The University of British Columbia

Physics 122 Assignment # 12:

DIFFRACTION

Wed. 27 March — finish by Wed. 03 April 2002

1. SOUND DIFFRACTION: You are standing 30 m away from a large, soundproof building, directly in front of a 1 m wide doorway, when it opens and you hear someone blowing a loud whistle at a frequency of 1320 Hz from somewhere directly behind the door, deep inside the building. How far sideways (parallel to the wall with the door in it) must you move before the sound first becomes imperceptible? [Assume that the speed of sound is 343 m/s.]

2. 10-SLIT MINI-GRATING: Consider a series of 10 equal slits, each 0.004 cm wide, arrayed in a straight line with equal spacing so that 0.22 cm separates the centres of the first and last slits. This configuration is illuminated from behind by a distant source of light of wavelength 0.546 microns [μm].

(a) How many *major* intensity peaks will you see in the *entire* pattern displayed on a wide screen 20 m away before the pattern first fades away laterally because of the diffraction from each aperture?

(b) How far apart and how wide[1] (in mm) are the principal[2] maxima near the centre of the screen?

(c) *Sketch* the intensity pattern from the central maximum out to the second diffraction minimum on one side.

3. DIFFRACTION-LIMITED VISION: In fairly bright light the pupil of your eye will contract to a diameter of about 4 mm. Under these conditions, assuming that you have "perfect" vision,

(a) how far from your eye can you hold a book and still be able to resolve two identical black dots 10 μm in diameter, separated by 100 μm, using yellow light with $\lambda =$ 575 nm?

(b) Describe in detail what you would see at this distance when observing a *single white dot* 10 μm in diameter on a *black page* illuminated with *white* light (all wavelengths).

[1] [The *width* is the distance from the nearest zero on one side to the nearest zero on the other side.]

[2] ["principal" ≡ "major"]