

## Sequence 5: image formed by a converging lens



**Fiches de synthèse mobilisées** (collection en français) :

- Fiche n°4 : lentilles convergentes et modèle optique de l'œil
- Fiche n°5 : la relation de conjugaison des lentilles



**Sommaire des activités ETLV :**

ACTIVITY 1: determining the focal length of a converging lens

ACTIVITY 2: comparing focal length measurements

### ACTIVITY 2: comparing focal length measurements

The objective is to use the autocollimation and Bessel methods in order to determine the focal length of a thin lens. We will then calculate statistical uncertainties in order to compare the two methods.

#### DOCUMENT 1: autocollimation

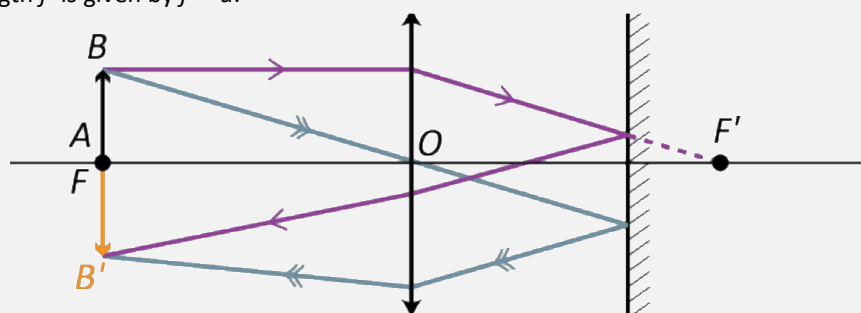
The method of autocollimation is the simplest method used to determine the focal length of a converging lens.

This method is based on the reversibility of the ray path for incident parallel light propagated along the axis and for rays through the focal point: the parallel light beam is reflected by a mirror behind the lens so that the image of an object is viewed right next to that object.

To apply this method, here are the different steps you need to follow:

- Place an object in front of a converging lens
- Behind the lens, place a reflecting mirror
- Search for the distance  $d$  between the object and the lens so that the object and the image are exactly the same size and on the same plane.

Then, the focal length  $f'$  is given by  $f' = d$ .

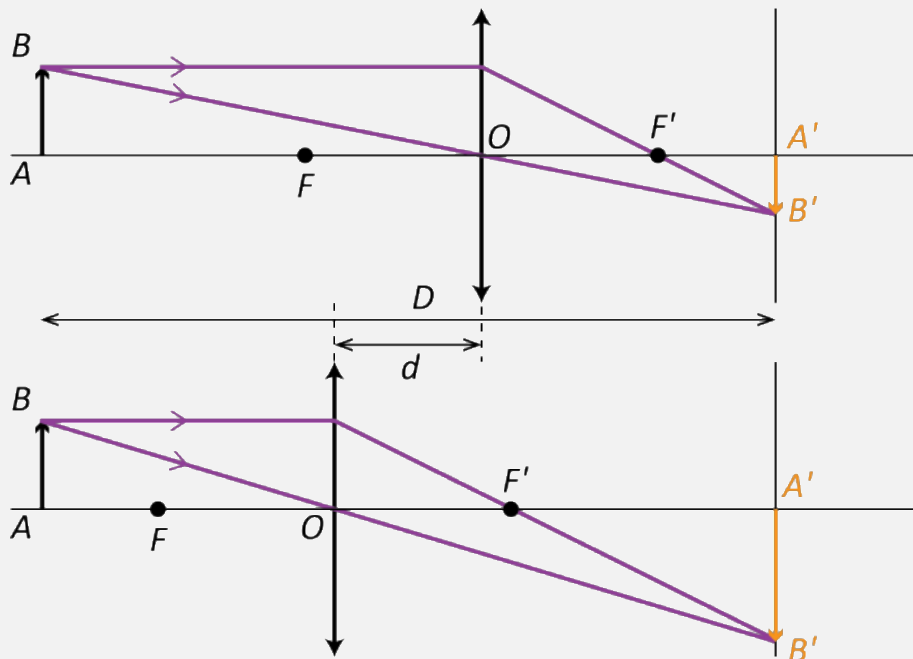


**DOCUMENT 2: the Bessel method**

- Place an object and a screen at a minimum distance of  $4f'$
- Place a converging lens so that a shortened image is formed on the screen and note its position on the optical bench.
- Move the lens so that a larger image is formed on the screen and note the distance  $d$  from the previous position.

The distance between these two positions is named  $d$ . Therefore, we can calculate the focal length of this lens with:

$$f' = \frac{D^2 - d^2}{4D}$$



**DOCUMENT 3: available laboratory equipment**

- An optical bench with a source light and a screen;
- A plane mirror;
- A transparency film with a grid pattern (object) and a white sheet of paper (screen) to observe the image of the object;
- A 5-diopter thin converging lens.

**DOCUMENT 4: accuracy of a method**

To approach the “best value” of a measurement, we average a large number (N) of measurements. The average value is  $\bar{x}$ . The uncertainty of this mean value  $\bar{x}$  is given by:

$u(\bar{x}) = \frac{\sigma}{\sqrt{N}}$  where  $\sigma$  is the standard deviation (we recommend using your calculator) and N is the number of measurements.

■ Acquiring vocabulary:

English	French
	Autocollimation
Plane mirror	
Optical bench	
	Infini
	Lentille convergente
Focal length	
Measurement	
Uncertainty	
Average value	
Accuracy	

■ Questions

1. Use both methods presented in the documents in order to determine the focal length of the lens.
2. Collect and write the results of the entire class for each method then calculate the average value  $\bar{f}'$  and its accuracy  $u(\bar{f}')$ . For each method, write the results as:

$$\mathbf{f}' = (\bar{f}' \pm u(\bar{f}')) \mathbf{m}$$

3. Evaluate the most accurate method.
4. Present your results to the class.

# Connaissances et capacités à maîtriser

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## Ce qu'il faut savoir :

Le vocabulaire à savoir définir et utiliser à bon escient :

- Autocollimation
- The focal length
- The optical power
- A light beam
- An optical bench
- An average value/ a mean value
- Accurate/accuracy
- The uncertainty

Les grandeurs physiques à savoir définir et exprimer avec la bonne unité :

- The focal length
- The optical power

## Ce qu'il faut savoir faire :

Compétences	Capacités à maîtriser
RCO	Focal length
	Optical power
APP	Utiliser du vocabulaire spécifique
	Lire et comprendre des documents scientifiques
ANA	Mettre en lien des documents pour émettre des hypothèses en réponse à une question scientifique
REA	Mettre en œuvre un protocole
COM	S'exprimer à l'oral en utilisant le vocabulaire adapté