659.

Problem 46.17 (RHK)

The two headlights of an approaching automobile are 1.42 m *apart. We have to find* (a) *angular separation and* (b) *the maximum distance at which the eye can resolve them. We may assume a pupil diameter of* 5.00 mm *and a wavelength of* 562 nm. *Also, we will assume that diffraction effects alone limit the resolution.*

Solution:

(a)

We will use Rayleigh's criterion that two objects must have an angular separation at least θ_R to be resolvable by a lens of aperture *d* using light of wavelength λ .

$$\theta_R = \sin^{-1}\left(\frac{1.22\lambda}{d}\right).$$

Data of the problem are

$d = 5.00$ mm,

$\lambda = 562$ nm.

Therefore,

$$\theta_R = \sin^{-1}\left(\frac{1.22\times 562\times 10^{-9}}{5.0\times 10^{-3}}\right) = 0.137\times 10^{-3}\ \text{rad}$$

$$= 137\ \mu\text{rad}.$$

(b)

The maximum distance at which the headlights separated by a distance of 1.42 m will be barely resolvable will therefore be

$$\frac{1.42\ \text{m}}{l} = 137\times 10^{-6}\ \text{rad},$$

or

$$l = \frac{1.42\ \text{m}}{137\times 10^{-6}} = 10.36\ \text{km};\ 10.4\ \text{km}.$$