Wave Review

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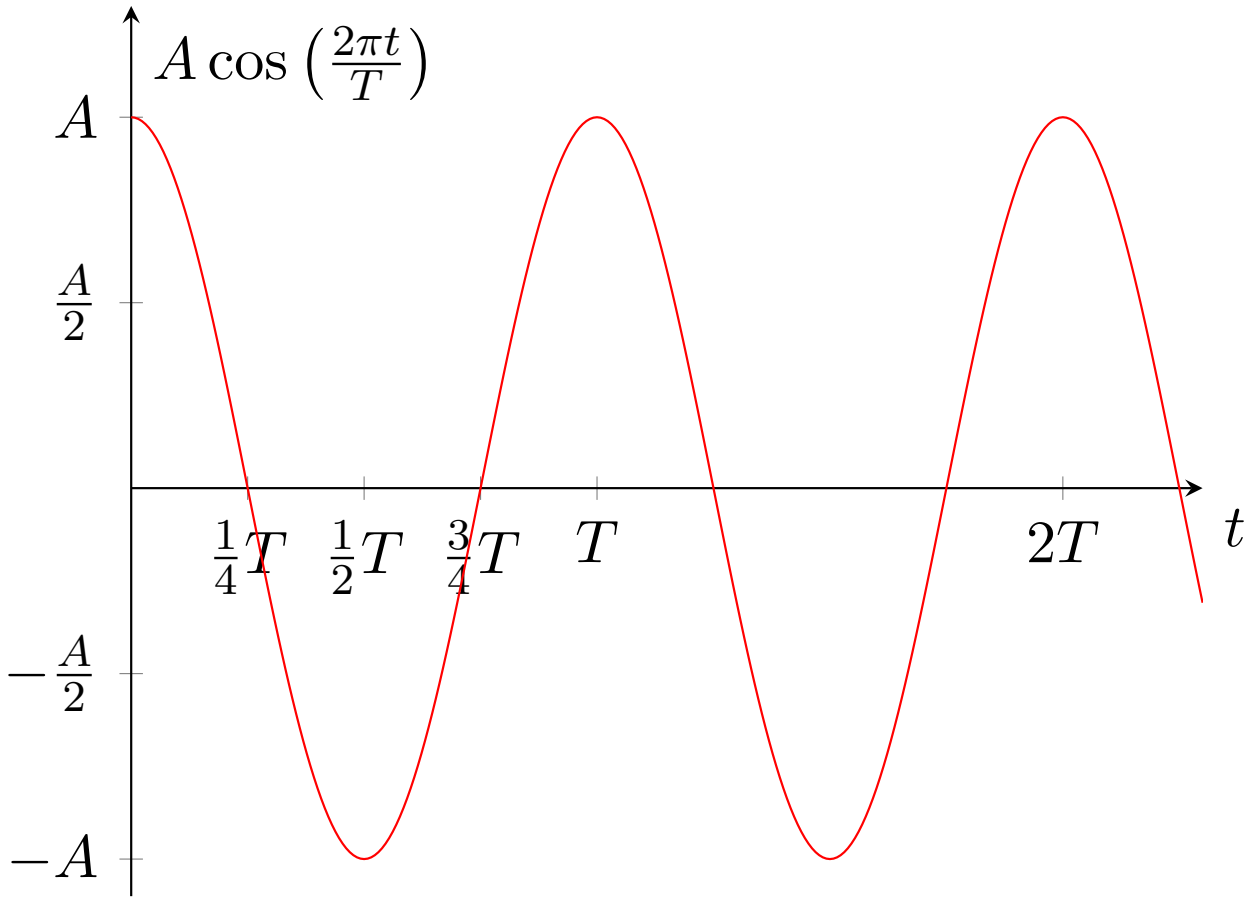
Oscillation vs. Wave

- An oscillation is a periodic disturbance in time.
- A wave is a periodic disturbance in space and time.
- A wave has an amplitude and a period, like an oscillation, but a wave also has a *wavelength*.

If we sit at one point in space, a wave looks like an oscillation.



- A is amplitude, T is period

Period, frequency, and angular frequency are related in the same way for waves that they are for oscillations.

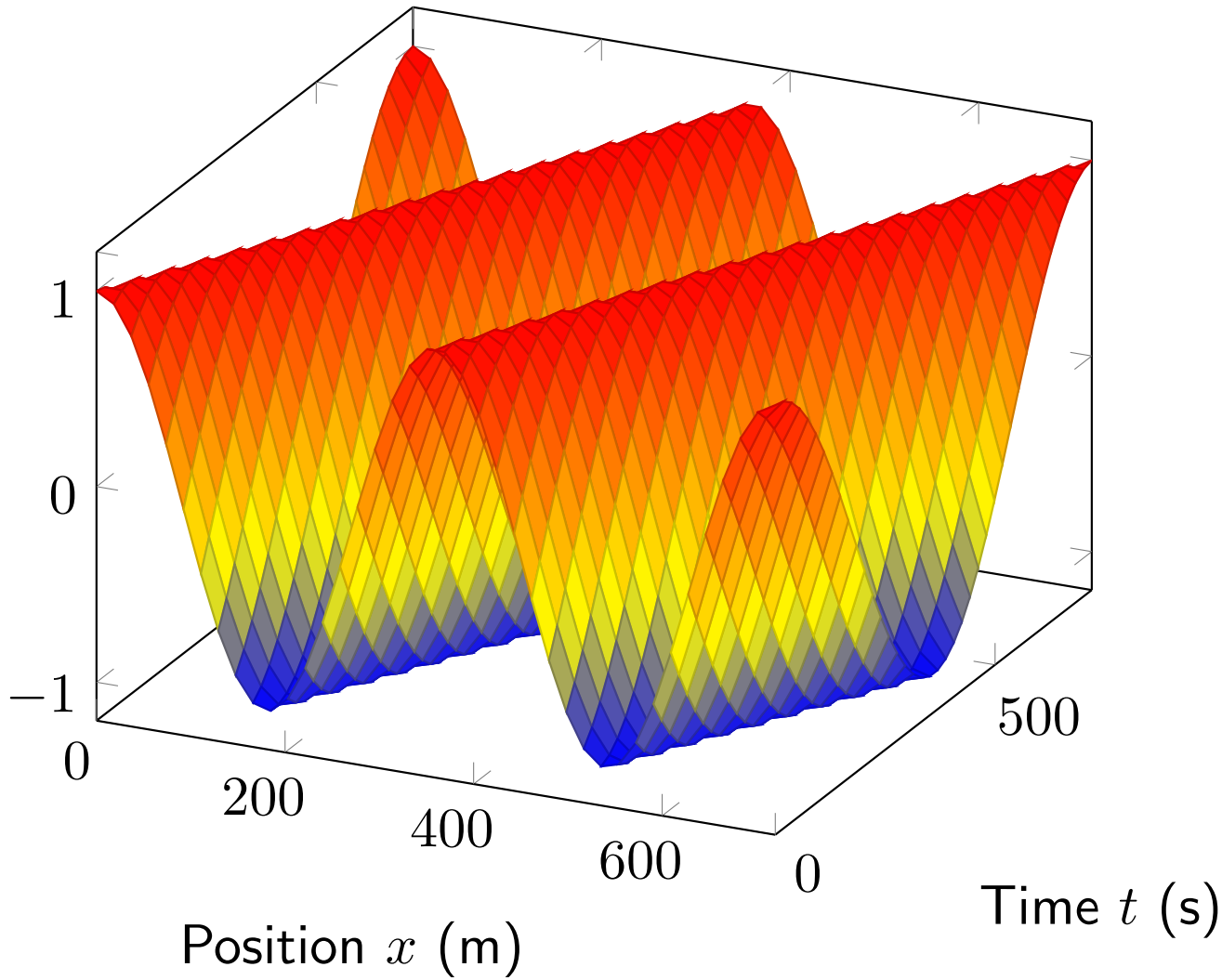
Quantity	Symbol	Unit
Period	T	s
Frequency	f	Hz $=$ cycle/s $=$ rev/s
Angular frequency	ω	rad/s

$$f = \frac{1}{T}$$

$$\omega = 2\pi f$$

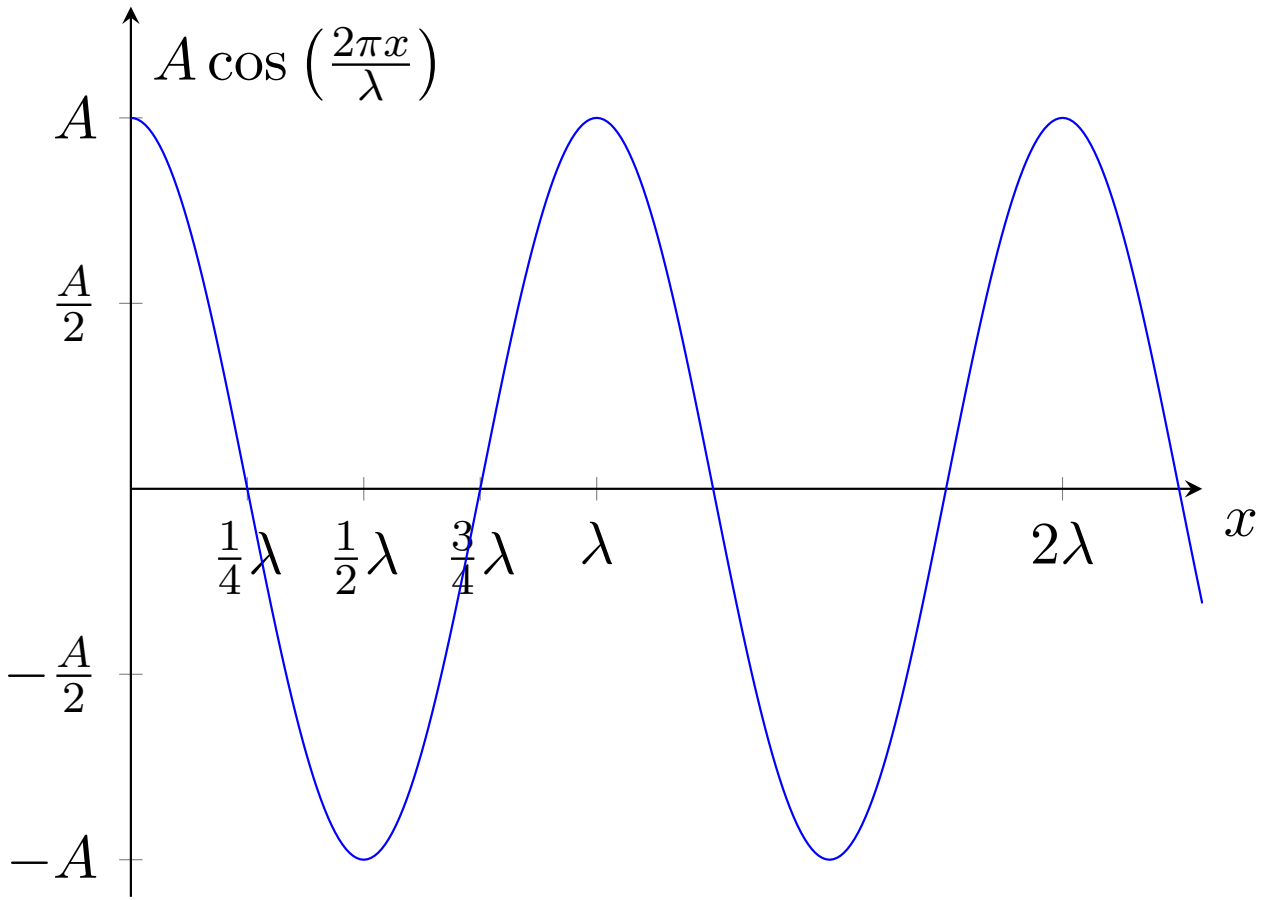
Animation of a 1D traveling wave

A wave moves in space and time



- This wave moves in the positive x direction.

Wavelength is the distance between crests.



- A is amplitude, λ is wavelength

A traveling wave has a wave speed

$$v = \frac{\lambda}{T}.$$

(You can remember this because a speed is a length divided by a time.)

- How are wavelength and frequency related? Since

$$f = \frac{1}{T},$$

we know that

$$v = \lambda f.$$

So, wavelength times frequency is wave speed.

Kinds of waves

- Sound waves (piano is 27.5 Hz to 4186 Hz)
- Ultrasound waves (2 MHz to 15 MHz)
- Light waves (400 THz to 790 THz)
- Microwaves (like the oven, 2.45 GHz)
- Radio waves (like WXPN, 88.5 MHz)
- Water waves
- Waves on a string (like a guitar string, 82 Hz to 330 Hz)

Speeds of waves

Wave	type	speed
Sound	mechanical (3D)	≈ 340 m/s (in air)
Ultrasound	mechanical (3D)	≈ 1500 m/s (in water)
Light	electromagnetic	3×10^8 m/s
Microwaves	electromagnetic	3×10^8 m/s
Radio	electromagnetic	3×10^8 m/s
Water waves	mechanical (2D/surface)	≈ 2 m/s
Guitar string	mechanical (1D)	≈ 250 m/s

Mechanical waves need a medium

- Sound waves can't travel in empty space.
- Sound waves have a different speed in air than in water. (Speed depends on medium.)

Electromagnetic waves don't need a medium

- Light waves can travel in empty space.
- Light waves have a different speed in air than in water.

A wave can exhibit interference

Wave summary

Property	Symbol	Unit
Wavelength	λ	m
Period	T	s
Frequency	f	Hz
Speed	v	m/s
Amplitude	depends	depends

$$f = \frac{1}{T}$$

$$v = \frac{\lambda}{T} = \lambda f$$