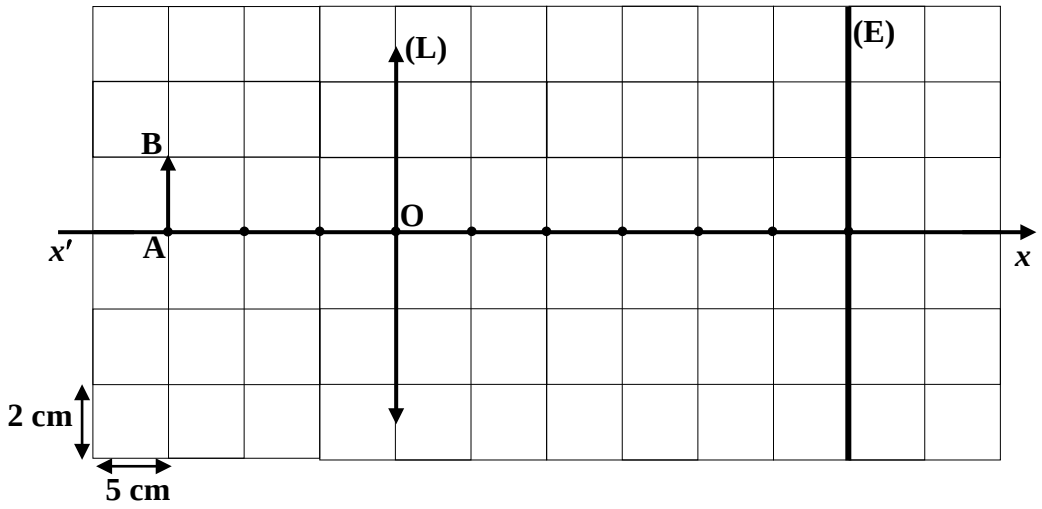
مسابقة في مادة الفيزياء
المدة: ساعة واحدة

الاسم:
الرقم:

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

<u>First Exercise</u>: Exploitation of a document concerning a converging lens (7.5 points)

The document below represents a converging lens (L), its optical axis ($x'Ox$), a luminous object AB and a screen (E).



A – Construction of the image A_1B_1 of the object AB given by (L)

The image A_1B_1 is formed on the screen.

1) Redraw, with the same given scale, the above document.
2) Specify, with justification, the position of the image A_1 of A.
3) Trace, with the necessary explanations, the path of one luminous ray which allows the determination of the position of the image B_1 of B.

B – Characteristics of the image A_1B_1

1) Give the nature of A_1B_1 and find its length.
2) Is the image A_1B_1 erect or inverted with respect to AB?
3) Find the distance $d = OA_1$ between the lens and the image.

C – Determination of the focal length of (L).

1) Trace, with justification, the path of the luminous ray which allows the determination of the position of the image focus F′ of (L).
2) Deduce the value the focal length f of (L).

<u>Second Exercise</u>: The circuit breaker in a kitchen (6.5 points)

The electrical installation in a kitchen is fed by a sinusoidal alternating voltage of effective value U = 220 V. This installation includes the following electrical appliances:

- A refrigerator;
- A washing machine;
- An electric water heater (which can be considered as a resistor) of power P = 1540 W;
- An incandescent lamp carrying the following indications (220 V, 100 W).

1) These electrical appliances are connected in parallel. Why?

2) **a)** The lamp functions normally. Why?
b) Calculate the effective electric current I_1 through the lamp.

3) **a)** The effective voltage across the water heater is 220 V. Why?
b) Calculate the effective electric current I_2 through the water heater.

4) Knowing that under normal functioning the effective electric currents through the refrigerator and the washing machine are respectively $I_3 = 5$ A and $I_4 = 10$ A, determine the value of the effective main electric current when all the given electrical appliances function at the same time.

5) We intend to protect these electrical appliances with a circuit breaker, which one of the three available circuit breakers rated at 25 A, 30 A, and 40 A is the most adequate to be used in this kitchen? Why?

<u>Third Exercise</u>: Measuring the pressure of a confined gas (6 points)

To determine the pressure of a confined gas, a group of students made the two following experiments. Given g = 10 N/kg.

A – First experiment:

Determination of the atmospheric pressure

The group filled the tube (T) completely with mercury of density $\rho = 13600$ kg/m^3, then turned it upside down and immersed it in a container containing mercury. The level of the mercury dropped down and settled at 75 cm above the free surface of the mercury that is found in the container.(figure 1)

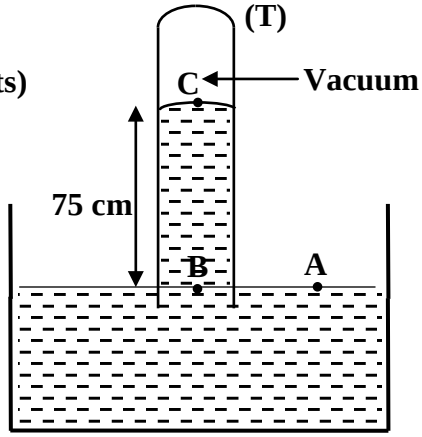


Figure 1

1) What is the value of the pressure P_C at C? Why?
2) Determine, in Pascal, the value of the pressure P_B at B.
3) The pressure at A and the pressure at B have the same value. Why?
4) Deduce the value of the atmospheric pressure P_{at}.

B – Second experiment:

Determination of pressure of a confined gas in the tube

After the determination of the atmospheric pressure, the students inject in the tube a certain quantity of gas. The level of the mercury in the tube drops again to become 70 cm above the free surface of the mercury that is found in the container.(figure 2)

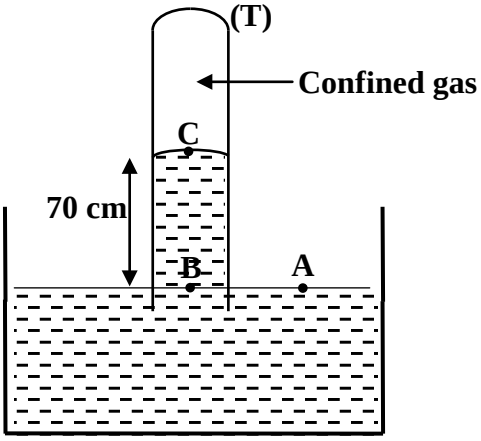


Figure 2

1) Determine, in Pascal, the new value of the difference in pressure $(P_B - P_C)$.
2) Deduce the value of the pressure P of the confined gas in the tube.

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First Exercise (7 ½ pts)

A – 1 – Redraw ½

2 – A is situated at the optical axis therefore its image A1 is situated on the optical axis, because A, O, A1 are collinear. In addition A1 is situated on the screen therefore A1 is the intersection of (E) with the axis x'Ox **1**

3 – Trace ½

Explanation: The luminous ray issued from B passes through point O without deviation.

The intersection of this ray with the screen (E) represents B_1 . **1**

B –

1 – A_1B_1 is a real image ½

$A_1B_1 = 2 \times 2 = 4$ cm ½

2 – A_1B_1 is an inverted image ½

$d = OA_1 = 6 \times 5 = 30$ cm ½

C – 1 - Trace ½

Explanation: The luminous ray issued from B parallel to the optical axis emerges and passes through B_1 and F'. The intersection of the emergent ray with the optical axis represents F′.

2 – $f = OF' = 2 \times 5 = 10$ cm **1**

½ ½

Second Exercise (6 ½ pts)

1 – In order to function independently. **1**

2 –

a) The voltage to function normally that indicated on the Lamp is 220 V. But the voltage across the lamp is 220 V therefore it will function normally. **1**

b) $P_L = U_L I_1$ ½ $\Rightarrow I_1 = 0.45$ A. ¾

3 –

a) Because it is connected in parallel with the lamp L ½

b) $P = UI_2 \Rightarrow I_2 = 7$ A. ½ ¾

4 – $I = I_1 + I_2 + I_3 + I_4$ ½ $\Rightarrow I = 22.45$ A ½

5 – The most adequate one the one which has the indication 25 A. ½

Because this value is the one which is just nearer and of greater value. ½

Third Exercise (6 pts)

A –

1 – $P_C = 0$. ½

Because the vacuum is found above C ½

2 – $P_B - P_C = \rho g h$ ½

Where $P_C = 0$

$\Rightarrow P_B = 13600 \times 10 \times 0.75 = 102000$ Pa **1**

3 – $P_A = P_B$

Because A and B∈ to the same level and same liquid. ½

$P_{at} = P_A$ ½ $\Rightarrow P_{at} = 102000$ Pa ½

B –

1 – $P_B - P_C = \rho g h'$

$= 13600 \times 10 \times 0.7 = 95200$ Pa ½

2 – $P_B - P_C = 95200$ Pa $\Rightarrow P_{at} - P_C = 95200$ Pa

$\Rightarrow P_C = P_{at} - 95200 = 6800$ Pa. **1**

But $P_C = P_{gaz} \Rightarrow P = 6800$ Pa ½