وزارة التربية والتعليم العالي
المديرية العامة للتربية
دائرة الامتحانات

امتحانات الشهادة المتوسطة

دورة سنة ٢٠٠٧ العادية

مسابقة في مادة الفيزياء
المدة: ساعة واحدة

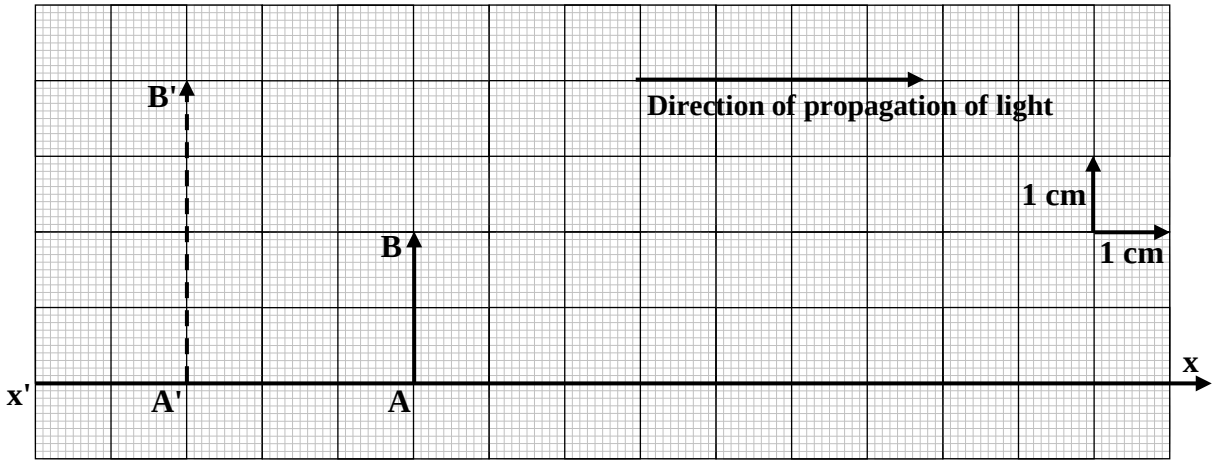
الاسم:
الرقم:

This exam is formed of three obligatory exercises in two pages

<u>Non-programmable calculators are allowed</u>

<u>First exercise</u> (6 pts) Determination of the focal length of a converging lens

The aim of this exercise is to determine, by geometrical construction, the focal length **f** of a lens (L). The figure below represents, in real scale, a luminous object AB, its virtual image A'B' given by (L) and the optical axis x'x of (L).



1) **<u>Nature of (L)</u>**

The lens L is a converging. Why?

2) **<u>Position of (L)</u>**

a) The optical center O of (L) is the intersection of the line BB' with the optical axis x'x. Why?

b) Redraw, on a graph paper and with a real scale, the above figure. Represent the lens (L) on this figure

3) **<u>Focal distance of (L)</u>**

a) A ray issued from B, parallel to the optical axis, meets the lens at a point I. Trace, with justification, the path of this ray.

b) The emergent ray meets the optical axis in a particular point. What does this point represent for the lens (L)?

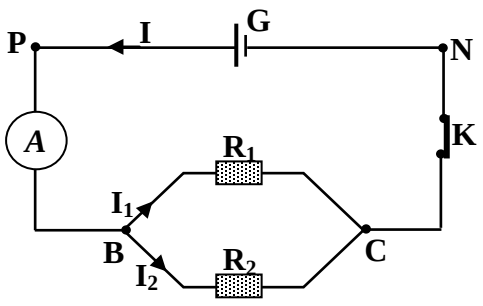
c) Deduce the focal length of (L).

<u>Second exercise</u> (7 pts) Study of an electric circuit

During a laboratory session, we construct the circuit represented in the adjacent figure.

- G is a generator that maintains across its terminals a constant voltage $U_{PN} = 12$ V.
- (A) is an ammeter of negligible resistance.
- (R_1) is a resistor of resistance $R_1 = 30\,\Omega$.
- (R_2) is a resistor of resistance R_2.
- (K) is a switch.

When we close (K), the ammeter (A) indicates 0.6 A.



1) **Determination of the value of U_{BC}**

a) The voltage across (A) is zero. Why?
b) The voltage across (K) is zero. Why?
c) The voltage U_{BC} is 12 V. Justify.

2) **Determination of the value of R_2**

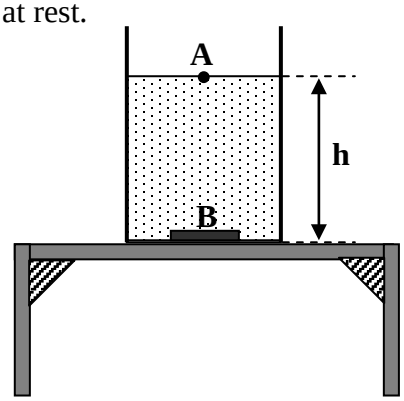
a) Determine the value of the current I_1 through (R_1).
b) Deduce the value of the current I_2 through (R_2).
c) Show that the value of R_2 is $60\,\Omega$.

3) **Equivalent resistance**

The two resistors (R_1) and (R_2) can be replaced by a single resistor (R) of resistance R, so that (A) indicates the same value I = 0.6 A.
a) Out of the following values ($90\,\Omega$; $50\,\Omega$; $20\,\Omega$), which one matches the value of R? Why?
b) An instrument allows a direct measurement of R. Name this instrument.

Third exercise (7 pts) Pressing force

A vessel contains a quantity of water to a height h = 30 cm. At the bottom of the vessel, we place a sheet of metal of negligible thickness and of surface area S = 10 cm^2. The vessel is placed on a horizontal table as shown in the adjacent figure. The water in the vessel is at rest.



Given:

- atmospheric pressure : P_{atm} = 75 cm of mercury ;
- density of mercury : ρ_{Hg} = 13600 kg/m^3 ;
- density of water: ρ_{water} = 1000 kg/m^3 ;
- g = 10 N/kg.

1) **Pressure at the surface of water**

a) The free surface of water in the vessel is plane and horizontal. Why?
b) Calculate, in pascal, the value of pressure at the point A of this surface.

2) **Pressure at the bottom of the vessel**

a) Calculate the pressure exerted by water at a point B of the sheet of metal.
b) Deduce the value of the total pressure at the point B.

3) **Representation of the pressing force**

a) Calculate the value **F** of the force $\vec{F}$ exerted on the sheet of metal.
b) Give the line of action and the direction of the force $\vec{F}$.
c) Represent $\vec{F}$ at the point B using the scale: ***35 N ⟷ 1 cm***

أسس تصحيح المسابقة في مادة الفيزياء

First exercise (6 pts)

1- (L) is a converging lens because it gives for the object , a virtual image larger than the object. **(1 pt**)

2- a) Because any luminous ray passing through the optical center continues its path without deviation (or because B, B' and O are collinear). **(1 pt).**

b) Redraw **(½ pt);** Representation of the lens L **(½ pt)**

3- a) Trace **(1 pt).**

Justification: any ray issued from B emerges from the lens seeming to come out of B' the image of B. **(½ pt)**

b) The image focus F' **(½ pt)**

c) f = OF' **(½ pt)** f = 6 cm **(½ pt)**

Second exercise: (7 pts)

1- a) $U_{(A)} = 0$ because its resistance is negligible **(½ pt)**

b) $U_{(K)} = 0$ because (K) is closed **(½ pt)**

c) $U_{BC} = 12$ V because $U_{PN} = U_{PB} + U_{BC} + U_{CN}$

$U_{PN} = 0 + U_{BC} + 0$ $U_{BC} = U_{PN}$ **(1pt**)

or $U_{BC} = U_{PN}$ because $U_K = U_A = 0$

2- a) $U_{BC} = R_1 I_1$ **(½ pt)** $I_1 = \dfrac{U_{BC}}{R_1} = \dfrac{12}{30} = 0.4$ A **(1pt)**

b) $I = I_1 + I_2$ **(½ pt)** $I_2 = I - I_1 = 0.6 - 0.4 = 0.2$ A **(½ pt)**

c) $U_{BC} = R_2 I_2$ **(½ pt)** $R_2 = \dfrac{12}{0.2} = 60\ \Omega$ **(½ pt)**

3- a) $R = 20\ \Omega$ **(½ pt)**

$U_{BC} = RI$ $R = \dfrac{12}{0.6} = 20\ \Omega$ **(½ pt)**

or $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} \Rightarrow$ $R = \dfrac{R_1 R_2}{R_1 + R_2} = 20\ \Omega$

or because R is smaller than the smallest resistance.

b) Ohmmeter **(½ pt)**

Third exercise: (7 pts)

1- a) Because all the points of the free surface of the liquid are under the same pressure. **(½ pt)**

b) $P_A = P_{atm}$ **(½ pt)**) $P_A = \rho_{Hg}\, g\, h$ **(½ pt)**

$P_A = 13600 \times 10 \times 0.75 = 102000$ Pa **(½ pt)**

2- a) $P_{water} = \rho_{water}\, g\, h$ **(½ pt)**

$P_{water} = 1000 \times 10 \times 0.3 = 3000$ Pa **(½ pt)**

b) $P_t = P_{water} + P_{atm}$ **(½ pt)**)

$P_t = 3000 + 102000 = 105000$ Pa **(½ pt)**

3- a) $P = \dfrac{F}{S}$ **(½ pt)** $\Rightarrow F = PS = 105000 \times 0.001 \Rightarrow F = 105$ N **(½ pt)**

b) Line of action: vertical **(½ pt)**

Direction: downward **(½ pt)**

c) 35 N ⟶ 1cm

105 N ⟶ 3cm

Vector **(1 pt)**