

Light and Reflection

Problem A**ELECTROMAGNETIC WAVES****PROBLEM**

The atoms in an HCl molecule vibrate like two charged balls attached to the ends of a spring. If the wavelength of the emitted electromagnetic wave is $3.75 \mu\text{m}$, what is the frequency of the vibrations?

SOLUTION

Given: $\lambda = 3.75 \times 10^{-6} \text{ m}$

$$c = 3.00 \times 10^8 \text{ m/s}$$

Unknown: $f = ?$

Use the wave speed equation, and solve for λ .

$$c = f\lambda$$

$$f = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \text{ m/s}}{3.75 \times 10^{-6} \text{ m}} = 8.00 \times 10^{13} \text{ Hz}$$

ADDITIONAL PRACTICE

1. New-generation cordless phones use a $9.00 \times 10^2 \text{ MHz}$ frequency and can be operated up to 60.0 m from their base. How many wavelengths of the electromagnetic waves can fit between your ear and a base 60.0 m away?
2. The highest *directly* measured frequency is $5.20 \times 10^{14} \text{ Hz}$, corresponding to one of the transitions in iodine-127. How many wavelengths of electromagnetic waves with this frequency could fit across a dot on a book page? Assume the dot is $2.00 \times 10^{-4} \text{ m}$ in diameter.
3. Commercial trucks cause about 18 000 lane-change and merging accidents per year in the United States. To prevent many of them, a warning system covering blind spots is being developed. The system uses electromagnetic waves of frequency $2.40 \times 10^{10} \text{ Hz}$. What is the wavelength of these waves?
4. A typical compact disc stores information in tiny pits on the disc's surface. A typical pit size is $1.2 \mu\text{m}$. What is the frequency of electromagnetic waves that have a wavelength equal to the typical CD pit size?
5. A new antiterrorist technique detects the differences in electromagnetic waves emitted by humans and by weapons made of metal, plastic, or ceramic. One possible range of wavelengths used with this technique is from 2.0 mm to 5.0 mm. Calculate the associated range of frequencies.
6. The U.S. Army's loudest loudspeaker is almost 17 m across and is transported on a special trailer. The sound is produced by an electromagnetic coil that can generate a minimum frequency of 10.0 Hz. What is the wavelength of these electromagnetic waves?