670.

Problem 47.3 (RHK)

With light from a gaseous discharge tube incident normally on a grating with distance $1.73\ \mu\text{m}$ *between adjacent slit centres, a green line appears with sharp maxima at measured transmission angles* $\theta = \pm 17.6^0,\ 37.3^0,\ -37.1^0,\ 65.2^0,$ and -65.0^0.

We have to compute the wavelength of the green line that best fits the data.

Solution:

A principal maximum occurs when the path difference between rays from any pair of adjacent slits, which is given by $d\sin\theta$, is equal to an integral number of wavelengths, or

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

This is called the grating equation.

In our problem the slit separation *d* is

$$d = 1.73\ \mu\text{m} = 1730\ \text{nm}.$$

The principal maxima at $\theta = \pm 17.6^0$ correspond to

$m = \pm 1.$

So from this measurement the value of wavelength will be

$$\lambda_1 = 1730 \times \sin\left(17.6^0\right)\ \text{nm} = 523.1\ \text{nm}.$$

Also,

$$\lambda_2 = 523.1\ \text{nm}.$$

The maxima observed at 37.3^0, and -37.1^0 correspond to $m = 2,\ -2$, respectively.

From these observations, we find the value of wavelength to be

$$\lambda_3 = \tfrac{1}{2} \times 1730 \times \sin 37.3^0\ \text{nm} = 524.2\ \text{nm},$$

and

$$\lambda_4 = \tfrac{1}{2} \times 1730 \times \sin 37.1^0\ \text{nm} = 521.8\ \text{nm}.$$

The maxima observed at 65.2^0, and -65.0^0 correspond to $m = 3,\ -3$, respectively.

From these observations, we find the value of wavelength to be

$$\lambda_5 = \tfrac{1}{3} \times 1730 \times \sin 65.2^0 = 523.5\ \text{nm},$$

and

$$\lambda_6 = \tfrac{1}{3} \times 1730 \times \sin 65.0^0 = 522.6\ \text{nm}.$$

From these measurements, we find the average value of the measured wavelength. It is

$$\lambda = 523.0\ \text{nm}.$$