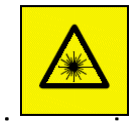
TAP 322- 2: Measuring the wavelength of laser light

An experiment using the relationship $n\lambda = d \sin \theta$

The demonstration shows how a grating produces a series of maxima of intensity. The angles at which the maxima are found let you measure the wavelength of the laser light.

You will need

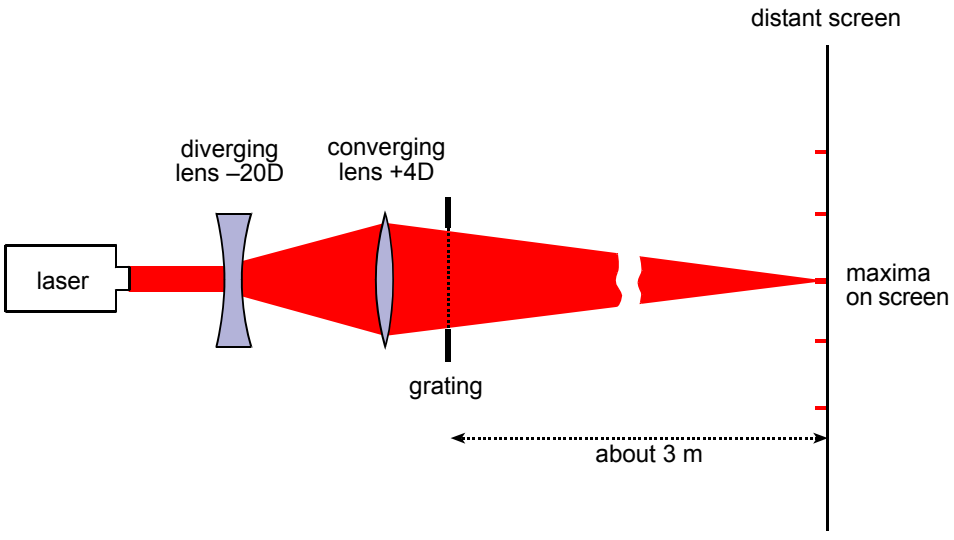
- ✓ laser
- ✓ lens, –20 D
- ✓ lens, +4 D
- ✓ metre rule
- ✓ lens holders
- ✓ support for slits
- ✓ set of coarse gratings
- ✓ projector screen or light-coloured wall



Safety

Provided the laser is class 2 (less than 1 mW), the warning ‘Do not stare down the beam' is sufficient.

What to do



The idea is to shine the laser light through a grating – an array of many slits, not just two. To get the laser beam to go through many slits it has to be broadened. That is what the lenses in the diagram are for.

1. Shine the diverged laser light through one of the gratings and use the converging lens to focus the pattern on the screen.

2. Change the grating for one with a smaller slit spacing. What do you observe?
3. Change the grating for one with a greater slit spacing. What do you observe?
4. Choose a grating which gives several bright patches on the screen. Choose one patch and find n by counting out from the centre (the centre counts as zero). Measure how far the bright patch is from the centre, and how far the screen is from the grating. Calculate the angle θ.
5. Use the formula $n\lambda = d \sin \theta$ to find the wavelength of the laser light.

You have

1. Seen the maxima separate as the slits are brought closer together.
2. Practised using the grating formula.

Practical advice

This is a simple, effective demonstration. It should focus on the effect of grating spacing, not on the number of slits. It is worth drawing attention to the fact that grating spectra are bright and sharp, compared with the two-slit pattern.

	**Safety** Provided the laser is class 2 (less than 1 mW), the warning ‘Do not stare down the beam' is sufficient. Take care to avoid reflections.

Social and human context

Joseph Fraunhofer (1787–1826) was the first to use a grating to produce a spectrum from white light. The Fraunhofer dark lines in the spectrum of the Sun, which reveal chemical elements present in the Sun, are named after him. He was a poor boy with little education who found a job in an optical works housed in a disused abbey near Munich. It made high-quality glass, and by his twenties Fraunhofer was put in charge of the optical department. It was in the pursuit of careful measurement of optical properties of glass that he used gratings, to obtain monochromatic light.

External reference

This activity is taken from Advancing Physics chapter 6, 240E

Park D 1997 The fire within the eye (Princeton University Press)