Problem # 11 Fall 2003

$$k^2c^2 = \omega^2 - 4\pi n e^2/m_e$$

$c = 3\times10^{10}$ $m_e = 9.11\times10^{-28}$ $e = 4.8\times10^{-10}$

a) <u>For Transmission</u>

$$\omega^2 - \frac{4\pi n e^2}{m_e} \geq 0$$

otherwise K is imaginary and the radiation is absorbed

$$\Rightarrow \frac{4\pi n e^2}{m_e} = \omega^2$$ is the frequency where transmission stops.

$$n = \frac{\omega^2 m_e}{4\pi e^2} = \frac{(2\pi\, 10^7)^2(9.11\times10^{-28})}{4\pi(4.8\times10^{-10})^2}$$

$$n \approx \frac{\pi}{25}\frac{10^{14}\times10^{-27}}{10^{-20}} = \frac{\pi}{25}10^7$$

So from the information given, one might conclude that Radiation with frequencies below 10 MHz can't be recieved from space because the earth is surrounded by a plasma of density $n \approx \frac{\pi}{25} 10^7$

I looked on the internet, and indeed this is the case.

b) $K = \frac{\omega}{v}$ $n = 0.01 \text{ cm}^{-3}$ $d = 1 \times 10^{22} \text{ cm}$

$d = v t$ $t = \frac{d}{v}$ $\omega_2 = 10 \text{ KHz}$ $\omega_1 = 6 \text{ KHz}$

$$\frac{1}{v} = \frac{1}{c}\sqrt{1 - \frac{4\pi n e^2}{\omega^2 m_e}}$$

$$t = \frac{d}{v} = \frac{d}{c}\sqrt{1 - \frac{4\pi n e^2}{\omega^2 m_e}}$$

$$t_2 - t_1 = \frac{d}{c}\left\{\sqrt{1 - \frac{4\pi n e^2}{\omega_2^2 m_e}} - \sqrt{1 - \frac{4\pi n e^2}{\omega_1^2 m_e}}\right\}$$