

Model Solution: Homework 5A

Physics U603

Summer 1 2006

Hecht 3-21: The flux density $\vec{J} = \rho\vec{v}$ of any quantity depends on its density ρ and the average velocity \vec{v} of the particles carrying the quantity. For the locusts in this problem, the flux density is $\vec{J} = \left(100 \text{ bugs/m}^3\right) (6 \text{ m/min})\hat{j} = 600\hat{j} \text{ bugs/m}^2\text{min} = 10\hat{j} \text{ bugs/m}^2\text{s}$, if the coordinate system is oriented with the y -axis pointing north.

Hecht 4-2: The oscillating electric field in the floodlight will induce charged particles (electrons) in the gas molecules to oscillate at the same frequency. In turn, these charged particles will emit electromagnetic waves with an intensity

$$\langle S \rangle = \frac{\mu_0}{32\pi^2 c} \frac{p_o^2 \sin^2 \theta}{r^2} \omega^4$$

that depends on the direction θ (relative to the incident electric field, not beam direction) as well as on frequency. We can assume that p_0 does not depend on frequency, for frequencies far from any resonances. In other words, the electrons in the gas molecules respond equally well at all frequencies. In this case, the relative intensity of light scattered at frequencies ω_y and ω_v is $(\omega_y^4/\omega_v^4) = (\lambda_v/\lambda_y)^4 = (400/580)^4 = 0.226$.