

# CLASS EXERCISE #21 - 26 July 2005

Laser light of wavelength  $\lambda$  passes through two slits onto a screen. The slits each have width  $a$  and the separation between the centers of the two slits is six times as large:  $d = 6a$ .

What is the smallest value of  $\sin \theta$  (in terms of  $\lambda$ ,  $d$ , and  $a$ ) for an angle  $\theta > 0$  where an interference maximum appears to be missing because it coincides with a diffraction minimum?

Which interference maxima appear to be missing (for example, the 3rd, 5th, 7th, etc.)?

*Explain in words your reasoning and the formulas you are using to show this.*

The interference maxima occur for  $d \sin \theta = m\lambda$  or

$$\sin \theta = m\lambda/d = m\lambda/6a \text{ for } m = 0, 1, 2, 3, \text{ etc.}$$

or  $\sin \theta = \lambda/6a, 2\lambda/6a, 3\lambda/6a, 4\lambda/6a, 5\lambda/6a, 6\lambda/6a,$   
 $7\lambda/6a, 8\lambda/6a, \dots$

The diffraction minima occur for  $a \sin \theta = m'\lambda$  or

$$\sin \theta = m'\lambda/a \text{ for } m' = 1, 2, 3, \text{ etc.}$$

or  $\sin \theta = \lambda/a, 2\lambda/a, 3\lambda/a, 4\lambda/a, 5\lambda/a, 6\lambda/a, \dots$

The smallest value of  $\sin \theta$  that occurs on both these lists is

$$\sin \theta = \lambda/a$$

corresponding to the first diffraction minimum and the sixth interference maximum (not counting the central maximum). The sixth interference maximum will then be missing.

More generally an interference maximum coincides with a diffraction minimum when  $m\lambda/6a = m'\lambda/a$  or  $m = 6m'$ , or for  $m = 6, 12, 18, \dots$  (every 6th interference maximum).