677.

Problem 47.19 (RHK)

White light $(400 \text{ nm} < \lambda < 700 \text{ nm})$ is incident on a grating. We have to show that no matter what the value of the grating spacing d is, the second- and third-order spectra will overlap.

Solution:

The grating equation is

$$d \sin \theta = m\lambda, \ m = 0, \pm 1, \pm 2, ...$$

The spread of the visible light in the second- and third-order spectra will therefore be

2ⁿᵈ order

$$A = \sin^{-1}\left(\frac{800 \text{ nm}}{d}\right) < \theta < \sin^{-1}\left(\frac{1400 \text{ nm}}{d}\right).$$

3ʳᵈ order

$$B = \sin^{-1}\left(\frac{1200 \text{ nm}}{d}\right) < \theta < \sin^{-1}\left(\frac{2100 \text{ nm}}{d}\right).$$

We note that

$A \cap B$ is not $\varnothing$. Therefore, the second and third orders of the white light spectra will overlap irrespective of the grating spacing.