

Problems are from Tipler Chapter 33:

(1) **7** As the width of a slit producing a single-slit diffraction pattern is slowly and steadily reduced, how will the diffraction pattern change?

(2) **12** It is claimed that the Great Wall of China is the only human object that can be seen from space with the naked eye. Make an argument in support of this claim based on the resolving power of the human eye. Evaluate the validity of your argument for observers both in low-earth orbit (~ 400 km altitude) and on the moon.

(3) **18** Light of wavelength 500 nm is incident normally on a film of water 10^{-4} cm thick. The index of refraction of water is 1.33. (a) What is the wavelength of the light in the water? (b) How many wavelengths are contained in a distance $2t$ where t is the thickness of the film? (c) What is the phase difference between the wave reflected from the top of the air-water interface and the wave reflected from the bottom of the water-air interface after it has traveled this distance?

(4) **22** Light of wavelength 600 nm is used to illuminate two glass plates at normal incidence. The plates are 22 cm in length, touch at one end, and are separated at the other end by a wire of radius 0.025 mm. How many bright fringes appear along the total length of the plates?

(5) **31** Using a conventional two-slit apparatus with light of wavelength 589 nm, 28 bright fringes per centimeter are observed on a screen 3 m away. What is the slit separation?

(6) **38** Plane microwaves are incident on a thin metal sheet with a long, narrow slit of width 5 cm in it. The first diffraction minimum is observed at $\theta = 37^\circ$. What is the wavelength of the microwaves?

(7) **40** How many interference maxima will be contained in the central diffraction maximum in the interference-diffraction pattern of two slits if the separation d of the slits is 5 times their width a ? How many will there be if $d = na$ for any value of n ?

(8) **55** Two sources of light of wavelength 700 nm are separated by a horizontal distance x . They are 5 m from a vertical slit of width 0.5mm. What is the least value of x for which the diffraction pattern of the sources can be resolved by Rayleigh's criterion?

(9) **60** The star Mizar in Ursa Major is a binary system of stars of nearly equal magnitudes. The angular separation between the two stars is 14 seconds of arc. What is the minimum diameter of the pupil that allows resolution of the two stars using light of wavelength 550 nm.

(10) **86** In a pinhole camera, the image is fuzzy because of geometry (rays arrive at the film after passing through different parts of the pinhole) and because of diffraction. As the pinhole is made smaller, the fuzziness of geometry is reduced but the fuzziness due to diffraction is increased. The optimum size of the pinhole for the sharpest possible image occurs when the spread due to diffraction equals the spread due to the geometric effects of the pinhole. Estimate the optimum size of the pinhole if the distance from the pinhole to the film is 10 cm and the wavelength of the light is 550 nm.