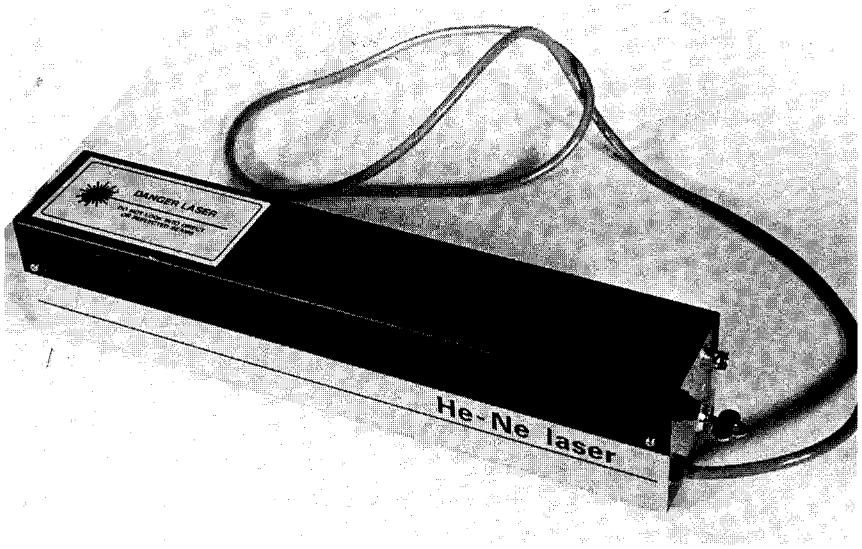
LASER

The laser is a light source which produces a concentrated beam consisting of photons travelling in the same direction, in phase with each other and having the same wavelength-a completely coherent beam of light. This can be used as a powerful and effective source for many experiments demonstrating the properties of light.



The LASER (acronym for Light Amplification by Stimulated Emission of Radiation) comes fully contained within a metal housing, the beam emerging from a small hole in the centre of the front of the box.

SAFETY PRECAUTIONS

- A *laser safety sign* must be displayed at all entrances to the lab when the laser is being used.
- To comply with Department regulations, the power output should be less than 5 mW. At this energy level, the laser is considered safe for use in schools.
- Do not operate the laser at eye-level as the beam, if deflected into the eye, could do serious damage to the retina.
- Do NOT darken the room more than is absolutely necessary as this enlarges the pupil of the eye thus increasing the risk of eye damage.
- Before switching on the laser consider what surfaces around it might reflect the beam (glassware, metal fixtures, etc). *Remove or cover all reflective surfaces.*
- The laser must not be moved when switched on.
- When not in use either turn it off or block the beam at the laser.

SETTING UP AND USING THE LASER

It is worth checking the following items before an experiment is set up:

- Make sure you have the key to activate the laser.
- Remove or cover all reflective surfaces (glassware, metal fixtures, etc).

Extra equipment for the suggested learning experiences (numbers refer to appropriate experiences) includes:

- a retort stand, bosshead and wooden peg
- a white screen
- graph paper
- sticky tape

- plasticine
- a meter rule
- a diffraction grating (3)
- celluloid slides with single and double slits etched into them (1, 2)
- a compact disc (4)
- a microscope slide with a small dot of liquid paper on it (6)
- a sewing pin (small steel head) (7)
- colloidal suspension (milk powder in water) (5)
- pieces of polaroid (5)
- large (3L) glass beaker (5)
- converging lens (focal length 10cm) (6)
- diverging lens (focal length 5cm) (6)
- 'gem' single-edged razor blades (2)

Setting up the laser

- Place the laser on a bench or other stable fixture that is not at eye-level.
- Set up the screen between 1 and 2 metres away from the laser
- The laser beam exits through the middle hole at the end opposite the switch. Align the screen with this hole and check for reflective objects in its path.
- Switch on the laser by turning the key at the back.
- The laser will take 15 minutes to reach full power.
- Set the object to be studied between 2 and 10 cm away from the front of the laser. This may be held in a clamp attached to a retort stand or it may be attached to the desk using plasticine.

HANDY HINTS

The width of the laser beam, quoted in the specifications, is probably less than 1 mm. Some experiments may require the laser beam to be spread into a wider parallel beam (eg Poisson's spot and some double slit experiments). This can be achieved by placing a diverging lens (f = 5cm) and a converging lens (f = 10cm) spaced 1 Ocm apart in wooden lens holders between the laser and the object.

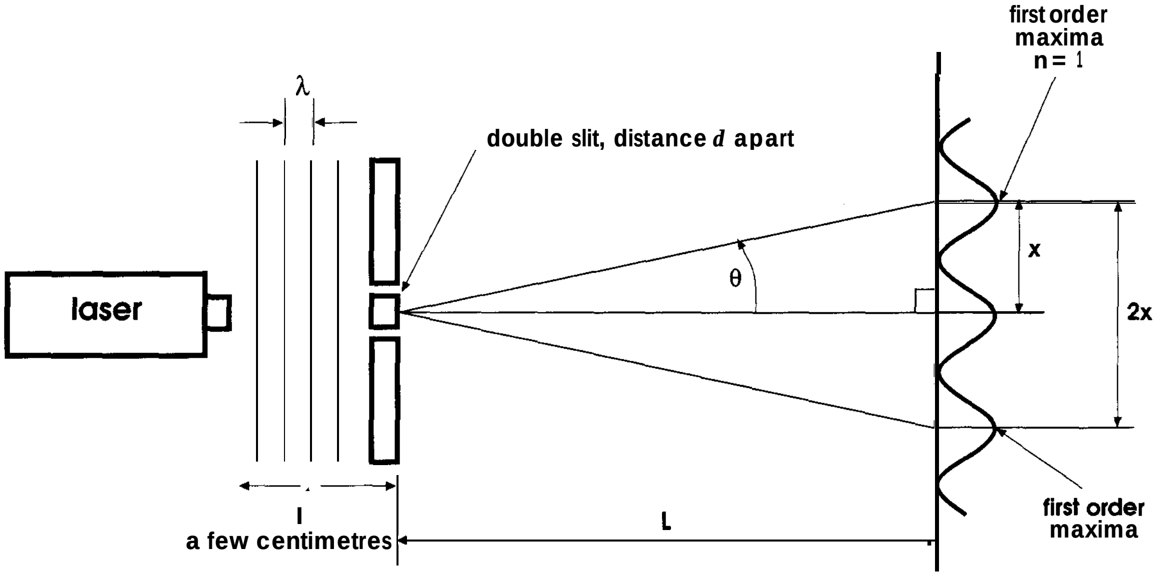


figure 1

SUGGESTED LEARNING EXPERIENCES

1. Demonstrate Young's double slit experiment and measure the wavelength of the laser beam.

Set up the prepared celluloid slide with various widths of double slit in the path of the laser beam. Aim the beam at the narrowest microscopic slits in the black strip found at the top of the slide. Observe the interference pattern produced on a screen about 1 metre away.

Measure the slit separation (d), distance to the screen (L) and the distance from the central maximum to the first order maximum (x).

To find the wavelength (λ) of light emitted by the laser, use the following equation :

$$\sin \theta = \lambda / d$$

where θ can be found from the equation $\tan \theta = x/L$. *See figure 1.*

Discover how the interference pattern changes as both the slit separation and the distance to the screen are independently varied. ***For more details see Activity 18.7 in Essential Physics.***

2. Observe the Fraunhofer diffraction pattern from a single slit.

Set up a variable width single slit using two 'gem' single-sided razor blades held in the path of the laser beam. Use plasticine to hold the blades in place. Observe the diffraction pattern on a screen 1 metre away from the slit. Observe and record how this pattern changes when both the slit width and distance to the screen are independently changed. ***For further details see Experiment C-7in Year 12 Senior Physics.***

3. Calculate the wavelength of the laser beam using the diffraction pattern from a diffraction grating. Set up a prepared slide containing a diffraction grating in the path of the laser beam. Observe the pattern on a screen 1 metre away. Use the formula $d \sin \theta = m \lambda$, where m = 1 for the distance from the central bright fringe to the first lateral maximum. ***For further details see Experiment C-8 in Year 12 Senior Physics.***

4. Observe the diffraction pattern from a compact disc or vinyl record (reflection).

Observe the diffraction pattern obtained by reflecting the laser beam off the face of a compact disc. Vary the angle of reflection and observe the results. Be very careful that the reflected light is not at eye-level.

5. Observe polarisation by scattering

Mix a colloidal solution of milk powder in water in a large 3L beaker. Direct the laser beam down through the middle of the beaker and observe the polarising effect by viewing the scattered light through pieces of polaroid at different angles. Be careful not to look directly into the laser beam.

6. Observe Poisson's spot

Place a small dot of liquid paper on a microscope slide and position it in the path of the laser beam. The 'dot' must be smaller in diameter than the laser beam (see ***Handy Hint section).*** Observe the diffraction pattern around the edge of the spot as it is projected on to screen about 1 m away. Observe the shadow of the dot and the central bright spot caused by constructive interference of the diffracted rays around the edge of the 'dot'.

7. Observe the diffraction pattern around a small object such as the head of a pin.

Broaden the beam from the laser using the method outlined in the Handy Hint section. Place the head of a pin in the path of the laser beam and observe the diffraction fringes around the edge of the shadow projected onto a screen a short distance away.