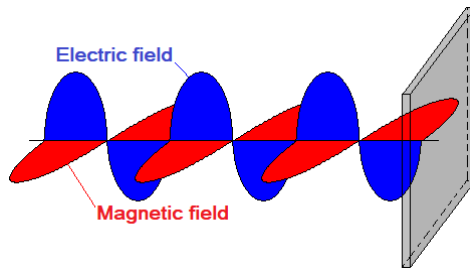


Physics II

EM Wave Intensity



The intensity of an electromagnetic wave is defined as power per area, or energy per time per area.

$$I = \frac{P}{A} = \frac{E}{tA}$$

The intensity of an electromagnetic wave is given by:

$$I = \epsilon_0 c E_{rms}^2 \quad \text{Where } E_{rms} \text{ is the root mean square value of the } \textit{electric field}$$

E stands for electric field, not energy, in this equation. If you use the peak value instead of the rms value, you need to divide the equation by 2.

$c = 2.998 \times 10^8$ m/s speed of light in vacuum

$\epsilon_0 = 8.85 \times 10^{-12}$ F/m Permittivity of free space

Problem 1.- A laser delivers 15 mJ to an area of 1 mm^2 in a pulse that lasts 10 ns. Calculate the amplitude of the electric field.

Problem 2.- A pulsed excimer laser emits 0.135J of energy in a pulse that lasts 15ns and it is focused over an area of 2.25 mm^2 . Calculate the amplitude of its magnetic field.

Problem 3.- If the amplitude of the electric field of an EM wave is 5.5 V/m, (a) Calculate the amplitude of the magnetic field and (b) Find the average intensity (power per unit area) of the wave.

Problem 4.- If the average intensity of an EM wave is $1.5 \times 10^{-3} \text{ W/m}^2$, calculate the amplitudes of the electric and magnetic fields. [$Z_0 = 377 \Omega$].

Problem 5.- Based on your newly acquired knowledge of electromagnetic waves, why would you say that water is heated in a microwave oven, but air not so much?

Problem 6.- An FM station broadcasts with a power of 1kW in all directions. How much is the amplitude of the electric field when detected by a car radio antenna 2.3 km away from the station?