Geometrical optics

Identification page

Instructions: Print this page and the following ones before your lab session to prepare your lab report. Staple them together with your graphs at the end. If you forgot to print it before your lab, you can reproduce it by hand but you have to follow the exact format (same number of pages, same items on each page, same space to answer question).

Complete all the identification fields below or 10% of the lab value will be deduced from your final mark for this lab.

For in-lab reports, hand in your report to your demonstrator at the end of the sessions or you will receive a zero for this lab.

For take-home reports, drop your report in the right box or 10% of the lab value will be deduced from your mark. Refer to the *General information* document for the details of the late report policy.

Experiment title: Geometrical optics

Name: _____

Student number: _____

Lab group number: _____

Course code: PHY

Demonstrator: _____

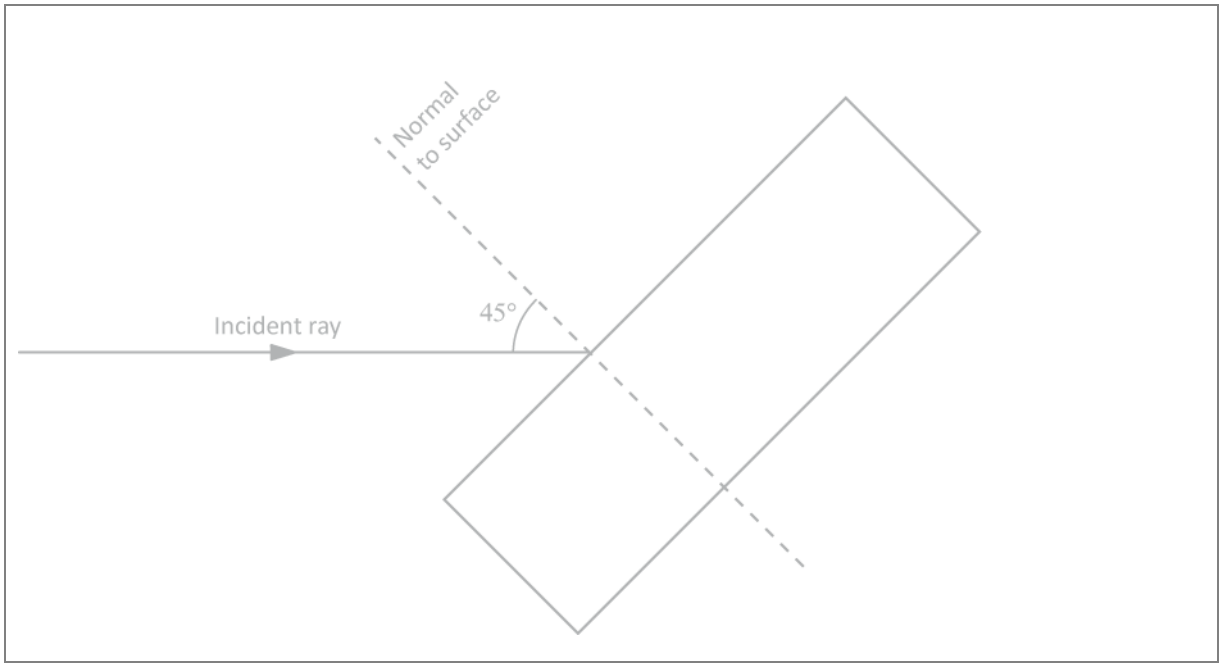
Date: _____

Partner's name: _____

Refraction

[1] How is the beam's trajectory affected at normal incidence with the rectangular prism? Explain.

[2] Make your measurements for the rectangular prism in the space below. Is the transmitted beam parallel to the incident beam?



[2] Calculate the refractive index of this acrylic piece (n_2). (No need for uncertainty calculations).

$n_2 =$ _____

[3] Fill the following table:

Table 1 – Incidence and refraction angles for acrylic

Incidence angle, θ_1 (degrees)	Refraction angle, θ_2 (degrees)	$\sin\theta_1$	$\sin\theta_2$
10			
20			
30			
40			
50			
60			

[4] Prepare Graph 1. Submit it online before the end of the lab session.

[1] What are the values of *m* (slope) and *b* (Y-intercept) in Graph 1? Provide the units.

m = _____ $\pm$ _____

b = _____ $\pm$ _____

[1] What is the physical meaning of the slope and the Y-intercept, if any? What values did you expect to get?

_____

_____

_____

[1] Compare your value of n_2 obtained graphically with the value you measured using the rectangular prism. Calculate the percentage difference

$$\%\text{diff} = \left|\frac{n_{\text{graphically}} - n_{\text{rectangular prism}}}{n_{\text{graphically}}}\right| \times 100,$$

and discuss.

_____

_____

_____

Light dispersion

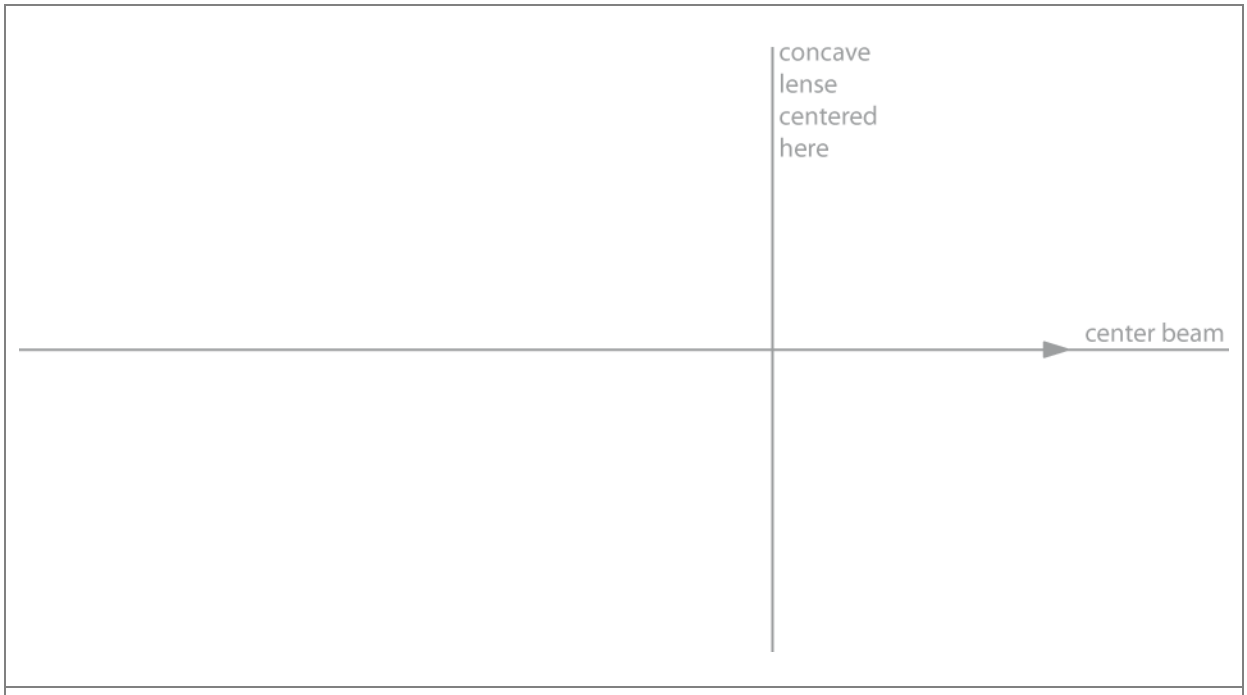
[2] Describe what happens to the ray of white light. Which colour has the largest refraction angle and which has the smallest?

Convex and concave lenses

[2] Prepare your converging lens ray diagram in the space provided below and measure the focal length (no uncertainty needed).

$f_{\text{convex}} =$ _____

[2] Prepare your diverging lens ray diagram in the space provided below and measure the focal length (no uncertainty needed).



$f_{\text{concave}} =$ _____

[2] How do the two focal lengths compare? What happens to the beam if the two lenses are placed together?

Real image and thin lens equation

Method 1: Object at infinity

[2] What is the focal length of the lens in cm?

$f =$ _____ $\pm$ _____

Method 2: Object closer than infinity

[3] Fill the following table:

Table 2 – Image distance vs object distance for 10 cm double convex lens

Object distance, p (cm)	Image distance, q (cm)	$1/p$ (cm^{-1})	$1/q$ (cm^{-1})
15			
20			
25			
30			
35			
40			
50			
65			

[4] Prepare Graph 2. Submit it online before the end of the lab session.

[1] What are the values of *m* (slope) and *b* (Y-intercept) in Graph 2? Provide the units.

$m =$ _____ $\pm$ _____

$b =$ _____ $\pm$ _____

[1] What is the physical meaning of the slope and the Y-intercept? What values did you expect to get?

_____

_____

_____

[2] Calculate the focal length of the lens (and its uncertainty) from your linear regression result.

$f =$ _____ $\pm$ _____

[1] Compare your value of f obtained graphically with the value you measured using $p \to \infty$. Calculate the percentage difference

$$\%\text{diff} = \left| \frac{f_{\text{graphically}} - f_{p\to\infty}}{f_{\text{graphically}}} \right| \times 100,$$

and discuss.

[1] Find under which conditions the image and the object have the same size?

Virtual images and the microscope

[1] Is the image observed through your microscope larger or smaller than the object? Is the image real or virtual?

_____

_____

[1] Record the distance between the object (the light source) and the objective lens. Record the distance between the two lenses.

Distance object to objective = _____

Distance objective to eyepiece = _____

[4] Assuming that the focal lengths **are exactly 10 cm and 20 cm**, calculate the magnification factor of your microscope, $M = |(q_o/p_o)(q_e/p_e)|$, where $p_o$and q_o refer to the image produced by the objective while p_e and q_e refer to the image observed through the eyepiece. (No need for uncertainty calculations).

$M =$ _____

Total : _____ / 44 (for the report and graphs)