

الاسم:
الرقم:

مسابقة في مادة الفيزياء
المدة ساعة

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

First exercise: focal length of a converging lens (7 points)

The aim of this exercise is to determine the focal length f_1 of a converging lens (L_1). For this, we consider an object (AB) of size $AB = 4$ cm, a screen (E), the lens (L_1) and a set of converging lenses of known focal lengths.

- I- We place (AB) perpendicularly to the optical axis of (L_1), A being on the optical axis at 60 cm from (L_1). The image (A_1B_1) of (AB) is obtained on the screen (E) as shown in figure 1.

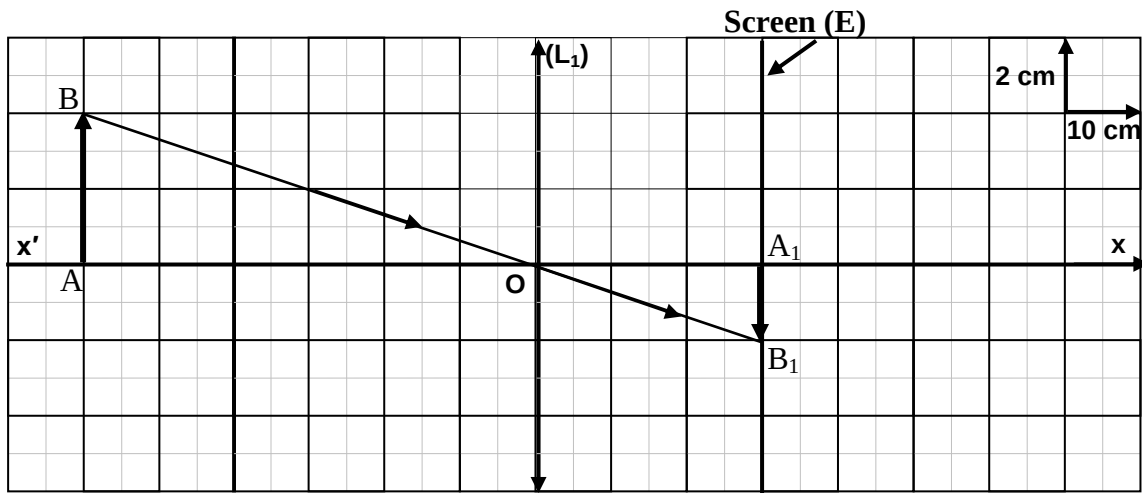


Figure 1

- 1) Redraw, with the same scale, the above figure.
- 2) The ray (BO) emerges from (L_1) without deviation. Justify.
- 3) a) Specify the nature of the image (A_1B_1).
b) Give the size of (A_1B_1).
c) Determine the distance d_1 between (L_1) and (A_1B_1).
- 4) a) Using a particular ray, determine the position of the image focus F'_1 of (L_1).
b) Deduce that $f_1 = 20$ cm.

II- We perform the preceding experiment again by replacing (L_1) successively by each of the converging lenses of the given set. For each lens we determine the distance d between the lens and the image of (AB). The curve of figure 2 represents the variation of d as a function of the focal length f knowing that the object (AB) being always in the preceding position.

Using the graph of figure 2:

- 1) Indicate whether d increases or decreases when f increases from 10 cm to 40 cm. Justify your answer by choosing two points from the curve.
- 2) Determine again the focal length f_1 of (L_1).

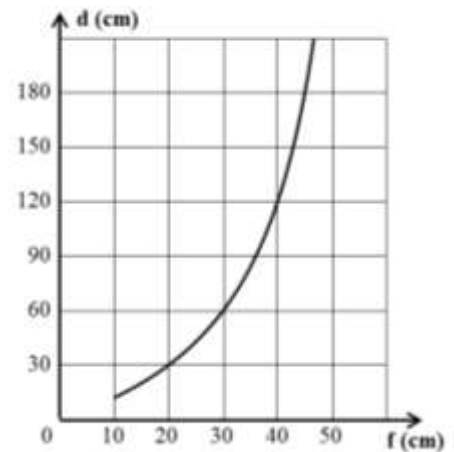


Figure 2

Second exercise: resistance of a voltmeter (7 points)

The aim of this exercise is to show that the resistance of a voltmeter is very large. For this we consider the series circuit that is represented in figure 1 which is formed of:

- a generator (G) maintaining across its terminals a constant voltage $U_{PN} = 12 \text{ V}$;
- an ammeter (A) of negligible resistance;
- two resistors (R_1) and (R_2) of resistances $R_1 = 10 \Omega$ and $R_2 = 20 \Omega$ respectively;
- A switch (k).

The switch k is closed.

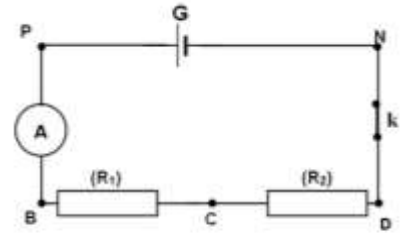


Figure1

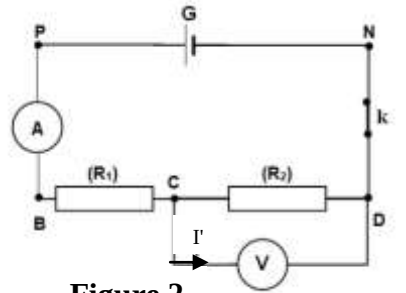


Figure 2

- 1) The voltage U_{PB} across (A) is zero. Justify.
- 2) The voltage U_{DN} across (K) is zero. Justify.
- 3) Deduce that the voltage $U_{PN} = U_{BD}$.
- 4) Calculate the equivalent resistance R_{eq} of (R_1) and (R_2).
- 5) Calculate the current flowing in the circuit.
- 6) Show that the voltage $U_{CD} = 8 \text{ V}$.
- 7) We connect, between C and D, a voltmeter (V) that can be considered as a resistor of resistance R as shown in figure 2. The current flowing in the voltmeter is $I' = 0.01 \text{ mA}$.
 - a) Knowing that the voltage U_{CD} remains 8 V . Calculate the resistance R of the voltmeter.
 - b) Deduce that the calculated value of R satisfies the aim of this exercise.

Third exercise: reaction of the bottom of a container (6 points)

The aim of this exercise is to determine the magnitude of the force exerted by the bottom of a container containing water on a sphere (S) totally immersed in water. The mass of (S) is $M = 0.5 \text{ kg}$ and its volume is

$$V = 2 \times 10^{-4} \text{ m}^3.$$

Given: density of water $\rho = 1000 \text{ kg/m}^3$;

gravitational field strength is $g = 10 \text{ N/kg}$.

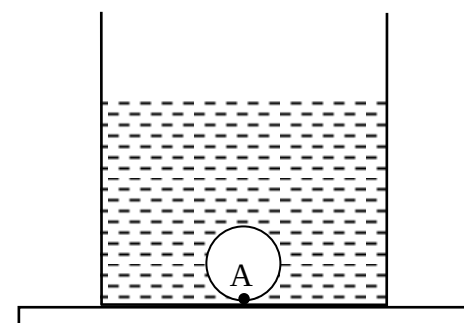
I- Real weight of (S)

- 1) Calculate the magnitude of the weight $\vec{W}$ of (S).
- 2) Indicate the direction and the line of action of $\vec{W}$.

II- Apparent weight of (S)

The sphere (S) is totally immersed in water as shown in the adjacent figure.

- 1) a) Calculate the magnitude F of Archimedes up-thrust $\vec{F}$ exerted by water on (S).
- b) Indicate the line of action and the direction of $\vec{F}$.
- 2) Deduce the magnitude W_{app} of the apparent weight of (S).



Horizontal table

III- Force exerted by the bottom on (S)

The sphere exerts on the bottom of the container a force $\vec{R}_1$ of magnitude $R_1 = 3 \text{ N}$.

Determine, using the principle of interaction, the magnitude of the force $\vec{R}_2$ exerted by the bottom of the container on (S).

First exercise (7 points)

Part of the Q.	Answer	Mark
I.1	Drawing	0.5
I.2	Any ray passing through the optical center of the lens emerges without deviation.	0.5
I.3.a.	Real image. It is formed on the screen	1
I.3.b.	$A_1B_1 = 2 \times 1 = 2 \text{ cm}$	0.5
I.3.c.	$d_1 = 3 \times 10 = 30 \text{ cm}$	0.5
I.4.a.	Tracing of the ray We draw a ray issued from B parallel to the optical axis of (L_1). It emerges the lens through B_1 . The point of intersection of the emergent ray and the optical axis of (L_1) is the image focus F_1' .	0.5 0.5 0.5
I.4.b.	$f_1 = OF_1' = 2 \times 10 = 20 \text{ cm}$.	0.5
II.1	As f increases the distance d increases For $f = 20 \text{ cm}$, $d = 30 \text{ cm}$, For $f = 40 \text{ cm}$ $d = 120 \text{ cm}$	1
II.2	For lens (L_1), when $OA = 60 \text{ cm}$, $d_1 = 30 \text{ cm}$ and graphically $f_1 = 20 \text{ cm}$.	1

Second exercise (7 points)

Part of the Q	Answer	Mark
1)	Because the ammeter has negligible resistance	0.5
2)	Because the switch is closed. (or it is acting as a connecting wire)	0.5
3)	$U_{PN} = U_{PB} + U_{BD} + U_{DN}$ (law of addition of voltages) $U_{PN} = 0 + U_{BD} + 0$ $U_{PN} = U_{BD}$	0.5 0.5
4)	R_1 and R_2 are connected in series: $R_{eq} = R_1 + R_2 = 10 + 20 = 30 \Omega$.	1
5)	Ohm's law : $U_{PN} = RI$, $I = \frac{U_{PN}}{R} = 0.4 \text{ A}$	1
6)	$U_{CD} = R_2 \cdot I = 20 \times 0.4 = 8 \text{ V}$	1
7.a)	$U_{CD} = RI$, $R = \frac{U_{CD}}{I} = 8 \times 10^5 \Omega$ ($0.01 \text{ mA} = 10^{-5} \text{ A}$).	1.5
7.b)	$R = 8 \times 10^5 \Omega$ which is very large.	0.5

Third exercise (6 points)

Part of the Q	Answer	Mark
I.1	$W = Mg$ $W = 0.5 \times 10 = 5 \text{ N}$	1
I.2	Line of action : vertical Direction : downward	1
II. 1.a	$F = \rho_L \cdot V_s \cdot g$ $F = 2 \text{ N}$.	1
II.1.b	Line of action : vertical Direction : up ward	1
II.2	$W_a = W - F$ $W_a = 3 \text{ N}$	1
III.	Principle of interaction $\vec{R}_1 = - \vec{R}_2$ so $R_2 = R_1 = 3 \text{ N}$	1

