Aim:

To explore how the effects of changing the wavelength of a monochromatic light source and distance from the source to the screen affects the pattern projected as the light shines through a stable water droplet.

Experiments

Variables:

First independent variable: Continuous

Distance from the apparatus and the screen where the pattern is projected. (cm)

Hypothesis: *If the distance between the apparatus and the screen is increased, the pattern projected by the water droplet will spread out.*

Second independent variable: Categorical = red, green

Wavelength (nm) Continuous = λ

Hypothesis: *If the wavelength is increased, the amount of spreading of the pattern projected by the water droplet will also increase, because the amount of spreading of a diffraction pattern is proportional to the wavelength.*

Limitations: *We only had access to two different wavelengths of laser beams, therefore a definitive statement on the effect of the colour of the laser beam on the pattern projected through the water droplet could not be made.*

Third independent variable: Categorical

Type of liquid of the water droplet for red laser beam.

Hypothesis: *If the thickness of the liquid is increased, then the pattern projected onto the screen will spread out, as refraction is proportional to the optical density of the medium.*

Controlled variables:

- Size of syringe and type of syringe used: *Changing the size/type of the syringe may interfere with the size of each droplet produced, confounding results.*
- Strength of laser: *lasers that differ in strength may affect the intensity of the pattern produced. During the course of the experiment, the batteries in the red laser started to run out, which may have caused the pattern to be less intense compared to measurements taken at the beginning of the investigation. This variable was hard to keep consistent throughout the investigation.*
- Darkness of the room: *The room in which we conducted our experiments consistently had the same amount of light coming in. Differing the amount of light coming into the room would have drastic effects of the pattern observed. Due to the dispersed pattern that some liquids and distances produced, if the amount of light in the room increased, it would become almost impossible to see the extent of the pattern.*

→ may have differed at different times of day

dependent variables:

- height of pattern (cm)
- length of pattern (cm)
- width of parabolic (bright) line

] quantitively

- shape, size of pattern
- intensity of pattern
- circular patterns observed: yes/no
- visability of bright line

] qualitatively

Materials

Materials needed:

- Laser of multiple wavelengths
- Preferably dark room
- Screen in which pattern can be projected
- 2 retort stands to support the syringe and the laser
- Plastic syringe (without needle) to produce water droplet
- Tape measure

ensures liquids aren't interfering with each other ↓

- liquids needed: → vinegar
  → Paraffin oil
  → Sunflower oil
  → dishwashing liquid

} different syringe for each liquid

Method

Method:

1. Place tape measure from screen to measure distance the apparatus needed to be set up from the screen.
2. Ensure screen is flat and upright
3. Secure laser onto clamps attached to retort stand
4. Allow the clamp to press down onto the button of the laser so the beam can remain on at all times.
5. Fill syringe with liquid, there is no specific amount needed.
6. Place syringe vertically into clamp attached to retort stand
7. Place both retort stands close to each other and adjust the clamps so the laser and the bottom of the syringe are level.
8. Softly push the syringe down so a droplet can form.
9. Droplet should be large enough that a spherical shape begins to form, but not large enough that the droplet falls due to the pressure.
10. Slightly adjust the laser so that the beam can shine directly through the centre of the water droplet
11. Ensure that the laser beam is not shining onto or through the plastic part of the syringe to ensure that it does not interfere with the pattern projected.
12. Describe the pattern projected onto the screen. Record the height, length etc of the pattern.

Control measurement:

- When water droplet was removed from syringe, a clear, focus dot appeared on the screen
- This shows that nothing else interfered in the path of the light ray
- only the water droplet could have formed the interference pattern we were seeing

Safety:

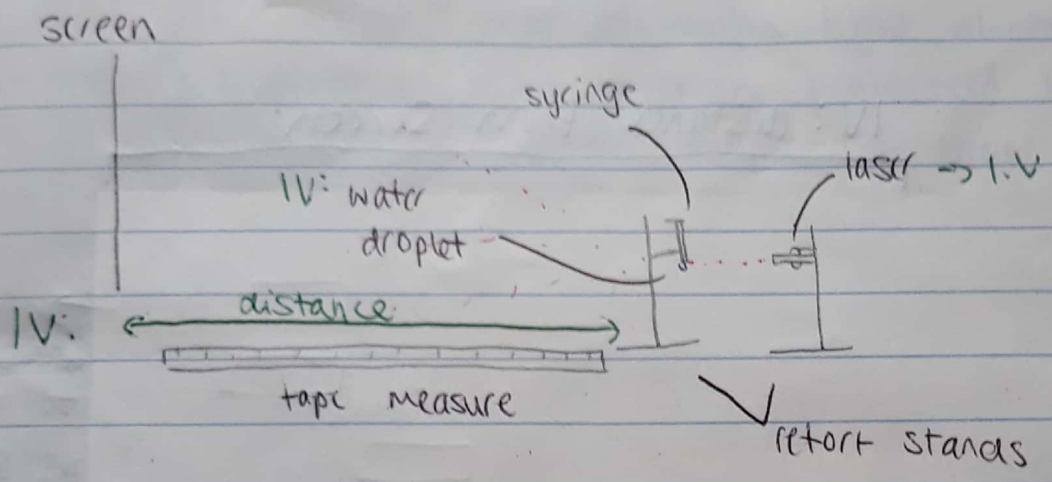
LASER: do not shine in others eyes to avoid damage

WATER: cleaning up spills from syringe to avoid people slipping

Chemicals: if chemicals are used to form water droplets, ensure they are disposed of safely

Set-up of experiment

IV = independent variable



Setup of experiment in classroom

Results

EXPERIMENT 1:

changing the distance between the apparatus & the screen

Summary:

IV: distance from screen

DV

	Classroom (10cm)	50 cm	125 cm	200 cm	275 cm	350 cm
Width of line	0.01 cm	0.4 cm	0.6 cm	1 cm	1.5 cm	n/a
Length (spreading)	19 cm	56 cm	58 cm	79 cm	223 cm	152.5 cm
Height of bright spot		22 cm	80 cm	117 cm	94 cm	97 cm

max

unable to record as did not exist at this point

bright spot = pattern

not recorded

average height of bright spot = 82 cm
average width of line = 0.702 cm
average length of pattern = 97.917 cm

NOTE:
distance from apparatus to screen is measured from the base of the retort stand to the screen

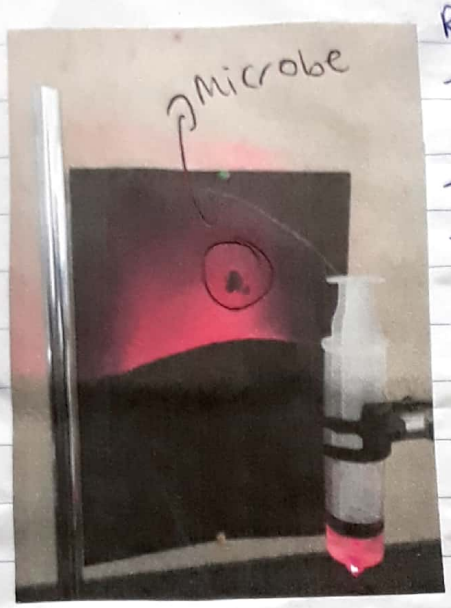
defining dependent variables (DV):

"line"
clear parabolic line, bright width measured

height of pattern

length of pattern

?



Results: distance = 10 cm
- perfect parabolic line is projected onto screen with light above it
- no pattern projected under parabolic line
- water droplet & laser acts as microscope
  → microbes can be seen moving around screen
    ↳ magnified ~~projected~~ from inside the water droplet (tap water)

Results: distance = 200 cm
- clear dark & light bands in two prominent circular patterns (outlined in pencil)
  * photo quality shows quite distorted bands
- similar to electron diffraction pattern & Newton's rings
- pattern very dispersed, takes up most of screen with not much intensity
- Dark and light bands seem to spread out from two different sources, which seem to become integrated towards the top of the screen
- Still retains clear parabolic line (although photo does not show as clear) with light above it, no light below line.
- width of dark and light bands seems to decrease as they get closer to the centre of each circle

Results: distance = 275 cm

- clearer pattern of rings shown (bright bands indicated by pencil)
- pattern only seemed to have one source of the circular bands
- as pattern spreads out, begins to look more eliptical
- clear, bright, paraboline line at the bottom of pattern noticed again

Results: Distance = 275 cm

- on closer inspection, it seemed that the whole pattern was made from very thin, clear individual lines.
- bright parabolic line shown by dashes, it is noticably thicker than the other lines
- photo was taken up close to the screen, at the bottom of the pattern
- lines begin to form beginning of circular pattern, or rather another pattern (bright bands indicated by pencil)

- this photo was taken on an angle, making the lines appear to be getting narrower as the pattern moves towards the centre