

Quantum Concepts – Electromagnetic Energy

Answer each question in the space required. Show all work.

Pick your favorite FM radio station in the Boston area.

1. List the station call letters and the frequency of transmission. (FM frequencies are MHz.)

2. Calculate the wavelength of the broadcast signal from your favorite radio station.

3. What is the energy of one quantum of EM radiation from the broadcast signal of your favorite station?

4. If you listened to a radio station that has a transmission wavelength that is twice that of your favorite radio station, at what frequency would you find this station on your radio dial?

5. What is the wavelength of EM radiation that has 10 times more energy per quantum than your favorite radio station?

6. Many radio stations transmit their signal with “fifty thousand watts of power”. Assume the radio transmitter broadcasts the signal evenly dispersed in all directions (spherically symmetric). At a distance of 75 kilometers, what power level per square meter would be measured?

Quantum Concepts – Electromagnetic Energy

7. A typical FM antenna on a car is what is called a “quarter wavelength” antenna. This means that the length of the antenna is equal to one quarter of the wavelength of the FM transmission. Assume your car antenna is a “quarter wavelength” antenna that is perfectly tuned to your radio station. What is the length of your car antenna?

8. Many car antennae are about 0.25 cm in diameter. Assume the cross-sectional surface area of the antenna that will “catch” the radio signal is a rectangle that is 0.25 cm wide and has the length from the previous question. What surface area does your car antenna present?

9. At a distance of 75 km from the radio transmitter, how many quanta of energy could your car antenna “catch” every second?

10. Consider This: Estimate the number of FM radio stations in your area. Consider the cross-sectional area that your body presents to each of these radio stations. Estimate the total quanta of radio signal EM radiation that pass through your body ever second!

11. How do you survive this constant irradiation of radio energy? (This is not intended to be a rhetorical question! Try answering it.)