

The speed of electromagnetic waves in vacuum is $3.0 \times 10^8 \text{ m/s}$.

(1) Determine the frequency range of visible light given $\lambda_{\text{red}} = 700 \text{ nm}$ and $\lambda_{\text{violet}} = 400 \text{ nm}$.

(2) Determine the wavelength range for FM radio and VHF television given the frequency range of $1.5 \text{ MHz} - 300 \text{ MHz}$.

(3) Determine the frequency range for x-rays given a wavelength range of $5.0 \text{ nm} - 1.0 \times 10^{-2} \text{ nm}$.

(1) solution

$$v = f\lambda$$

$$f = \frac{v}{\lambda}$$

$$f_{\text{red}} = \frac{3.0 \times 10^8 \text{ m/s}}{700 \times 10^{-9} \text{ m}} = \boxed{4.3 \times 10^{14} \text{ Hz}}$$

$$f_{\text{violet}} = \frac{3.0 \times 10^8 \text{ m/s}}{400 \times 10^{-9} \text{ m}} = \boxed{7.5 \times 10^{14} \text{ Hz}}$$

(2) solution

$$v = f \lambda$$

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{3.0 \times 10^8 \text{ m/s}}{1.5 \times 10^6 \text{ Hz}} = 200 \text{ m}$$

$$\lambda = \frac{3.0 \times 10^8 \text{ m/s}}{300 \times 10^6 \text{ Hz}} = 1.0 \text{ m}$$

(3) solution

$$v = f \lambda$$

$$f = \frac{v}{\lambda}$$

$$f = \frac{3.0 \times 10^8 \text{ m/s}}{5.0 \times 10^{-9} \text{ m}} = 6.0 \times 10^{16} \text{ Hz}$$

$$f = \frac{3.0 \times 10^8 \text{ m/s}}{1.0 \times 10^{-11} \text{ m}} = 3.0 \times 10^{19} \text{ Hz}$$