Chapter 14 Problem 19 [†]

Given
$v = 3.0 \times 10^8\ m/s$

Solution
a) Find the wavelength of a 1.0 MHz AM wave.

The relationship between wavelength and frequency is

$$v = f\lambda$$

Solving for wavelength gives

$$\lambda = \frac{v}{f} \tag{1}$$

Substituting in the know values gives

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

b) Find the wavelength of channel 9 (190 MHz).

Use equation 1 given above and substitute in the known values.

$$\lambda = \frac{(3.0 \times 10^8\ m/s)}{(190 \times 10^6\ Hz)} = 1.58\ m$$

c) Find the wavelength of police radar (10 GHz).

Use equation 1 given above and substitute in the known values.

$$\lambda = \frac{(3.0 \times 10^8\ m/s)}{(10 \times 10^9\ Hz)} = 3.0 \times 10^{-2}\ m = 3.0\ cm$$

d) Find the wavelength of IR radiation ($4.0 \times 10^{13}\ Hz$).

Use equation 1 given above and substitute in the known values.

$$\lambda = \frac{(3.0 \times 10^8\ m/s)}{(4.0 \times 10^{13}\ Hz)} = 7.5 \times 10^{-6}\ m = 7.5\ \mu m$$

e) Find the wavelength of green light ($6.0 \times 10^{14}\ Hz$).

Use equation 1 given above and substitute in the known values.

$$\lambda = \frac{(3.0 \times 10^8\ m/s)}{(6.0 \times 10^{14}\ Hz)} = 5.0 \times 10^{-7}\ m = 500\ nm$$

f) Find the wavelength of X-rays ($1.0 \times 10^{18}\ Hz$).

Use equation 1 given above and substitute in the known values.

$$\lambda = \frac{(3.0 \times 10^8\ m/s)}{(1.0 \times 10^{18}\ Hz)} = 3.0 \times 10^{-10}\ m = 0.30nm = 3.0\ \mathring{A}$$

[†]Problem from Essential University Physics, Wolfson