



All other familiar waves that travel through space involve only one quantity (water height, gas pressure, etc) that varies in a cyclic manner. They also travel through a physical medium (water, air, rock, etc).

As the figure to the left shows, electromagnetic waves involve two quantities that vary in step with each other: an electric field (red) and a magnetic field (blue). Electromagnetic waves do not require a medium to travel through because the fields that make them up are their own medium!

As with other wave phenomena, the speed, frequency and wavelength of electromagnetic waves are related by the simple formula  $c = f \times \lambda$  where  $c$  is the speed of light (299,792.4 km/sec).

**Problem 1** – The first electromagnetic wave ever created artificially was created in 1887 by the German physicist Heinrich Hertz in his laboratory. The wavelength was 4 meters. At what frequency did his transmitter have to oscillate to create these waves?

**Problem 2** – A physicist uses a piece of electrical equipment to generate an electric current that changes at a frequency of 1 trillion hertz. If he measures a wavelength of 0.0003 meters, what was the speed of the 'EM' radiation he was able to experimentally derive in this way?

**Problem 1** – The first electromagnetic wave ever created artificially was created in 1887 by the German physicist Heinrich Hertz in his laboratory. The wavelength was 4 meters. At what frequency did his transmitter have to oscillate to create these waves?

Answer: Frequency =  $c/w$  so  
= 300,000,000 m/s / 4 meters  
= 75,000,000 hz or 75 megahertz.

**Problem 2** – A physicist uses a piece of electrical equipment to generate an electric current that changes at a frequency of 1 trillion hertz. If he measures a wavelength of 0.0003 meters, what was the speed of the 'EM' radiation he was able to experimentally derive in this way?

Answer: Speed = frequency x wavelength  
=  $1.0 \times 10^{12}$  hz x 0.0003 meters  
=  $3 \times 10^8$  meters/sec

**Note to Teacher:**

Hertz did not realize the practical importance of his experiments. He stated that,

*"It's of no use whatsoever[...] this is just an experiment that proves Maestro Maxwell was right - we just have these mysterious electromagnetic waves that we cannot see with the naked eye. But they are there."*

Asked about the ramifications of his discoveries, Hertz replied,

*"Nothing, I guess."*