Light & Optics
Learning Guide

NewPath Learning

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LESSON 1

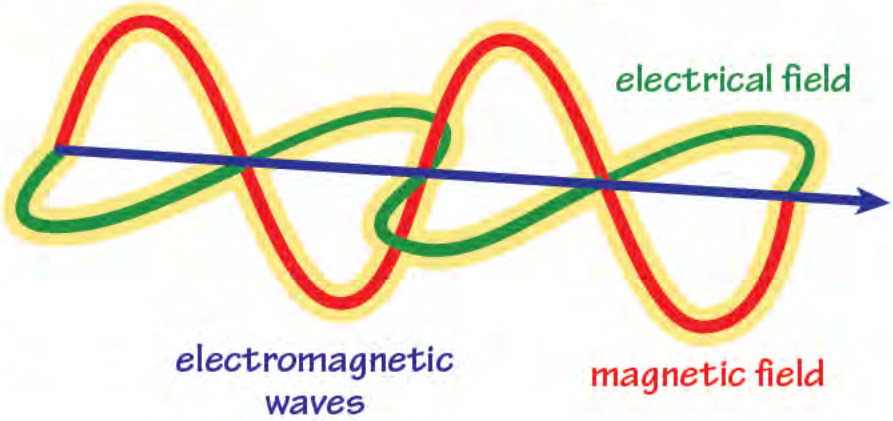
INTRODUCTION TO LIGHT

Electromagnetic Waves

What surrounds you and bombards you constantly? Most of it is invisible but you can't imagine living without it. It is **electromagnetic radiation**, a type of energy commonly known as **light**. This energy is produced by the **vibration of charged particles**.

As charged particles move back and forth, the **electric field** around them **vibrates**, creating a **vibrating magnetic field**. The two vibrating fields, which are at right angles to each other, produce **electromagnetic waves**.

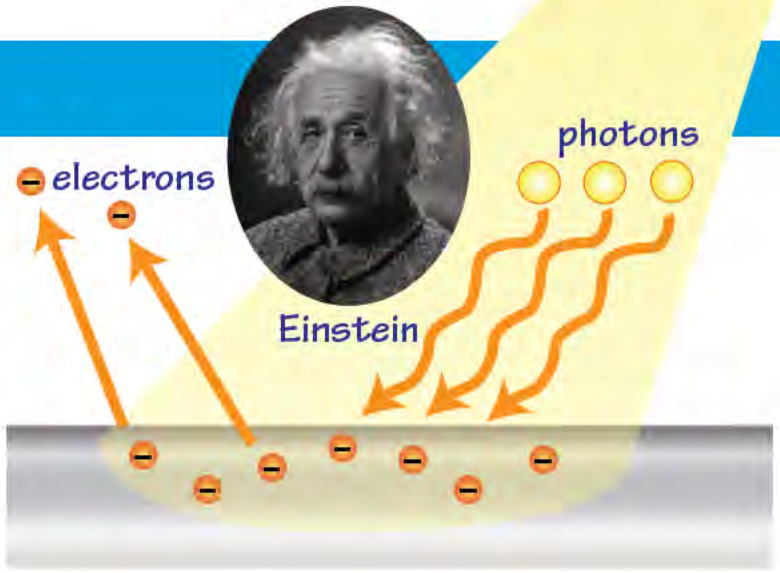
These waves can travel through materials as well as a vacuum. All **electromagnetic waves** travel at the incredible speed of about **300,000 km/s** in a vacuum, often called the **speed of light**. This speed is equal to the wavelength of light times its frequency and is represented by the equation **c = wavelength x frequency**.



c (speed of light) = 300, 000 km/s

c = wavelength (λ) x frequency (ν)

Light: Wave or Particle



Most of us think of **light** as a wave. **Waves** easily explain interactions such as **reflection**. However, early in the 20th century, some scientists noticed that light hitting a metal surface can sometimes **eject electrons**. How can **light waves** do this? **Albert Einstein** showed this can only happen if **light** is made up of tiny particles called **photons**. **Einstein** revolutionized physics by describing **light** as **photons**. Scientists now believe **light** exhibits **both** wave and particle properties.

Electromagnetic Spectrum

Although every **electromagnetic wave** travels at the **same speed**, each can have a **different wavelength** and **frequency**. The **electromagnetic spectrum** organizes the types of light by **decreasing wavelength** and **increasing frequency**, from left to right. It includes **radio waves, microwaves, infrared light, visible light, ultraviolet light, x-rays**, and **gamma rays**. The **energy** of the **electromagnetic wave** is also related to **wavelength** and **frequency**. **Energy** is **directly proportional** to **frequency** and **inversely proportional to wavelength**. Higher frequency, shorter wavelength waves have higher energy. The wave energy **increases** from left to right across the spectrum. On the spectrum, **radio waves** have the **lowest** energy while **gamma rays** have the **highest** energy.