WAVES

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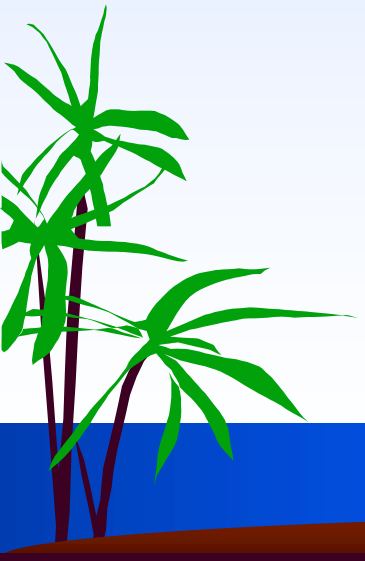
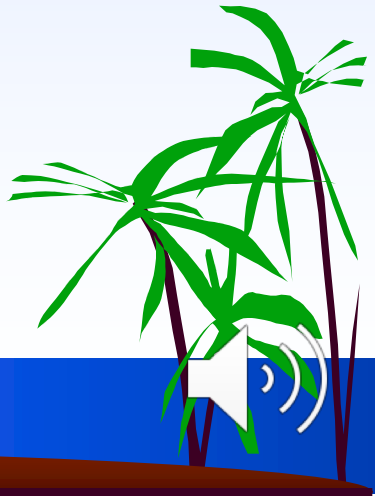


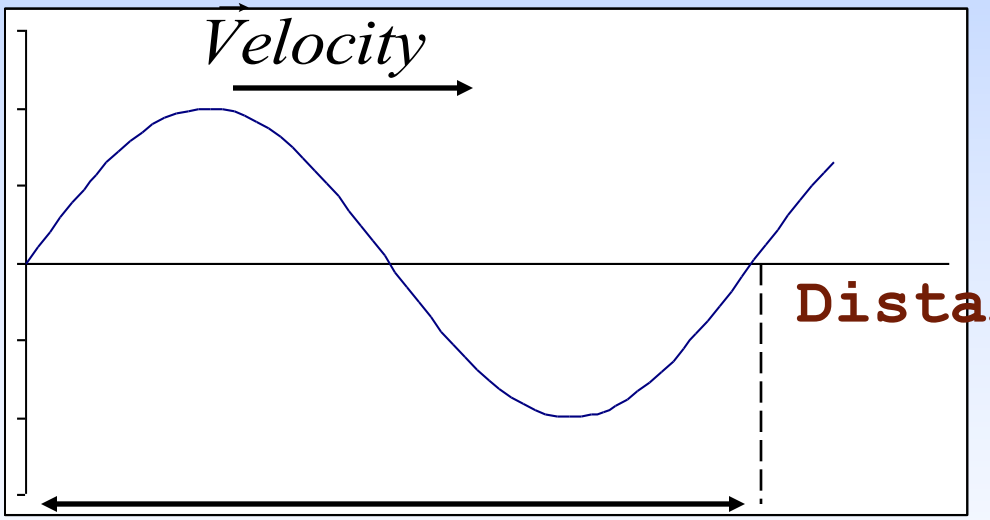


A.1) Wave Basics: focus on distance (and wavelength)

(common for general physics, Mech Engr, EE optics)

FREQUENCY (in Hz)

$$f = \frac{\vec{V}elocity}{WAVELENGTH}$$

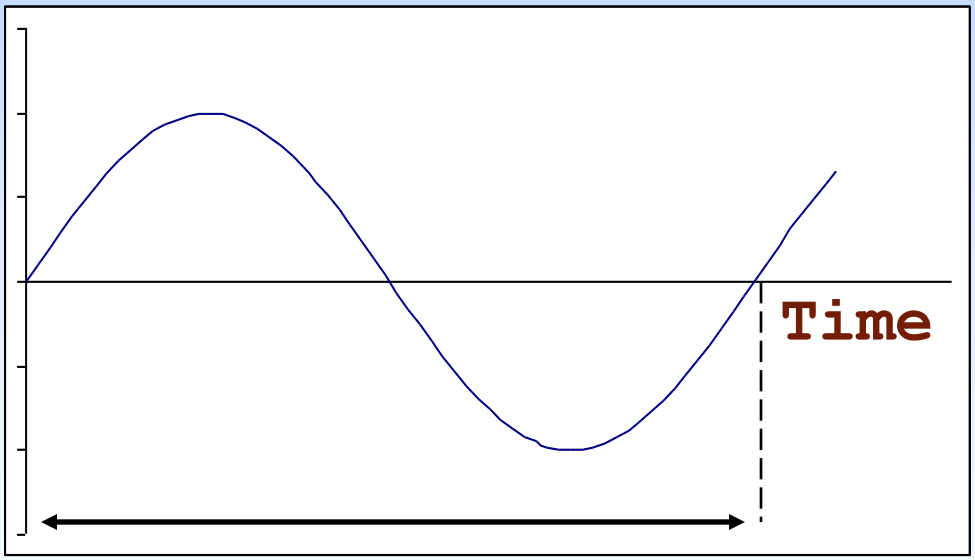


A.2) Wave Basics: *Focus on time*

(common for CS, CEngr, EE power, EE signals)

FREQUENCY (in Hz)

$$f = \frac{1}{PERIOD} = \frac{1}{CYCLE}$$

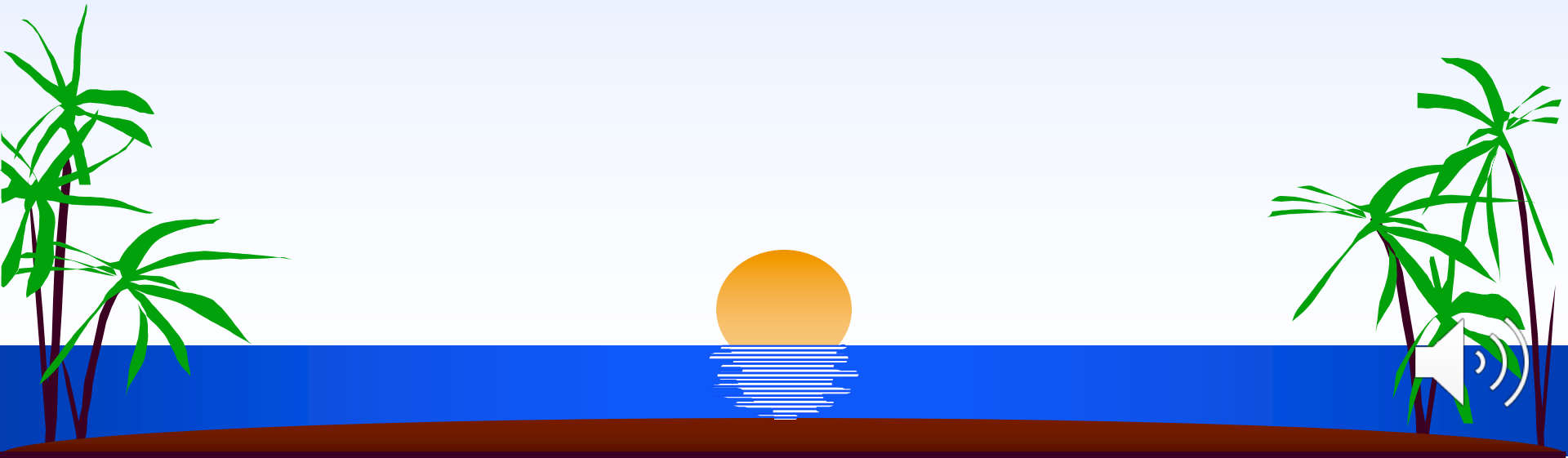


PERIOD or CYCLE

A.3) Wave Basics: *Complete understanding*

- For complete understanding, all Engineers and Scientists need to look at both distance and time (and amplitude)

- Need to use math tools
    - Trigometric functions (e.g., SIN)
    - Calculus: partial differential equations and chain rule as a function of time and distance

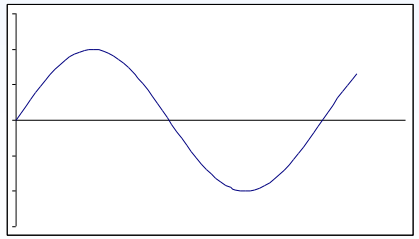


B.1) ANALOG

- Websters dictionary:
  "continuously variable quantities"

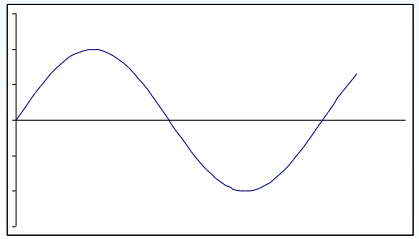
- No abrupt (step) changes over time

- Math: use Integrals and Derivatives of trigometric functions



B.2) ANALOG WAVES: Examples

- Ocean swells: focus on distance/time (velocity) and amplitude
- Sound: focus on distance/time (velocity) and amplitude (loudness)
- **P**lain **O**ld **T**elephone signals: focus on time and amplitude
- **E**lectro**M**agnetic radiation
    - Distance/time (velocity) approximately constant
    - Radio: focus on time, and amplitude
    - Light: focus on wavelength
- Electrical Power: focus on time, amplitude, and phase-shifts between related waves (e.g., Voltage lagging or leading Current)

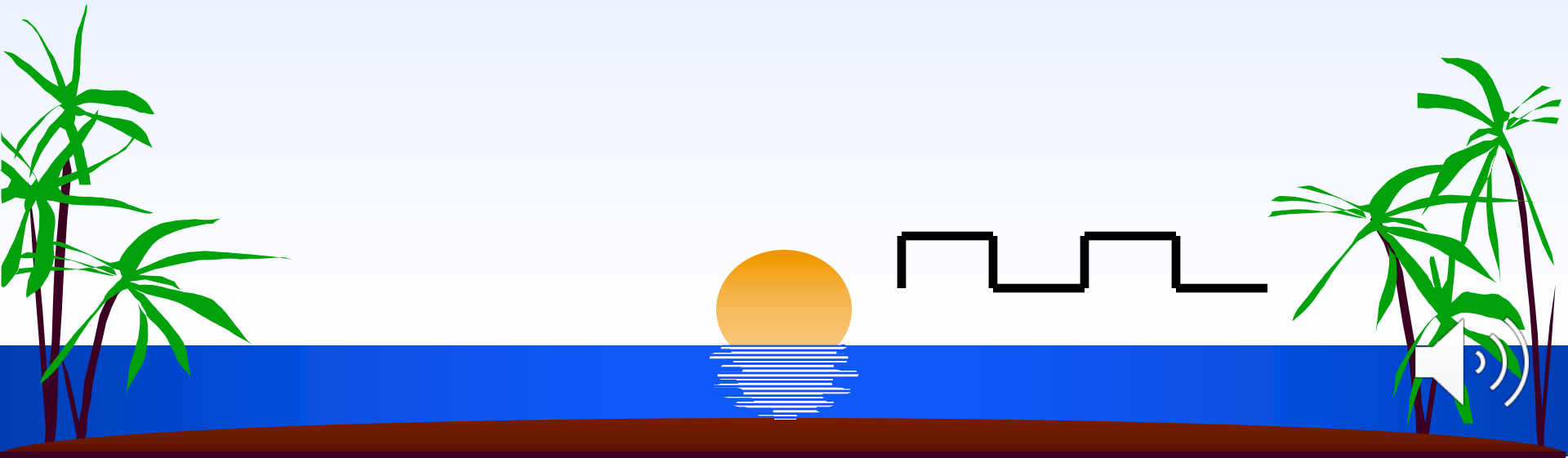


C.1) DIGITAL

- Wikipedia:

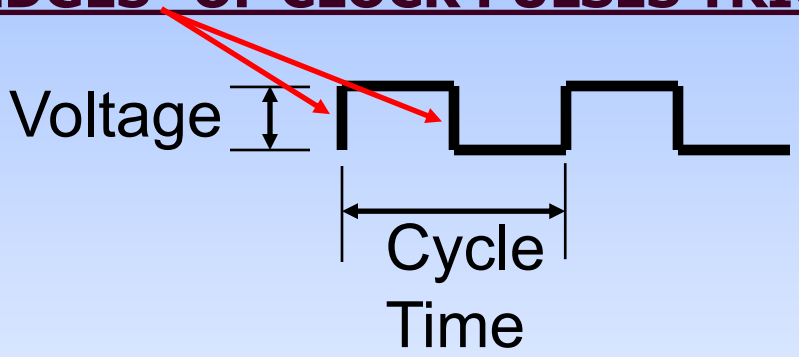
"uses numbers, especially binary numbers, for input, processing, transmission, storage, or display, rather than a continuous spectrum of values (an analog system) or non-numeric symbols such as letters or icons."

- Abrupt changes (steps) over time
- Math: Summations, time-series



C.2) DIGITAL WAVES: Examples

- Digital clock for CPU: focus on time (cycle) and amplitude (voltage)
- **VERTICAL "EDGES" OF CLOCK PULSES TRIGGER EVENTS**

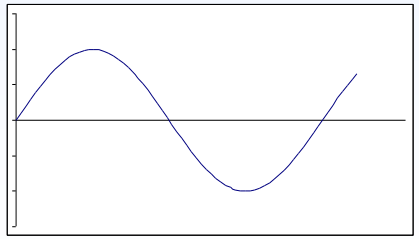


For example, in COMPUTER circuits, changes between machine states, or reading and writing to memory cells, or opening routing pathways for data

D) DIGITAL/ANALOG CONVERSIONS

- Modem (**Mod**ulate **Dem**odulate)
  - Converts between digital signals and analog signals on communication lines

- **A**nalog to **D**igital **C**onvertors and **D**igital to **A**nalog **C**onvertors
  - Allow digital computers to control the mostly analog physical systems of the natural world



E) SOME WAVE LIMITS

- Speed of Sound (in dry air): MACH 1 = **775 mi/hr** = **345 m/sec**

- Speed of Light (in vacuum): = 6.7x10^8 mi/hr = ~**3x10^8 m/sec**
  - Light year = 5.9x10^12 miles = the DISTANCE light travels in one year

- How much faster is light than sound? Answer:
  Since 345 = 3.45x10^2,
  3x10^8 / 3.45x10^2= ~10^6 = **1,000,000 times faster**

- Also, the Speed of Electricity in copper is ~ 1/3 speed of light

- *SOME TRIVIA (just for fun, answer these questions):*
  - *How fast is our fastest space ship?*
  - *How far away is the closest solar system?*
  - *How long would it take our fastest space ship to get there?*
  - *How long would it take our radio and TV broadcasts to get there?*