Dept. of Education and Science – Revised Sample Paper

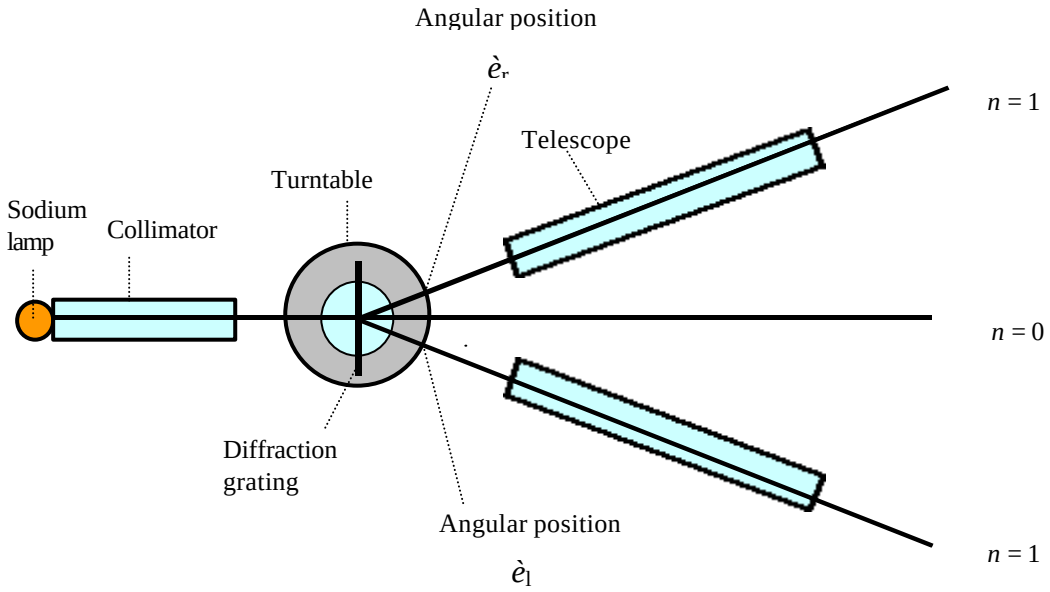
Question 2.

The following is part of a report given by a student of an experiment to measure the wavelength of monochromatic light.
"The apparatus was arranged so that a number of bright images could be observed. The angular position θ for each of these images was determined relative to the central bright image (n = 0). The data obtained are shown in the table. The diffraction grating had 600 lines per mm."

n	2	1	0	1	2
q / degrees	45.0	20.4	0.0	20.7	45.2

Describe, with the aid of a diagram, how the student obtained the above data.
Use the above data to calculate a value for the wavelength of the light.
Determine the maximum number of bright images that can be seen using this diffraction grating.
List two factors that affected the accuracy of the experiment.

Describe, with the aid of a diagram, how the student obtained the above data



The spectrometer was adjusted so that the telescope focussed parallel rays of light onto the crosshairs and so that the crosshairs were at the focus of the eyepiece (using the method of no-parallax). The collimator was then adjusted so that the slit was at the focus of the collimating lens and the image produced of it was sharp. The turntable was made level.
The telescope was rotated first left, and then right of the straight through (n = 0) position and the angles at which the bright fringes for the first and second orders appeared were noted.

Use the above data to calculate a value for the wavelength of the light.
Using the grating formula $n\lambda = d \sin\theta$,
For n = 1,

$$q_1 = \frac{20.4 + 20.7}{2} = 20.55 \quad \Rightarrow \quad l = \frac{1}{6.00\times10^5} Sin\ 20.55^0 \quad = \quad 5.85\times10^{-7}\,m$$

For n = 2,

$$q_2 = \frac{45.0 + 45.2}{2} = 45.1 \quad \Rightarrow \quad l = \frac{1}{2}\,\frac{1}{6.00\times10^5} Sin\ 45.1^0 \quad = \quad 5.90\times10^{-7}\,m$$

Obtaining the average of these values for the wavelength, we get $\lambda = 5.88 \times 10^{-7}$ m.

Determine the maximum number of bright images that can be seen using this diffraction grating.

The bright fringes must be formed at an angle less than 90^0. That is Sin θ < 1. Now,

$$n\lambda = d\,Sin\theta$$

$$Sin\theta < 1 \quad \Rightarrow \frac{n\lambda}{d} < 1 \quad \Rightarrow n < \frac{d}{\lambda}$$

$$n < \frac{1}{\frac{6.00\times10^{5}}{5.88\times10^{-7}}}$$

$$n < 2.8$$

As the highest order possible is 2, the maximum number of bright fringes is 5 (i.e. n = 0, 1 and 2)

List two factors that affected the accuracy of the experiment.

- How accurately the spectrometer telescope is set up to focus distant light onto its cross-hairs (i.e. to receive parallel light)
- How well the collimator slit is adjusted to give a sharp image on the cross-hairs of the telescope