مسابقة في مادة الفيزياء
المدة ساعة

الاسم:
الرقم:

This exam is formed of three obligatory exercises in two pages
Non programmable calculators are allowed

First exercise (7 points) Refraction and total reflection of light

The object of this exercise is to find the two conditions that must be satisfied by a luminous ray (SI) in order to undergo total internal reflection on the surface of separation of two transparent and homogeneous media.

I. (SI) is in air

In a first experiment, a luminous ray (SI), propagating in air, falls on the surface of separation (air-water). Its corresponding refracted ray (IR) forms an angle of refraction i_2.
In the table below, we have recorded some values of the angle of incidence i_1 and the corresponding values of the angle of refraction i_2.

i_1 (°)	0	30	45	90
i_2 (°)	0	22	x	49

1) Show, referring to the table, that air is less refractive than water.
2) Among the two given values 32^0 and 60^0, specify which correspond to x.
3) Show that, whatever the value of the angle of incidence i_1 is, (SI) does not undergo total internal reflection.

II. (SI) is in water

In a second experiment, the luminous ray (SI), propagating in water, falls on the surface of separation (water-air).

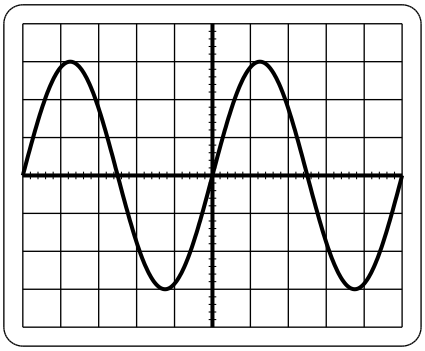
1) For an angle of incidence $i_1 = 49^o$, the refracted ray grazes the surface of separation. The angle 49° represents the critical (limiting) angle of the system (water-air). Justify.
2) For an angle of incidence $i_1 = 60^o$, the luminous ray (SI) undergoes at I total internal reflection. Justify.

III. Conclusion

Deduce, from the preceding, the two conditions that must be satisfied by a ray of light in order to undergo the phenomenon of total internal reflection on the surface of separation of two transparent homogeneous media.

Second exercise (7 points) Study of a voltage

In order to determine the characteristics of the voltage u delivered by a generator (G), we connect the terminals of (G) to an oscilloscope. The adjacent figure represents the waveform of the voltage u.



In absence of any voltage, the horizontal luminous line passes through the center of the screen.

The settings of the oscilloscope are:

- vertical sensitivity: s_v = 5 V/div;
- time base: v_b = 5 ms/div.

1) Indicate the type of the voltage u.

2) a) Determine the maximum value U_m of u.

b) Deduce the effective value U_{eff} of u.

3) a) Determine the period T of u.

b) Deduce its frequency f.

4) A lamp (L), carrying the indications (15 V; 9 W), is connected across the terminals of (G).

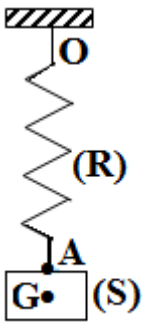
a) What does each of the indications carried by (L) represent?

b) The lamp glows weakly. Justify.

c) Calculate the electric current that should traverse the lamp in order to glow normally.

Third exercise (6 points) Stiffness of a spring

The object of this exercise is to determine the stiffness k of an elastic spring (R).
(R) is suspended vertically with its upper end O fixed to a horizontal support. Its lower end A carries a solid (S) of center of gravity G and of mass m = 0.5 kg.
The solid (S) is then submitted to two forces: its weight $\vec{W}$ and the tension $\vec{T}$ of the spring.
At equilibrium, the elongation of the spring is x = 10 cm.
Given: g = 10 N/kg.



1) Indicate for each of these forces if it's a contact force or a force acting at a distance.

2) Indicate the point of application, the line of action and the direction of $\vec{W}$.

3) Calculate the magnitude W of the weight $\vec{W}$.

4) Show that the magnitude of the tension $\vec{T}$ is T = 5 N.

5) Determine k.