Experiment 3: Focal Length of a Convex Lens

1. Purpose

To determine the focal length of a converging (convex) lens using two methods:

- A plane mirror method (Autocollimation).
- A graphical method (1/U against 1/V plot).

2. Apparatus

- Converging lens & holder
- Plane mirror
- Meter scale / optical bench
- Mounted pin (object)
- Screen

3. Procedure & Ray Layouts

Part 1: Finding Rough Focal Length (F')

1. Focus a distant object (e.g., a window) clearly onto the screen through the lens.
2. Measure the distance between the center of the lens and the screen. This distance equals the rough focal length F'.
3. Repeat at different positions and compute the average mean.

Layout Shape: [Distant Object] --- Parallel Rays ---> [Convex Lens] ---> Converging Rays ---> [Screen (Focus)]

Part 2: Graphical Method (U and V Measurements)

1. Place the object pin at a distance greater than the focal length (typically around 2F'). Measure this object distance (U).
2. Locate its real, inverted image on the opposite side of the lens using the screen. Measure this image distance (V).
3. Move the object pin to new positions (nearer and farther), re-locating and recording the new image positions each time.

Layout Shape: [Object Pin (Upward)] ---> (U) ---> [Convex Lens] ---> (V) ---> [Screen / Inverted Pin Image (Downward)]

Part 3: Plane Mirror Method (Autocollimation)

1. Position a plane mirror immediately behind the convex lens.
2. Adjust the distance of the object pin in front of the lens until a sharp, inverted image of the pin forms exactly alongside the object pin itself (eliminating parallax).
3. The measured distance from the pin to the center of the lens is exactly equal to the focal length (F).

Layout Shape: [Object & Inverted Image side-by-side] <--- (F) ---> [Convex Lens] [Plane Mirror]

4. Theory and Calculations

The relationship is governed by the thin lens equation:
1/F = 1/U + 1/V

When plotting 1/U (y-axis) against 1/V (x-axis), a straight line with a negative 45-degree slope is obtained:

- The intercept on the 1/V axis gives 1/F■ (where 1/U = 0). Therefore, F■ = V.
- The intercept on the 1/U axis gives 1/F■ (where 1/V = 0). Therefore, F■ = U.
- The final exact focal length is computed as the average: **F = (F■ + F■) / 2**

5. Graphical Analysis Shape

