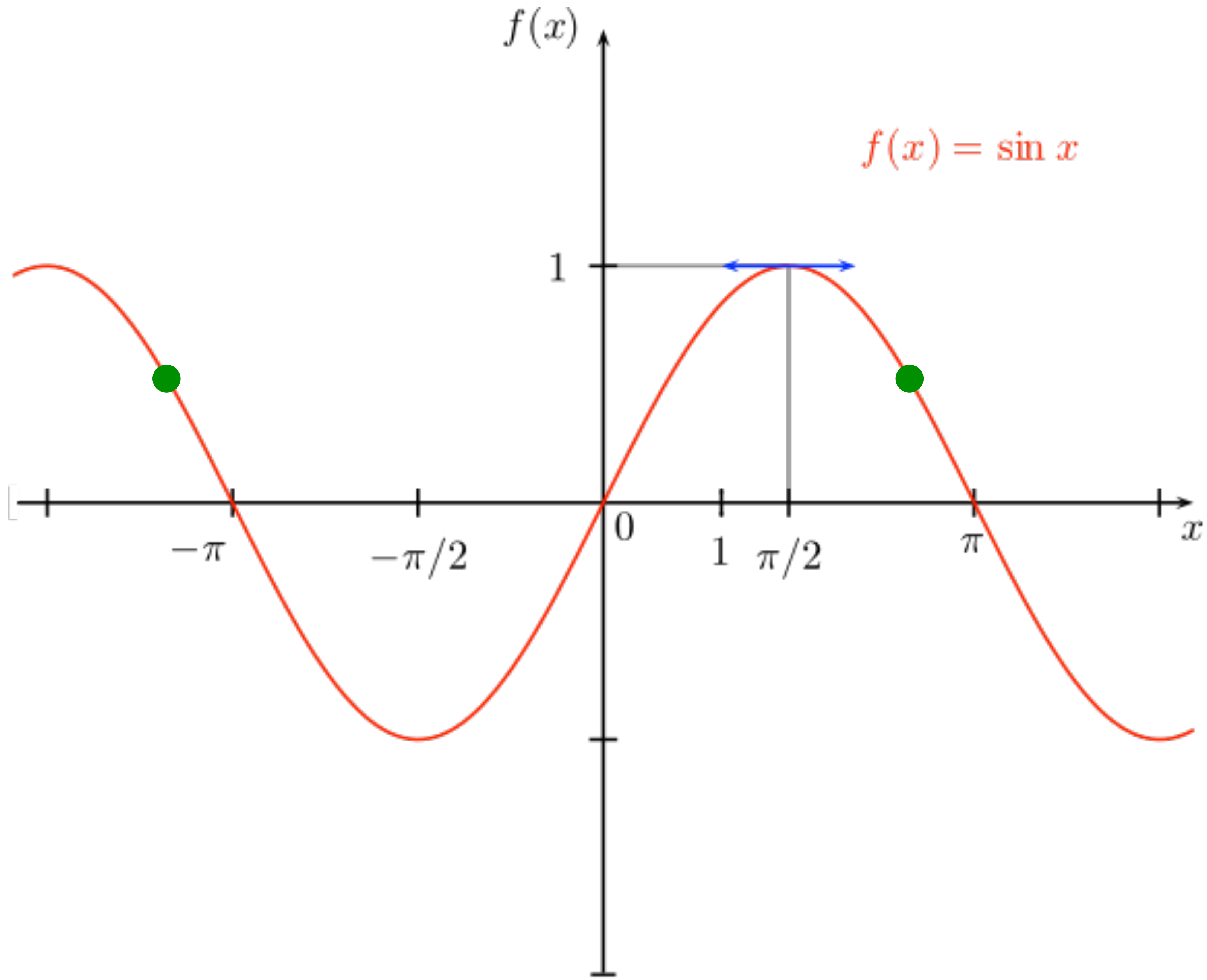
The sine wave





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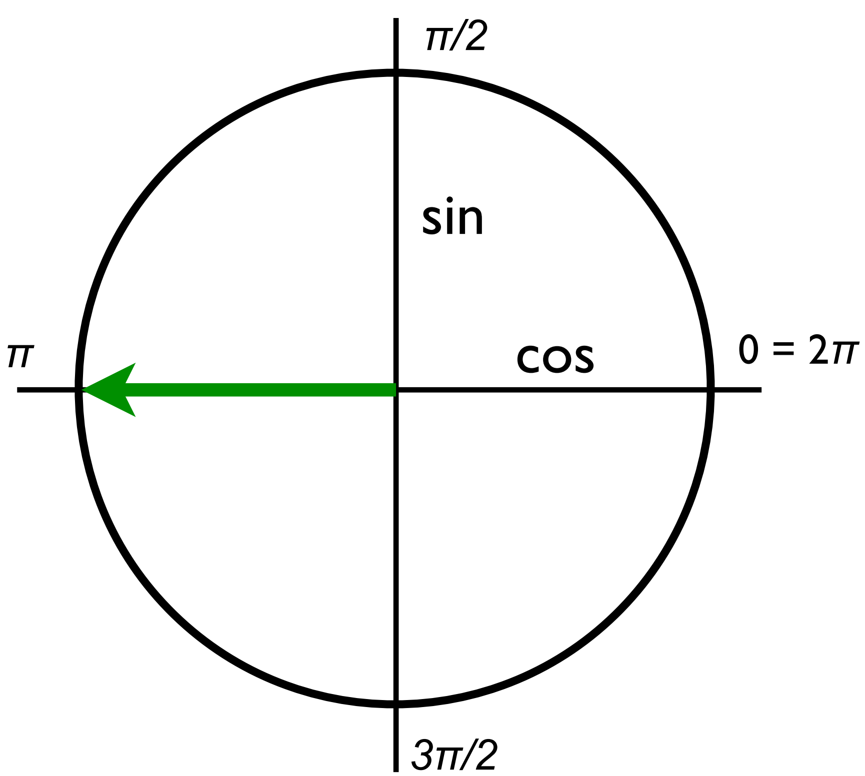

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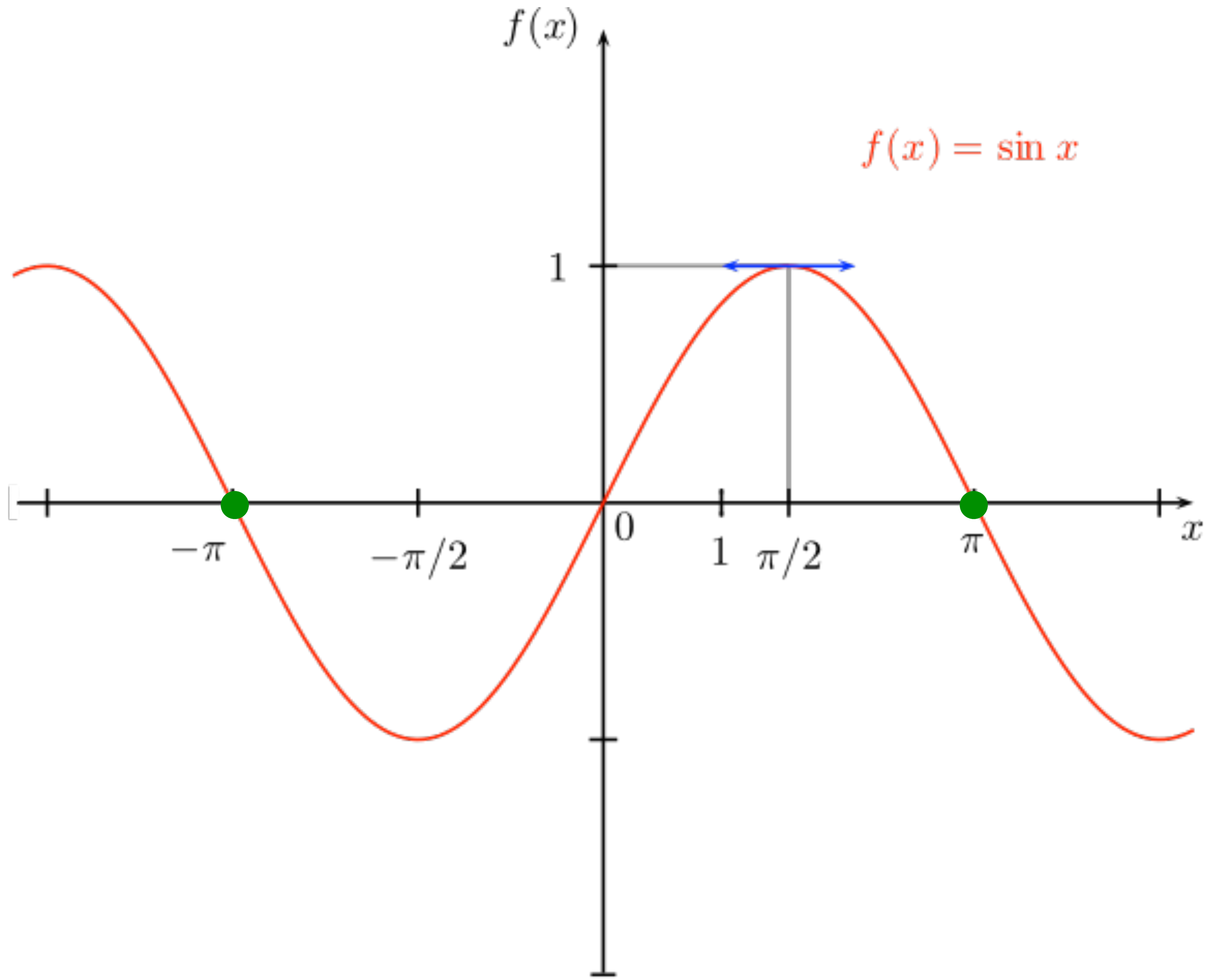

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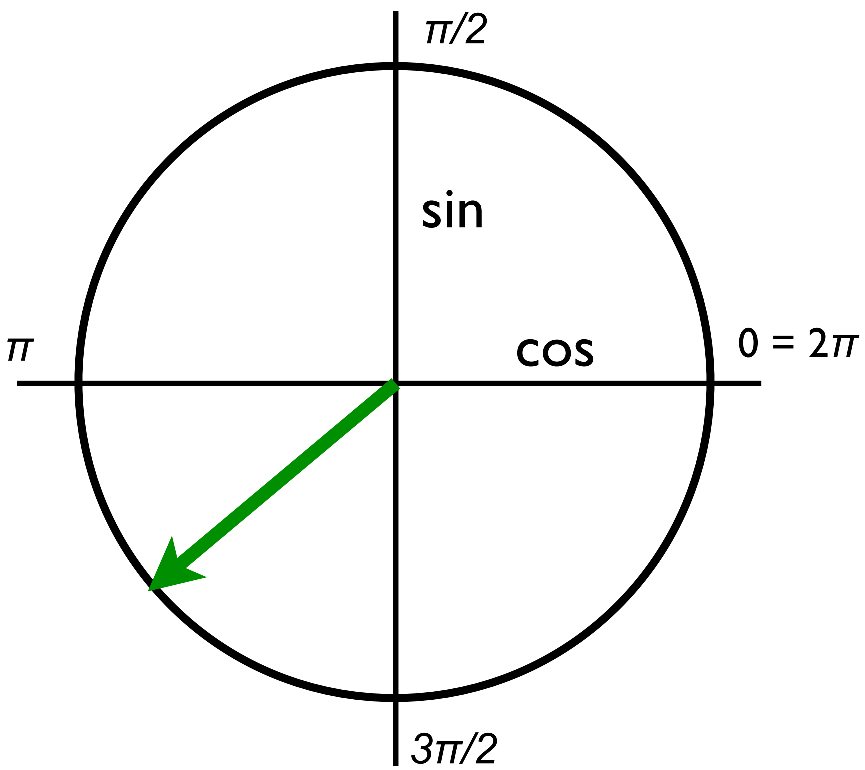

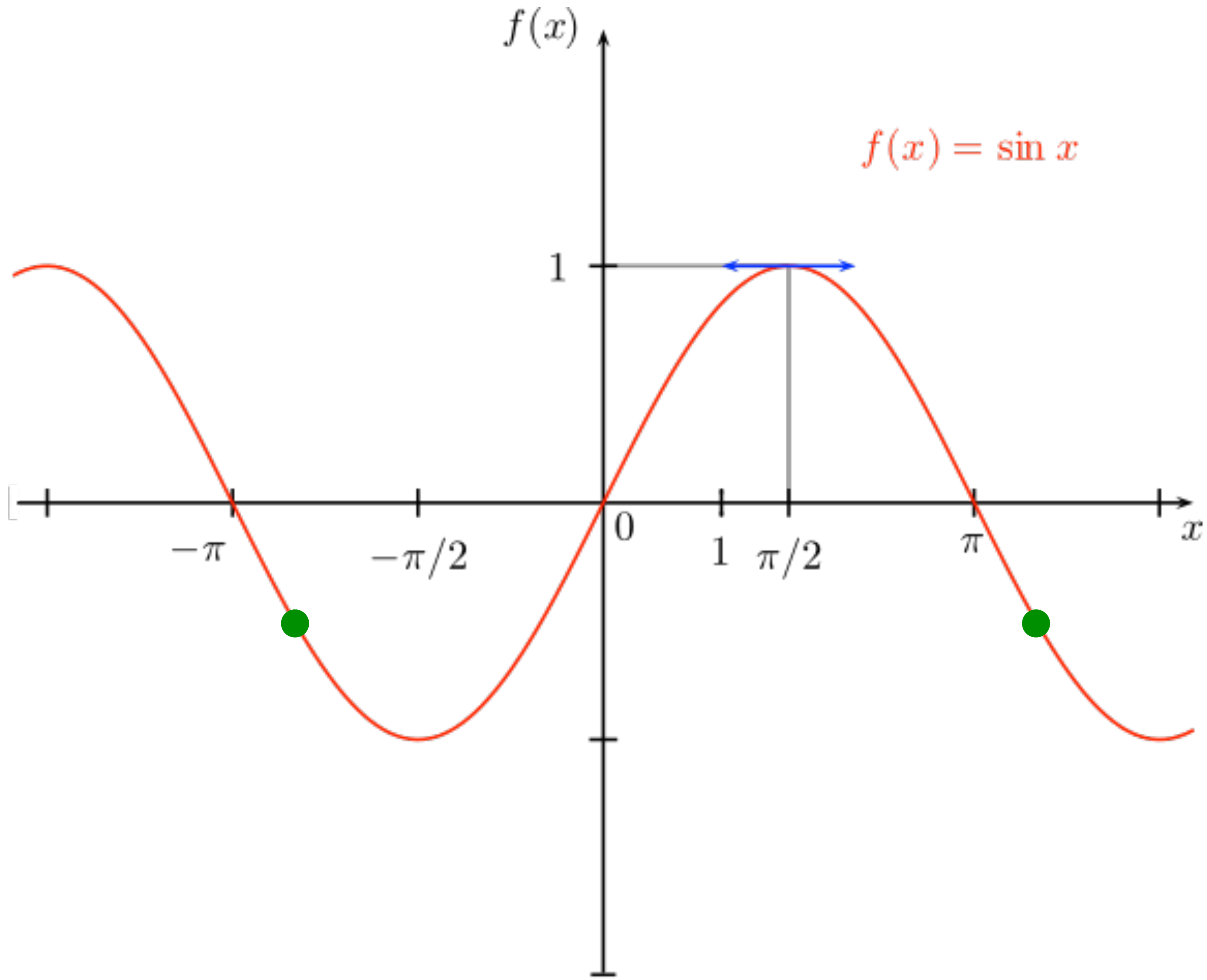

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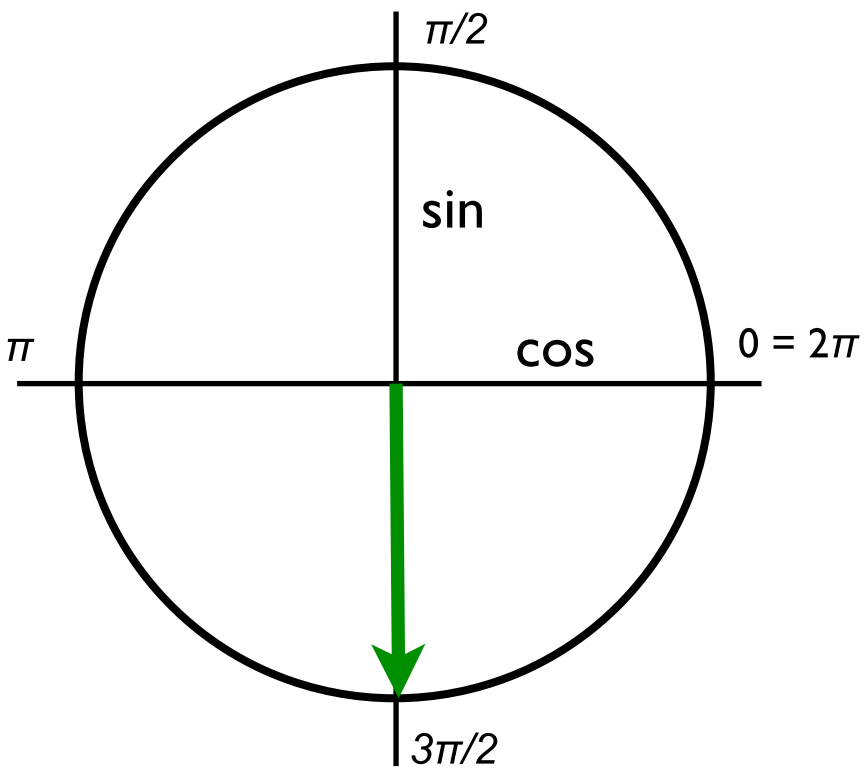

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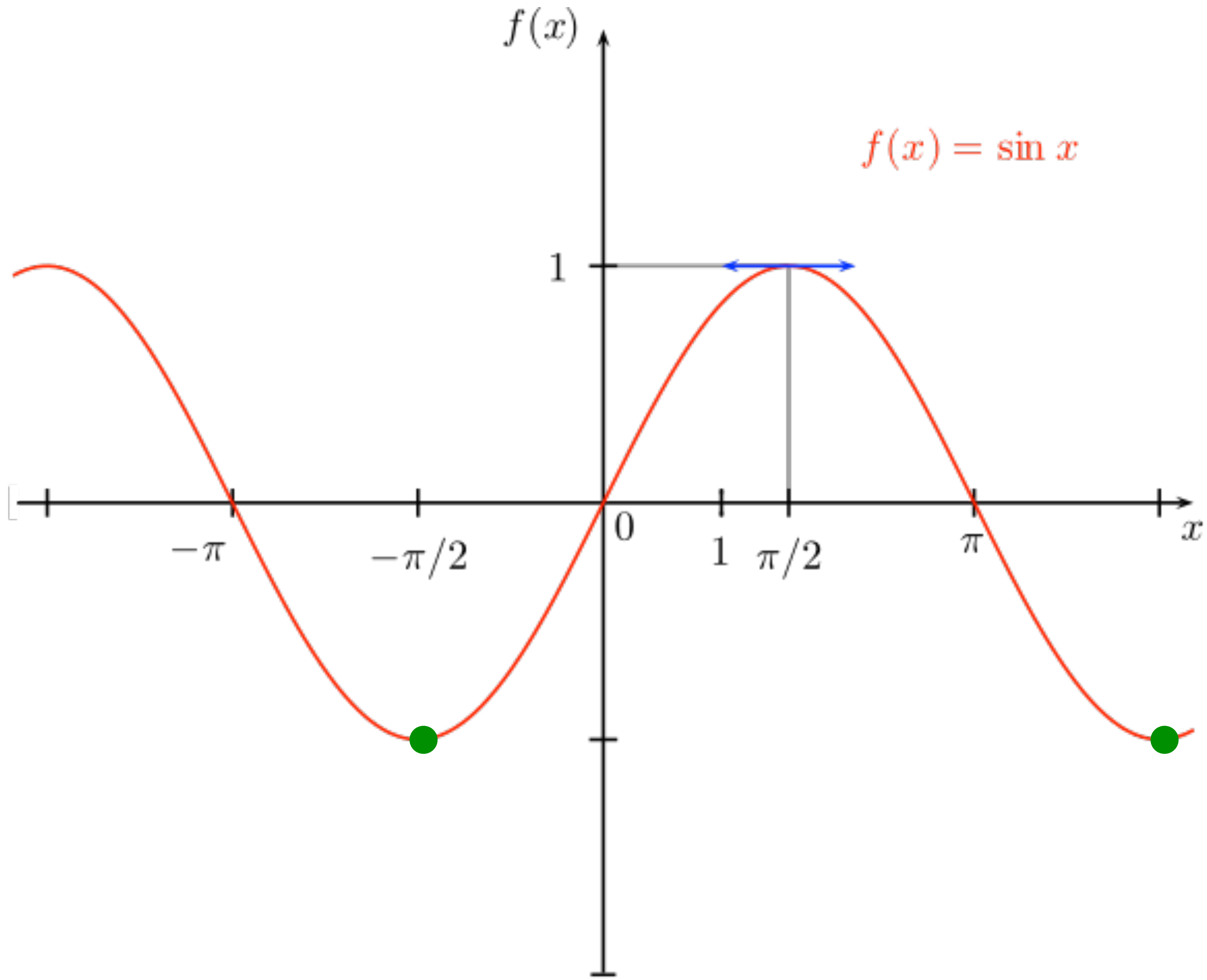

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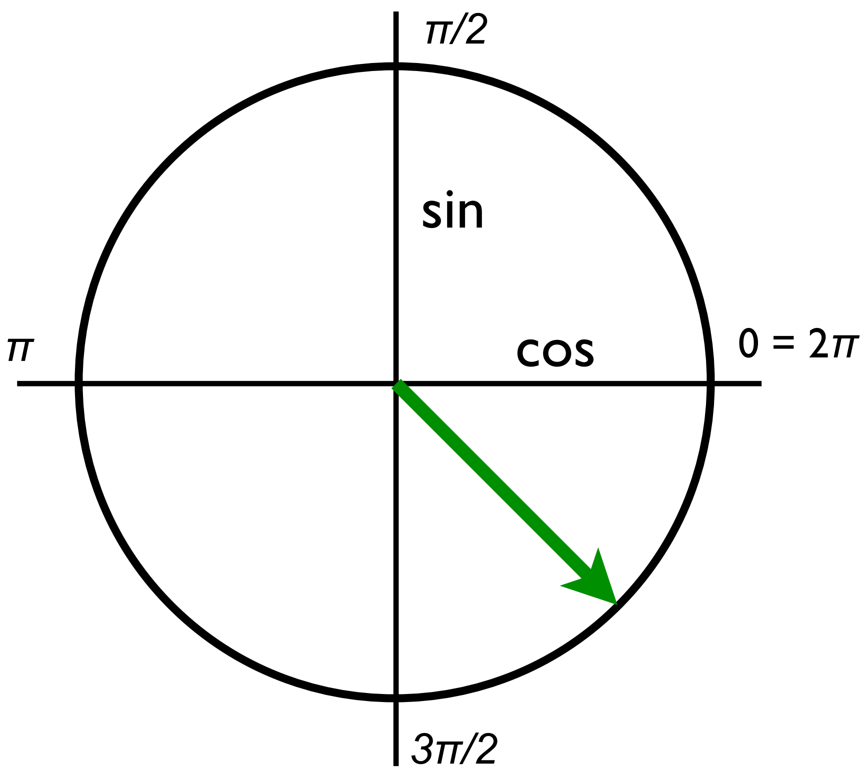

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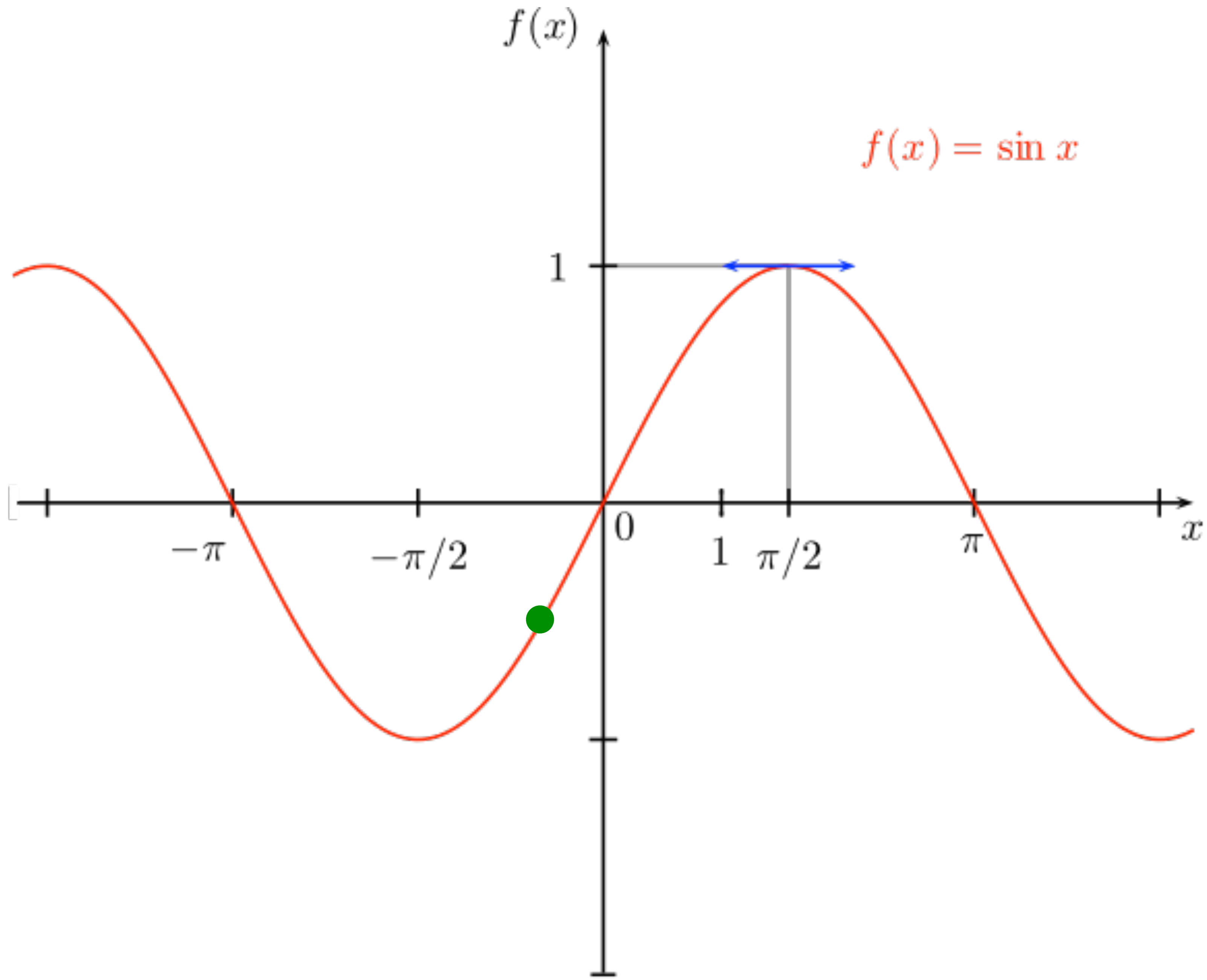
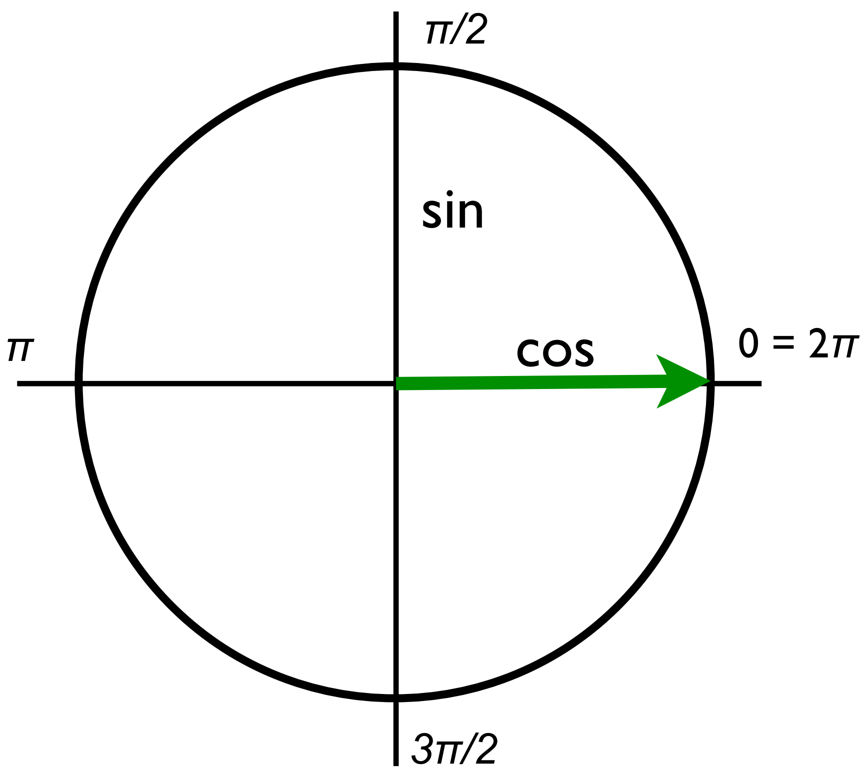


The sine wave



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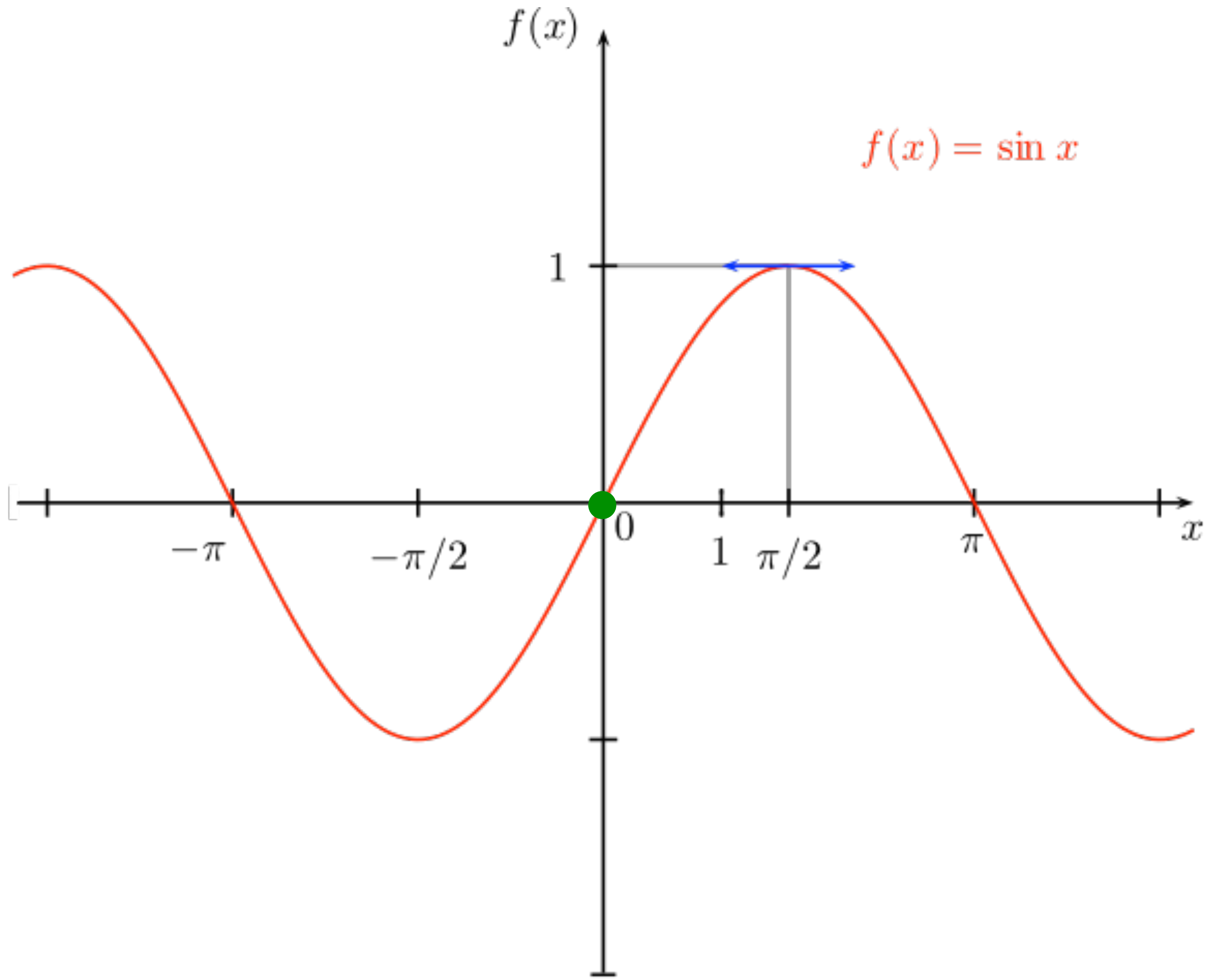
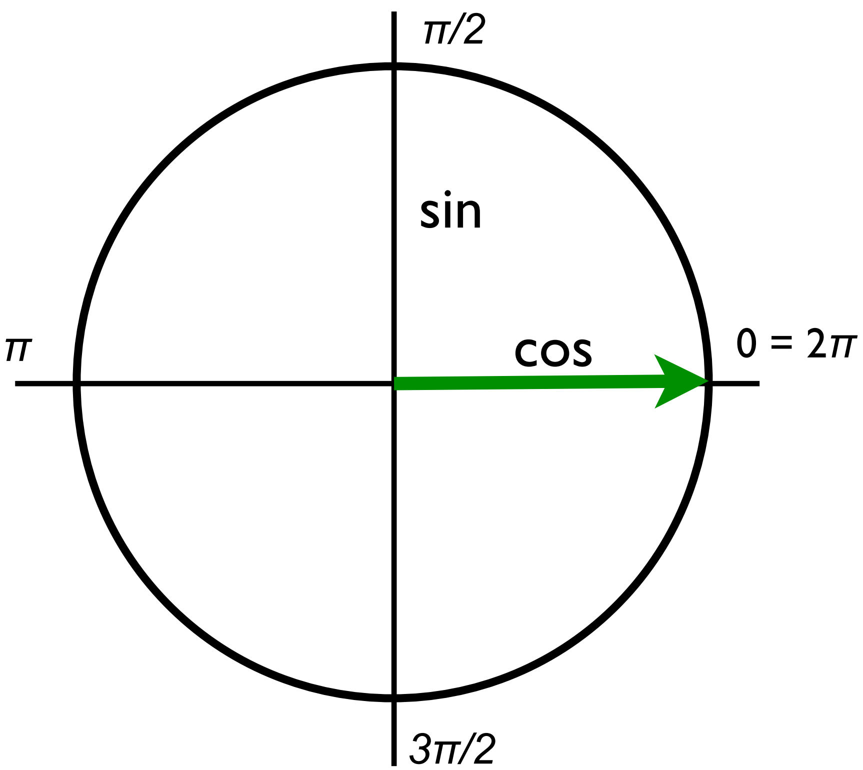
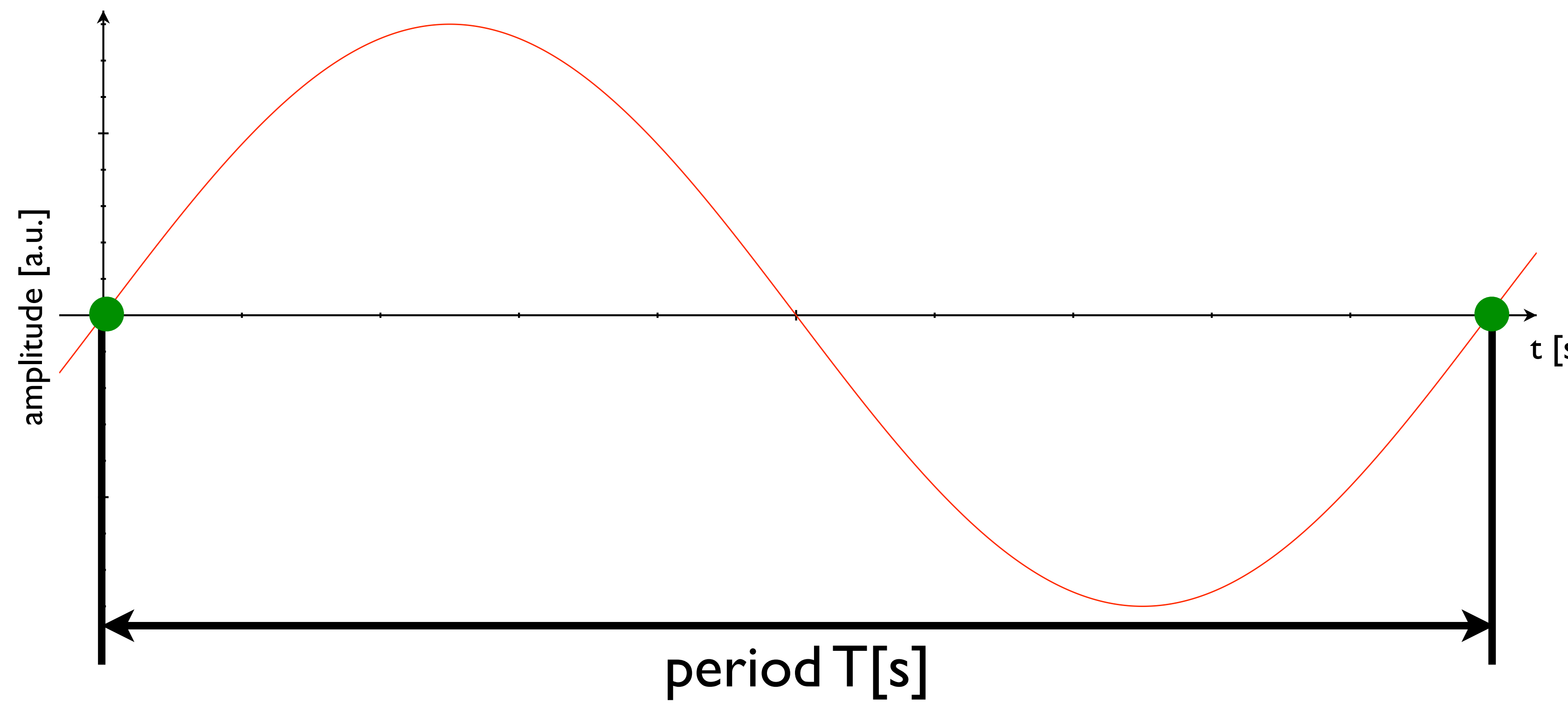


Period and frequency





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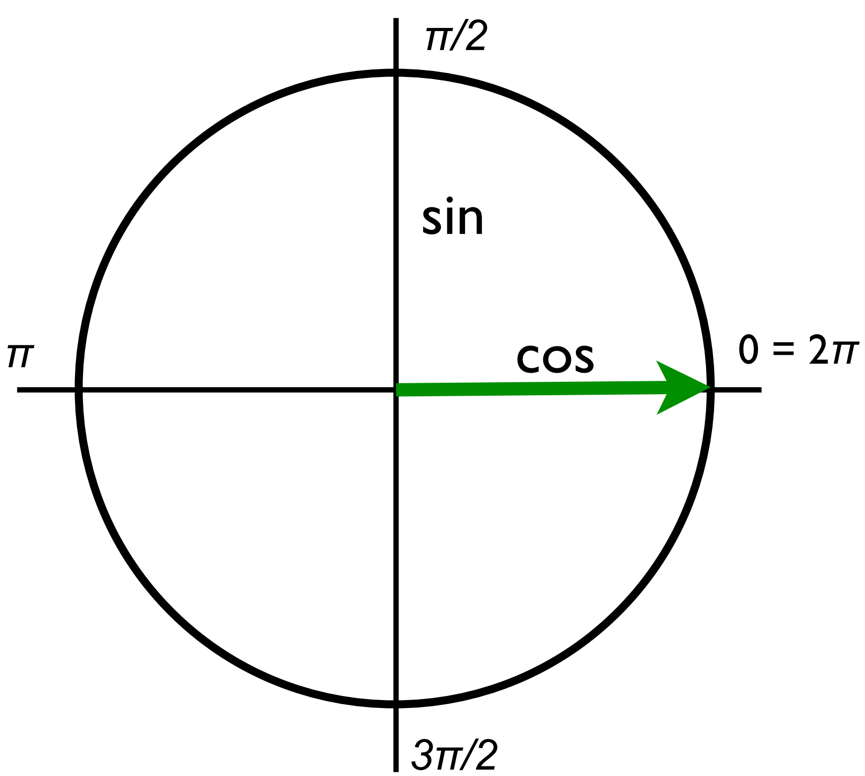
Period and frequency



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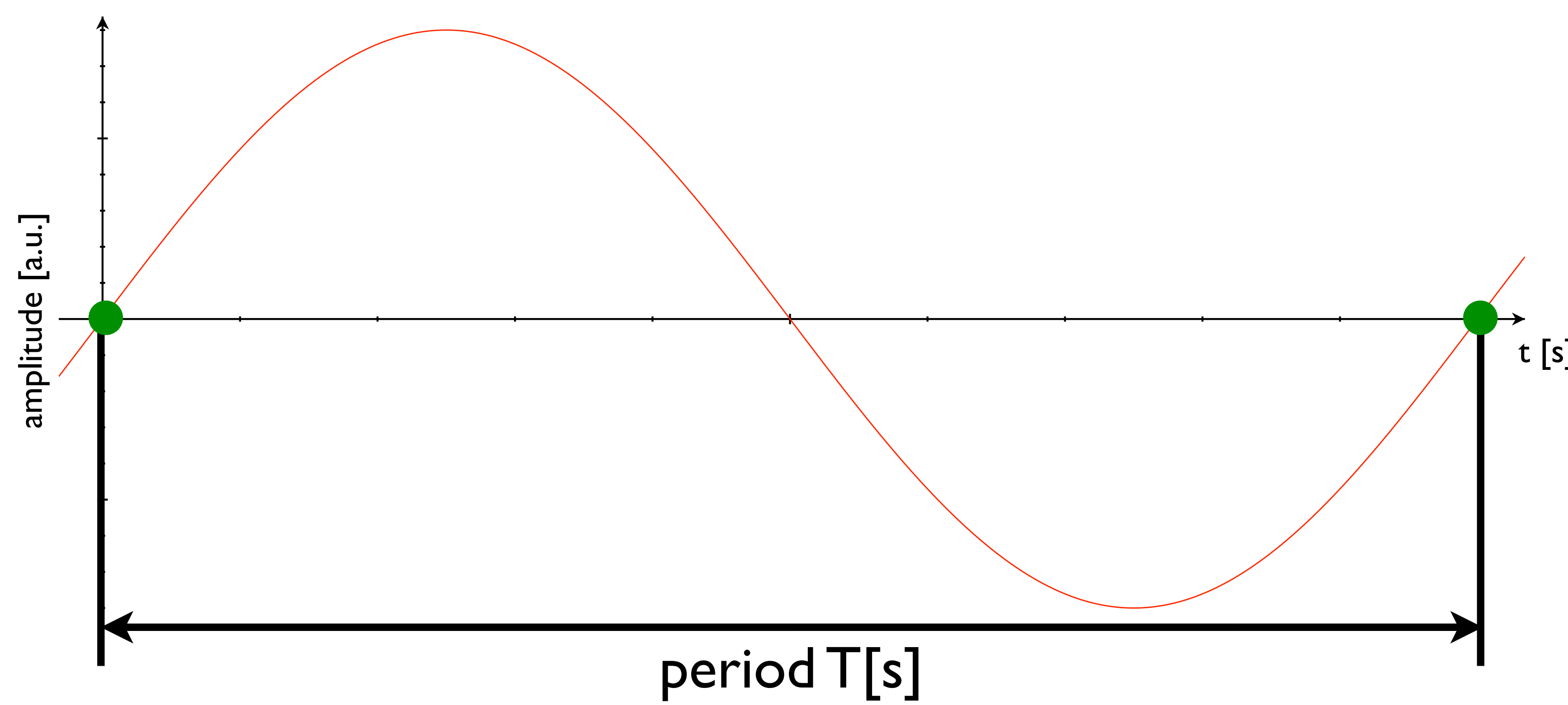
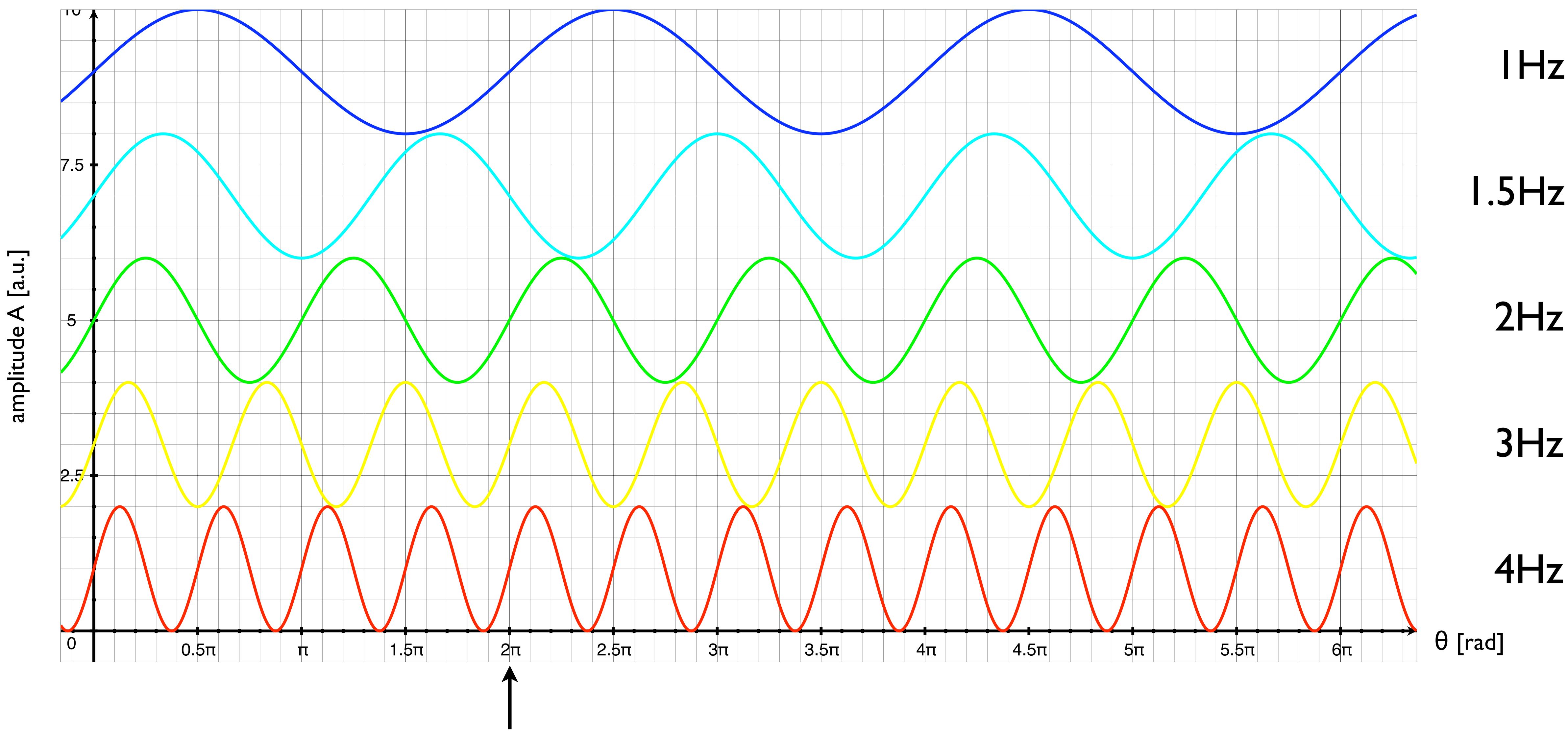
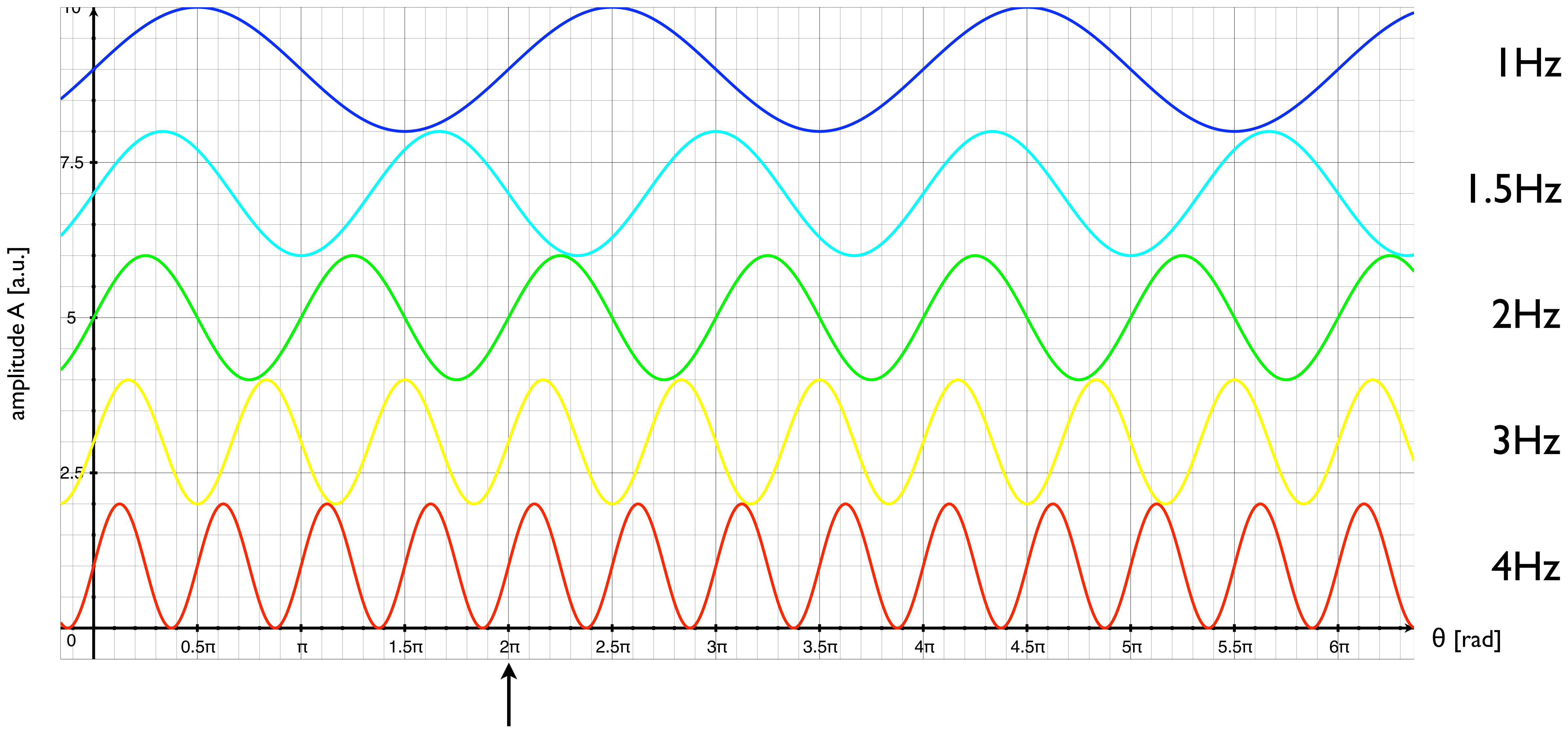


$$f = \frac{1}{T}\ [Hz]$$

Period and frequency

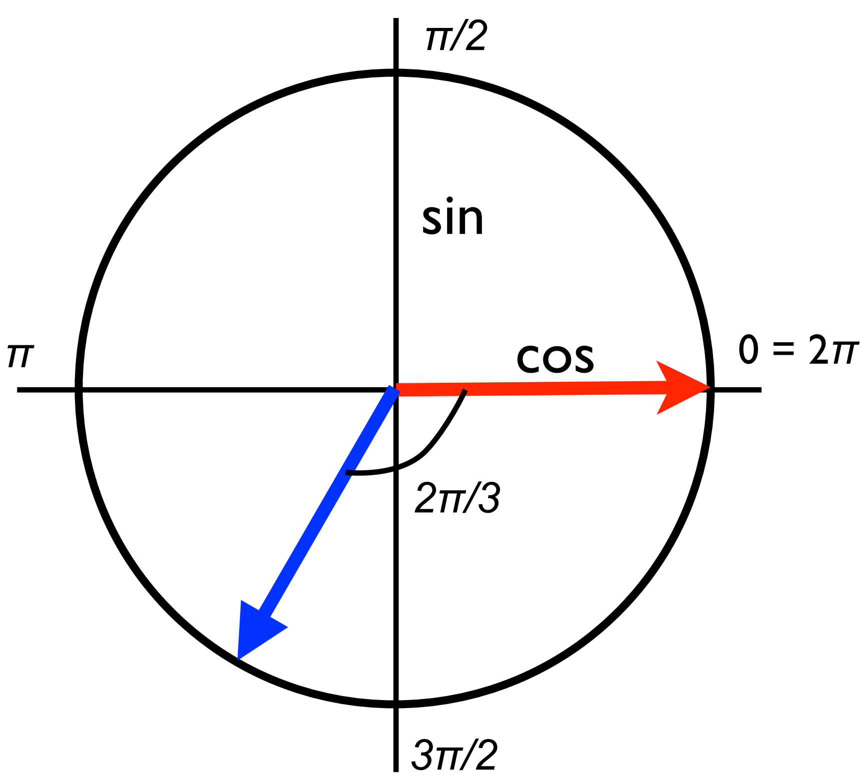


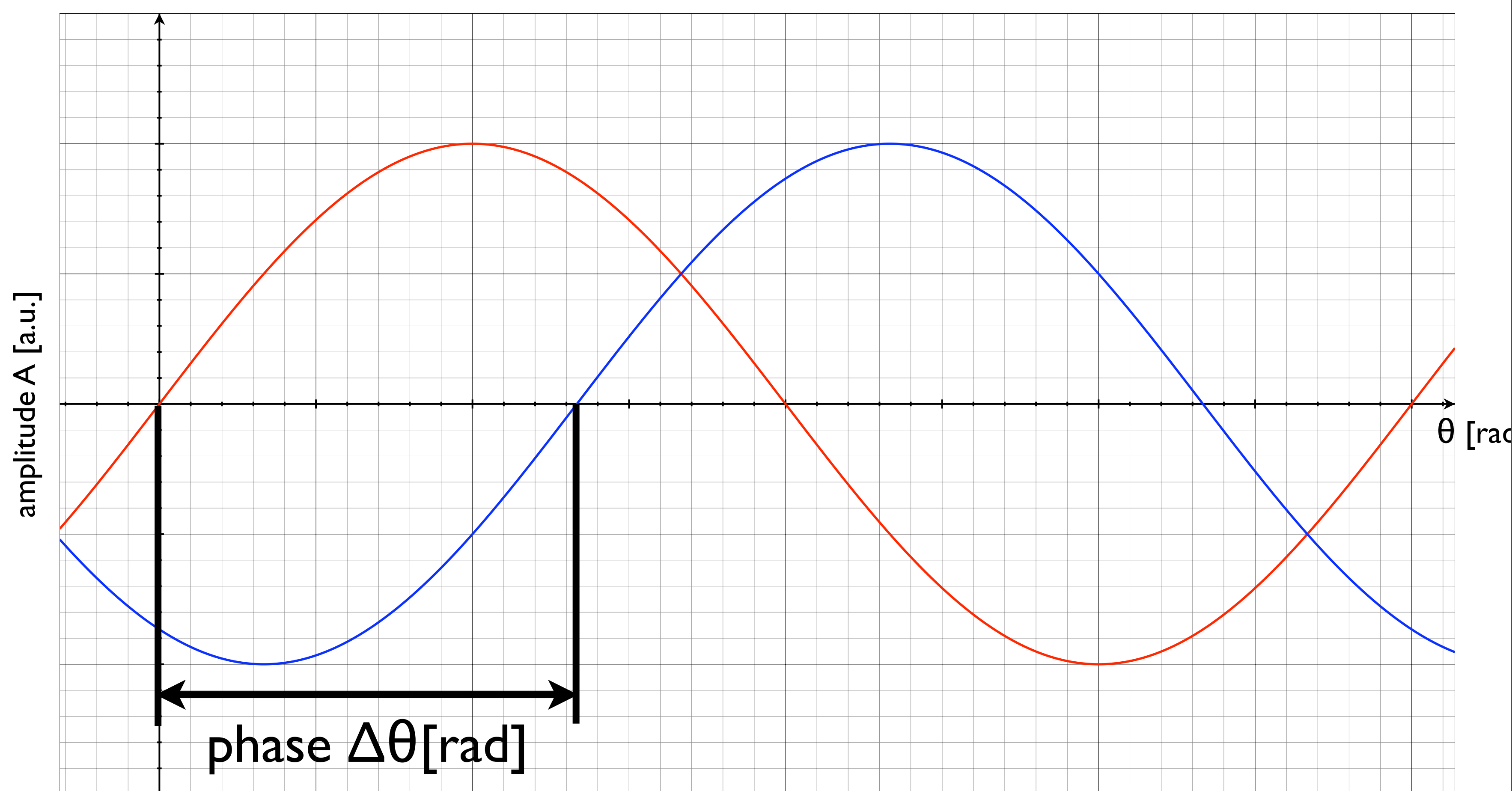
Period and frequency



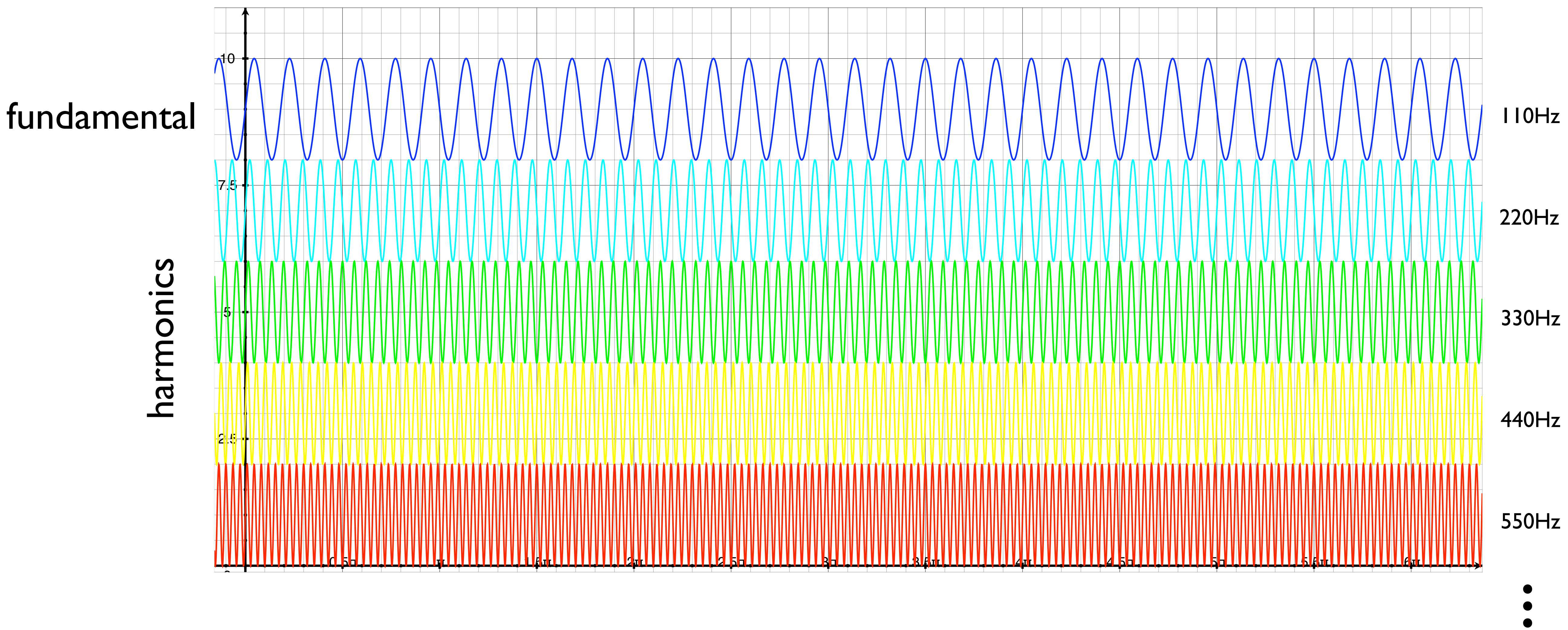
$$f = \frac{1}{T}\ [Hz]$$

The Phase Angle





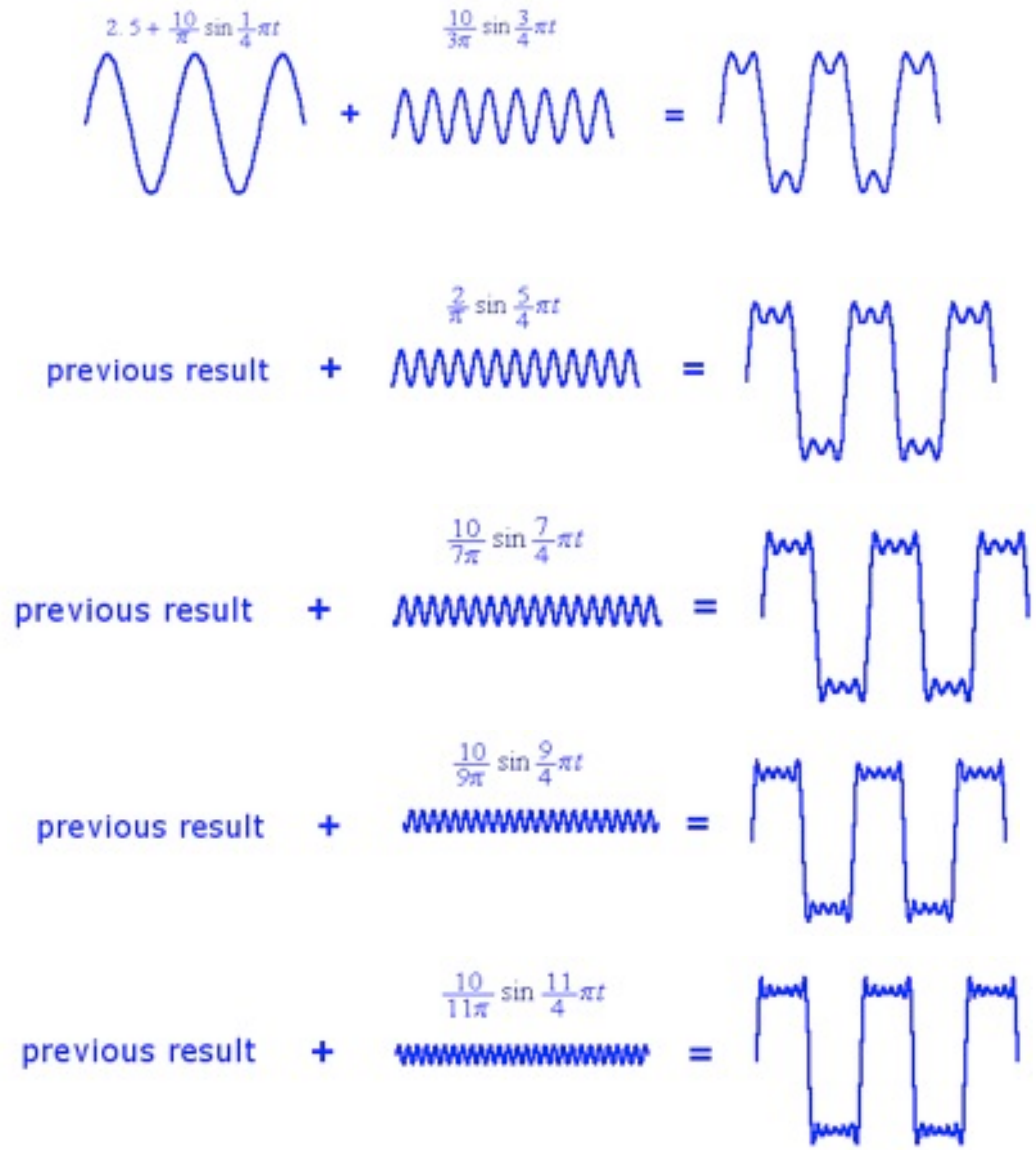
The Harmonics

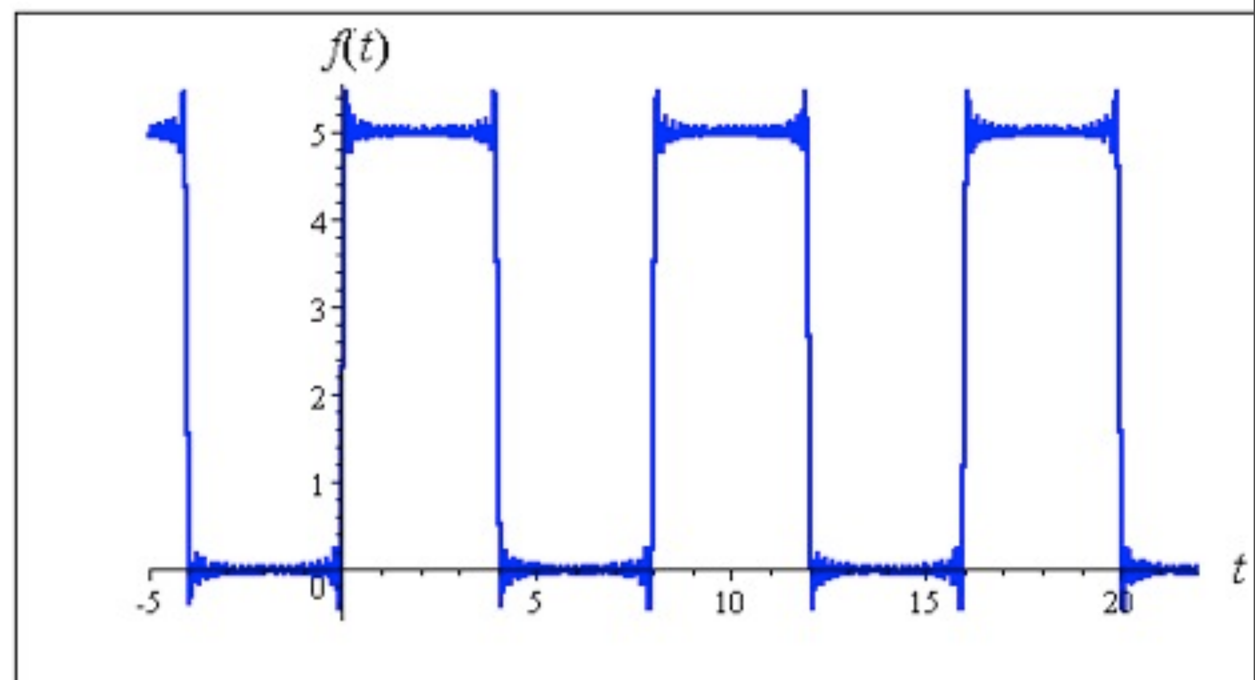


A **harmonic** of a wave is a component frequency of the signal that is an integer multiple of the fundamental frequency.

For example, if the fundamental frequency is *f*, the harmonics have frequencies *f*, 2*f*, 3*f*, 4*f*, etc

Building a square wave





$$2.5+\frac{10}{\pi}\sum_{n=1}^{20}\frac{1}{(2n-1)}\sin\frac{(2n-1)\pi t}{4}$$

A square wave is based on n harmonics!

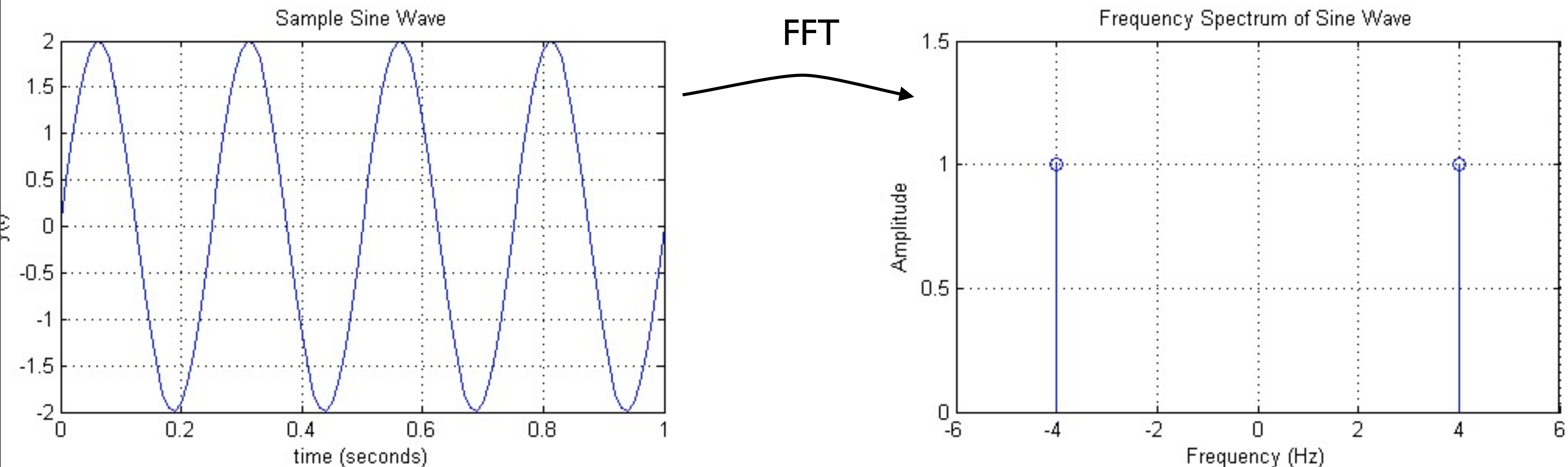
Building a square wave

$$SquarewaveApprox = \sum_{n=0}^{10} \frac{1}{(2 \cdot n + 1)} \cdot sin((2n + 1) \cdot x)$$

Approximated in "Audacity" using a base frequency of 60 Hz, or sin(377x) for n=0

http://www.youtube.com/watch?v=y6crWlxKB_E

The Spectrum



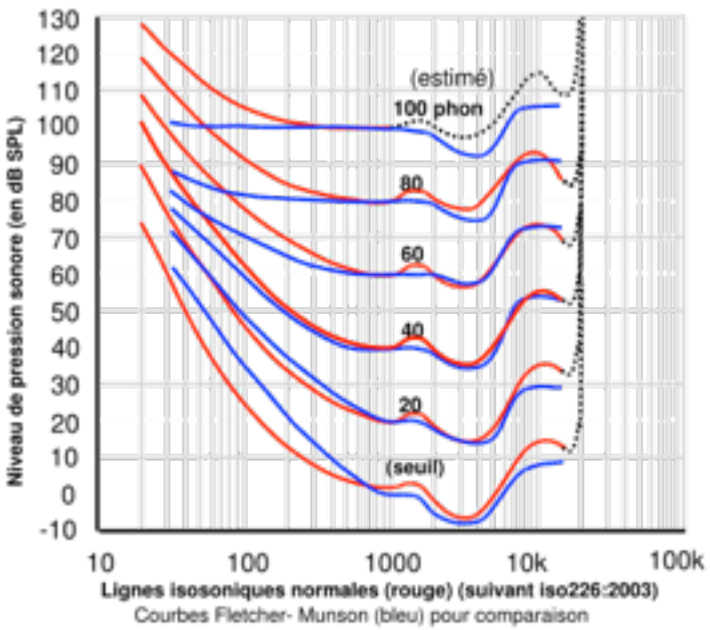
The Fourier Transform

We can represent a function either in the time domain or the frequency domain. It is the Fourier transform which converts between the two representations. The Fourier transform is defined by the expression:

$$F(\omega) = \int f(t)e^{-i\omega t}dt$$

http://www.intmath.com/Fourier-series/2_Full-range-fourier-series.php

The Spectrum



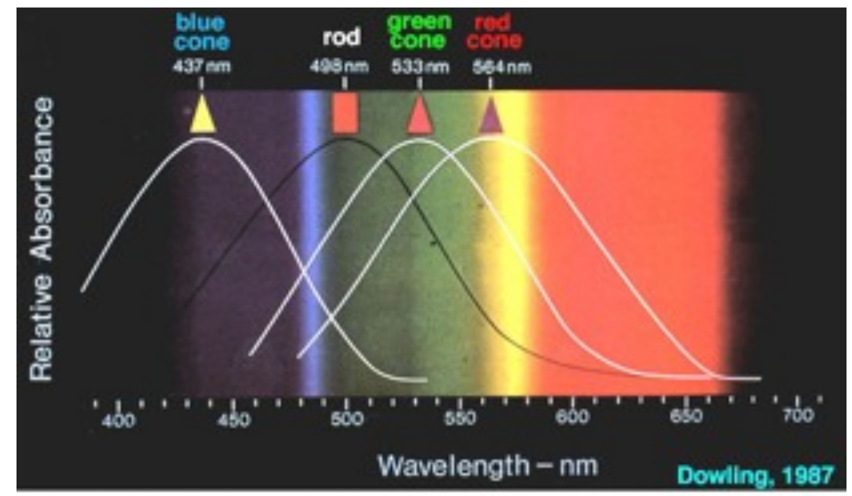


Fig. 14. The peak spectral sensitivities of the the 3 cone types and the the rods in the primate retina (Brown and Wald, 1963). From Dowling's book (1987).

$$\lambda = c * T = \frac{c}{f}$$