

# The Electromagnetic Spectrum



- The range of electromagnetic signals encompassing all frequencies is referred to as the **electromagnetic spectrum.**

# The Electromagnetic Spectrum

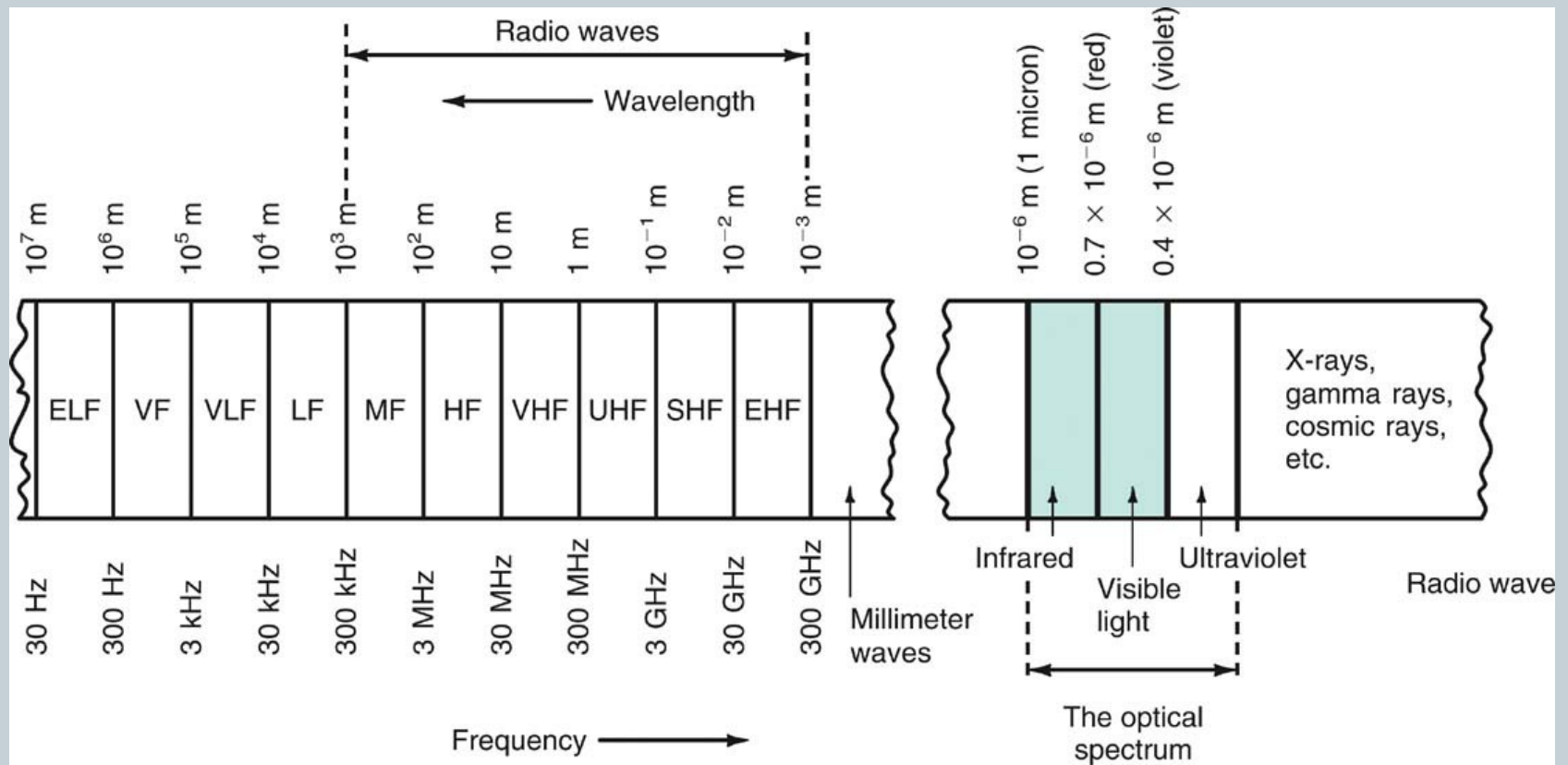


Figure 1-13: The electromagnetic spectrum.

# The Electromagnetic Spectrum



## Frequency and Wavelength: Frequency

- A signal is located on the frequency spectrum according to its frequency and wavelength.
- **Frequency** is the number of cycles of a repetitive wave that occur in a given period of time.
- A cycle consists of two voltage polarity reversals, current reversals, or electromagnetic field oscillations.
- Frequency is measured in cycles per second (cps).
- The unit of frequency is the hertz (Hz).

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## Frequency and Wavelength: Wavelength

- **Wavelength** is the distance occupied by one cycle of a wave and is usually expressed in meters.
- Wavelength is also the distance traveled by an electromagnetic wave during the time of one cycle.
- The wavelength of a signal is represented by the Greek letter lambda ( $\lambda$ ).

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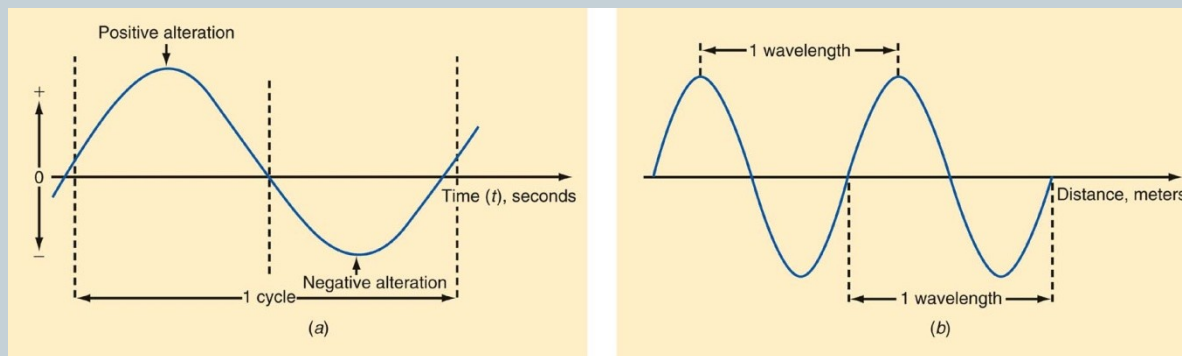


Figure 1-15: Frequency and wavelength. (a) One cycle. (b) One wavelength.

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## Frequency and Wavelength: Wavelength

Wavelength ( $\lambda$ ) = speed of light  $\div$  frequency

Speed of light =  $3 \times 10^8$  meters/second

Therefore:

$$\lambda = 3 \times 10^8 / f$$

Example:

What is the wavelength if the frequency is 4MHz?

$$\begin{aligned}\lambda &= 3 \times 10^8 / 4 \text{ MHz} \\ &= 75 \text{ meters (m)}\end{aligned}$$

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## Frequency Ranges from 30 Hz to 300 GHz

- The electromagnetic spectrum is divided into segments:

Extremely Low Frequencies (ELF)	30–300 Hz.
Voice Frequencies (VF)	300–3000 Hz.
Very Low Frequencies (VLF)	include the higher end of the human hearing range up to about 20 kHz.
Low Frequencies (LF)	30–300 kHz.
Medium Frequencies (MF)	300–3000 kHz AM radio 535–1605 kHz.

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## Frequency Ranges from 30 Hz to 300 GHz

High Frequencies (HF) (short waves; VOA, BBC broadcasts; government and military two-way communication; amateur radio, CB.	3–30 MHz
Very High Frequencies (VHF) FM radio broadcasting (88–108 MHz), television channels 2–13.	30–300 MHz
Ultra High Frequencies (UHF) TV channels 14–67, cellular phones, military communication.	300–3000 MHz



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## Frequency Ranges from 30 Hz to 300 GHz

<p>Microwaves and Super High Frequencies (SHF)</p> <p>Satellite communication, radar, wireless LANs, microwave ovens</p>	<p>1–30 GHz</p>
<p>Extremely High Frequencies (EHF)</p> <p>Satellite communication, computer data, radar</p>	<p>30–300 GHz</p>