

State Examination Commission – Physics Higher Level, 2013

Question 12 b

A narrow beam of light undergoes dispersion when it passes through either a prism or a diffraction grating. What is meant by dispersion? (6)

Textbook

Give two differences between what is observed when a narrow beam of light undergoes dispersion as it passes through a prism, and what is observed when a narrow beam of light undergoes dispersion as it passes through a diffraction grating. (6)

With a prism there will be only one spectrum, there will be several with the grating. The grating will produce a central fringe of white light, the prism will not.

Give another example of light undergoing dispersion. (4)

Rainbow

Yellow light of wavelength 589 nm is produced in a low-pressure sodium vapour lamp. What causes the sodium atoms to emit this light? (3)

Excited atoms returning to the ground state, with the electrons emitting the difference in energy between the higher energy level and ground energy level as photons of light.

Calculate the highest order image that could be produced when a beam of light of this wavelength is incident perpendicularly on a diffraction grating that has 300 lines per mm. (9)

$$\begin{aligned}\theta &< 90^\circ \\ \sin \theta &< \sin 90^\circ \\ \sin \theta &< 1 \\ \frac{n\lambda}{d} &< 1 \\ n &< \frac{d}{\lambda} \\ &= \left(\frac{1}{3.00 \times 10^5} \right) \\ n &< \frac{5.89 \times 10^{-7}}{3.00 \times 10^5} \\ n &< 5.7 \\ \text{max } n &= 5\end{aligned}$$