Exam 1 — Physics

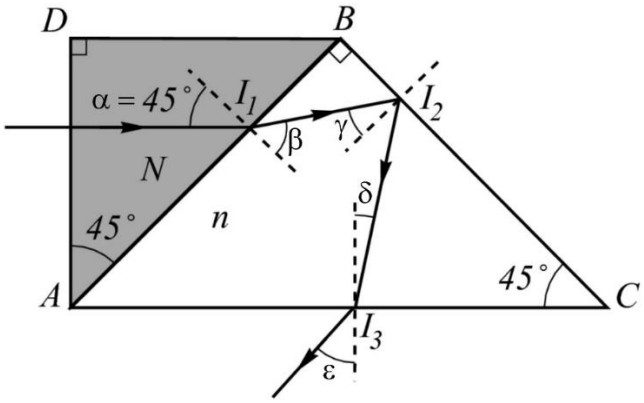
October 18, 2019, 5 pm — Duration : 1 hour

No document allowed. No mobile phone. ***No calculator****. The proposed grading scale is only indicative.*

The marks will account not only for the results, but also for the justifications, and the way you analyze the results. Moreover, any result must be given ***in its literal form involving only the data given in the text****. It is also reminded that the general clarity and cleanness of your paper may also be taken into account.*

LAST NAME : ***First Name :*** ***Group :***

Exercise 1 : Prisms placed side by side (≈ 6 points)



Two prisms, in the shape of right-angled isosceles triangles, are placed side by side. Their respective optical indices are denoted N and n, and AB is their common side. An incident ray comes onto the side AD under normal incidence. It is then refracted at I_1, reflected at I_2 and finally emerges at I_3 with the angle ε. The values of the optical indices N and n are such that there is total reflection at I_2. The optical index of air, in which the prisms are placed, is considered to be equal to 1.
Do not forget to define the other angles you use and place them on the scheme.

1) Give the expression of the Snell-Descartes' law at the point I_1.
2) Give the relation between the absolute values of the angles β and γ.
3) Find the condition on I_2, and deduce the condition on the optical indices N and n. The final expression should not involve any angle. It is recalled that $cos(\theta) = \sqrt{1 - sin^2(\theta)}$.
4) *Independent question:*
   Give the relationship between N and n so that the emerging angle ε is nil.

Exercise 2 : Projection system (≈ 7 points)

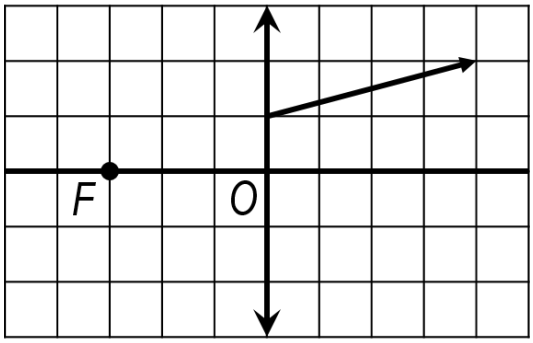
A projection system is an optical instrument, which provides on a screen a magnified image of a document printed on a transparency. The system studied here is composed of a light source, a support for the document and a thin lens. The light source is placed before the document, and the lens is placed between the document and the screen. The distance D between the document and the screen is fixed.
With this configuration, the projection system gives a magnification γ.

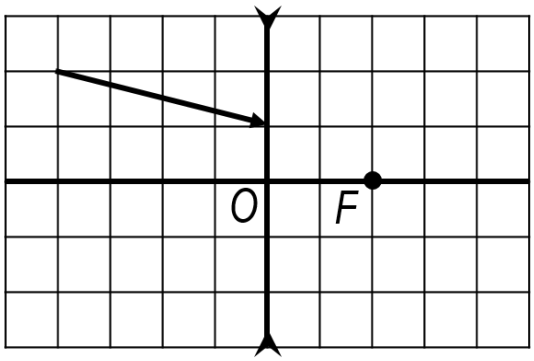
1) Are the object and the image real or virtual? Explain why.
2) Deduce the nature of the lens to be used. Where should the object be placed with respect to the lens (no calculation needed)?
3) Give and *justify* the *literal* expression of the lens focal length. The expression should contain only the parameters given in the text, namely D and γ.

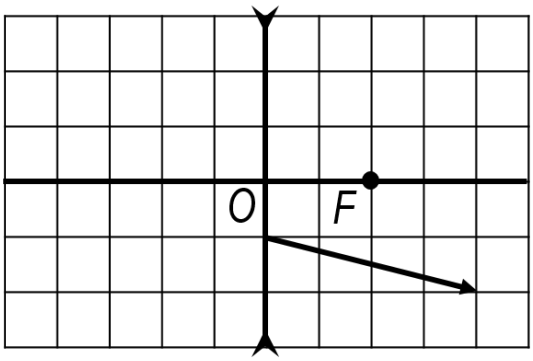
4) Numerical application: we want the image to be 9 times bigger than the document, with a distance D = 1 m. Give the value of the focal length.

Exercise 3 : Ray-tracing (≈ 3 points)

Complete the paths of the incident or emerging rays. Clearly indicate the rays and construction lines.







Exercise 4 : Image — object ray diagrams (≈ 4 points)

In each case, find the position of **the object** $\overline{AB}$ corresponding to the image $\overline{A'B'}$ through the thin lenses by tracing 3 different rays.