Edgenuity

Warm-Up | Electromagnetic Waves

Lesson Question

How do the types of electromagnetic waves differ?

Lesson Goals

Explore electromagnetic waves.

- **Identify** and compare the different regions of the electro-magnetic spectrum.
- **Solve** problems involving frequency, wavelength, speed, and energy.
- **Identify** uses and applications of electromagnetic waves.

Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

electric field	the area around a charged object that can exert a force on other charged objects
electromagnetic spectrum	the range of wavelengths and frequencies of electromagnetic waves
electromagnetic wave	a wave composed of electric and magnetic fields that radiates out from a source at the speed of light

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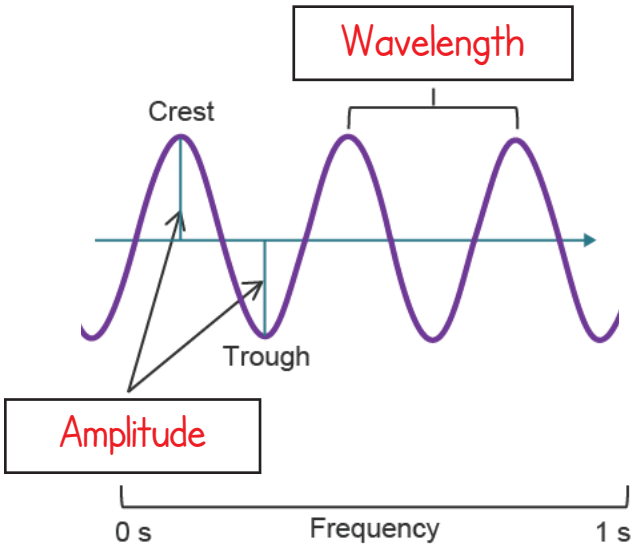
Words to Know

magnetic field	the area around a magnet that exerts a force on objects containing certain metals
polarization	a process that modifies light waves so that they vibrate in a single plane

Waves

- Types of waves
  - Mechanical – ocean waves
  - Electromagnetic – light waves
- Parts of a transverse wave
  - Crest
  - Trough
  - Amplitude
  - Wavelength
  - Frequency



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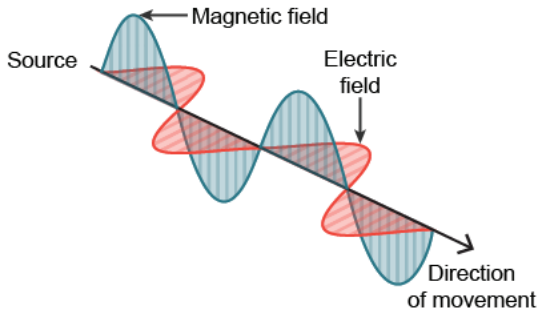
Electrical and Magnetic Fields

- An **electric field** is the area around a charged object that can exert a force on other [charged] objects.
- A **magnetic field** is the area around a magnet that exerts a force on objects containing certain [metals].

Electromagnetic Wave

- An electromagnetic wave is composed of electric and magnetic fields and [radiates] out from a source at the speed of light.
  - Speed of light $= 3 \times 10^8 \text{ m/s}$
- An electromagnetic wave is produced when charged particles are [disturbed].
  - Disturbed charged particles produce oscillating [magnetic] and electric fields.



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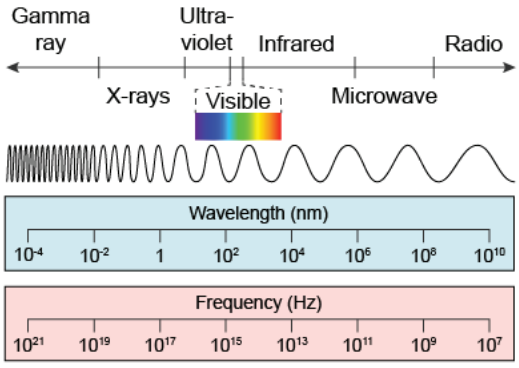
Regions of the Electromagnetic Spectrum

The **electromagnetic spectrum** is the range of [wavelengths] and frequencies of electromagnetic waves.

- Gamma rays have the [shortest] wavelength.
- The longest waves are radio waves.
- [Radio waves] have the lowest frequency.
- Gamma has the highest frequency.



Wavelength and Frequency

- Wavelength and frequency have an [inverse] relationship.
  - As the wavelength increases, the [frequency] decreases.
  - As the wavelength decreases, the frequency increases.

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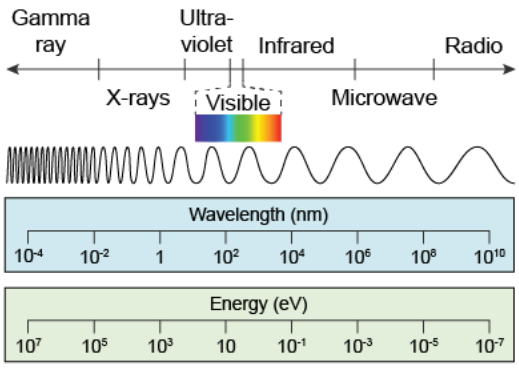
Frequency and Energy

The frequency of a wave and the [energy] transferred by the wave have a direct relationship.



$$E = hf$$

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Frequency, Wavelength, and Speed

- Variables:
  - c = speed of light in a [vacuum]
    $c = 3 \times 10^8$ meters per second
  - f = frequency of a [wave] (hertz)
  - λ = wavelength of a wave (meters)

$$c = f\lambda$$

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Frequency of a Wave

EXAMPLE

The wavelength of red light is 650 nm and its speed is $c = 3 \times 10^8$ m/s. What is the frequency of red light?

- Given
  - $\lambda = 650\,\text{nm}$
  - $c = 3 \times 10^8$ m/s
- Unknown: f
  - f
- Formula to use:
  - $f = \frac{c}{\lambda}$

Solution:

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

$$f = \frac{3 \times 10^8 \text{ m/s}}{650 \times 10^{-9} \text{ m}}$$

$$= \boxed{4.61 \times 10^{14}} \text{ Hz}$$

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Speed of Electromagnetic Waves in Different Media

- The speed of light is [different] in different media.
  - The differences in speed are due to the composition of the medium and the [density] of the particles in the medium.

Medium	Speed of light (m/s)
Vacuum	3×10^8
Air	2.99×10^8
Diamond	1.24×10^8
Glass	1.97×10^8
Ice	2.29×10^8
Water	2.25×10^8

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Frequency, Wavelength, and Speed of Waves Traveling in Various Media

$s = f\lambda$

- As a wave travels through different media, its:
  - speed [changes].
  - frequency remains the same.
  - wavelength changes.
- Speed and wavelength have a [direct] relationship.

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X-rays and Gamma Rays

X-rays are used for [diagnosis] and gamma rays are used for treatment of [diseases].

Ultraviolet Rays

Ultraviolet waves are used to destroy [bacteria] and viruses, and to [detect] counterfeit paper money.

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Visible Light

Visible light allows humans and many animals to see objects and perceive [color].

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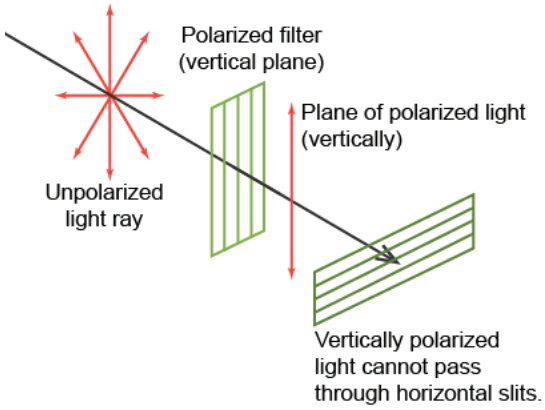
Polarization

- Visible light can be [manipulated] for eye protection through a process called **polarization**.
  - Polarizers modify light waves so that they vibrate in a [single] plane.



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Infrared Rays

Infrared waves are used in heat lamps and [remote] controls.

Microwaves

Microwaves are used to transmit information to cell phones and to warm up [food].

Radio waves

Radio waves are used to transmit [information] to radios and create MRI (magnetic resonance imaging) images to diagnose and [treat] illnesses.

Summary | Electromagnetic Waves

Lesson Question

How do the types of electromagnetic waves differ?

Answer

(Sample answer) The types of electromagnetic waves have different wavelengths, frequencies, and amount of energy they transfer, as well as different uses and applications.

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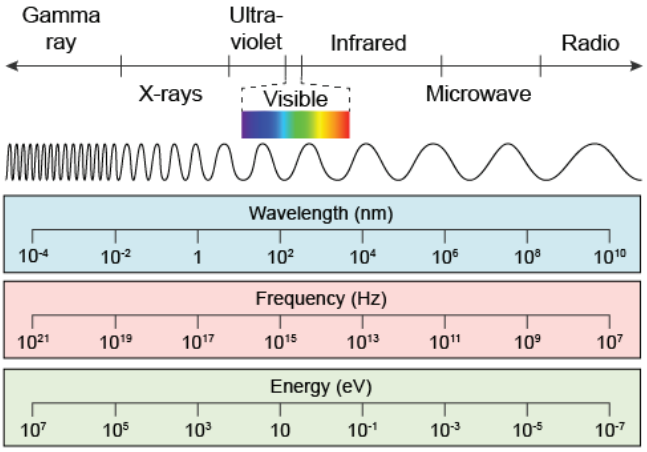
Review: Key concepts



We have gamma rays, X-rays, ultraviolet, the visible spectrum, infrared, microwave, and radio waves. They differ in [wavelength], [frequency], and the amount of energy that they transfer.

Summary | Electromagnetic Waves

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- The relationship between the frequency, wavelength, and speed of a wave can be expressed mathematically.

$$c = f\lambda$$

Wave	Applications
Radio waves	Radios and MRIs
Microwaves	Cell phones and microwaves
Infrared	Heat lamps and remote controls
Visible light	Vision
Ultraviolet	Germicidal lamps
X-rays	Medical imaging
Gamma rays	Lasers

Summary | Electromagnetic Waves

Use this space to write any questions or thoughts about this lesson.