

الاسم:
الرقم:

مسابقة في مادة الفيزياء
المدة ساعة

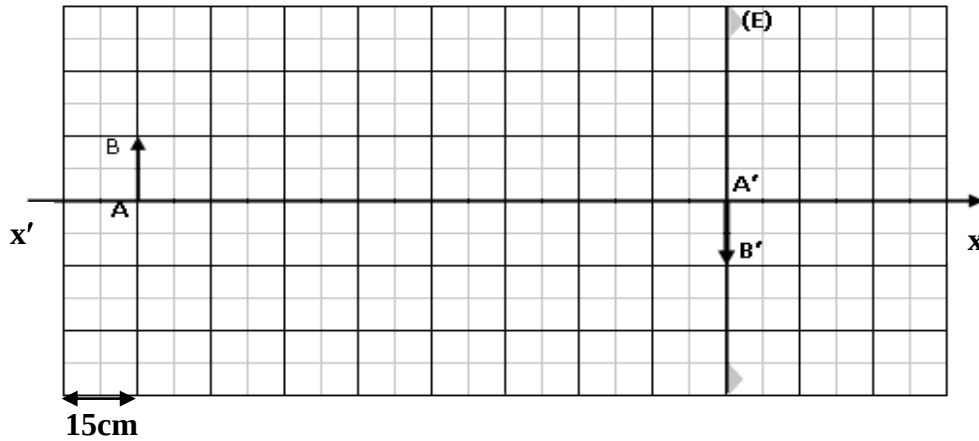
This exam is formed of three obligatory exercises in two pages
Non- programmable calculators are allowed.

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

The aim of this exercise is to determine the focal length f of a converging lens (L). For this, we place an object (AB) at a distance p from (L) perpendicular at A to its optical axis. On the other side of the lens, we place a screen (E), parallel to (AB), at a distance p' from (L).

We adjust the values of p and p' in such a way that the image (A'B') of (AB) is formed sharply on (E) and $AB = A'B'$

- 1) Specify the nature of the image (A'B').
- 2) Deduce that the image (A'B') is inverted with respect to (AB).
- 3) The figure below shows (AB), (A'B'), the screen (E) and the optical axis $x'x$ of the lens (L).



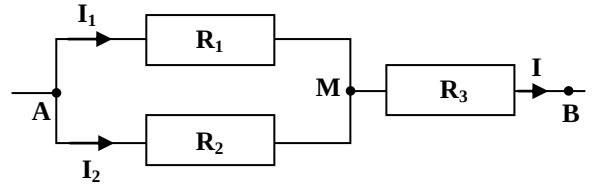
- a) Redraw, with the same scale, the above figure.
- b) Determine graphically the position of the optical center O of (L) and represent (L) on the figure.
- c) Trace the emergent ray corresponding to a luminous ray issued from B parallel to the optical axis.
- d) This emergent ray meets the optical axis at a particular point M. What does M represent for the lens (L)?
- e) Determine graphically p and p' .
- f) Compare p and p' . Deduce the relation between p and f .
- g) Deduce the value of f .

Second exercise: Electric power (7 points)

The aim of this exercise is to compare the sum of the electric power consumed by a grouping of resistors with that consumed by the equivalent resistor of this grouping.

Consider the circuit of the adjacent figure.

Given: $R_1 = 60 \, \Omega$; $R_2 = 30 \, \Omega$; $R_3 = 20 \, \Omega$; $I_1 = 1 \, \text{A}$.



I- Power consumed by the grouping

- 1) Calculate the voltage U_{AM} across the terminals of R_1 .
- 2) Show that the current carried by R_2 is $I_2 = 2 \, \text{A}$.
- 3) Deduce the current I carried by R_3 .
- 4) Calculate the electric power consumed by each of the three resistors.
- 5) Deduce the total electric power P_{total} consumed by the three resistors.

II- Power consumed by the equivalent resistor

- 1) Calculate the resistance R' of the resistor equivalent to R_1 and R_2 .
- 2) Show that the resistance equivalent to R' and R_3 is $R_e = 40 \, \Omega$.
- 3) Calculate the electric power P_e consumed by R_e .

III- Comparison of electric powers

Compare P_{total} and P_e .

Third exercise: Gravitational field strength on the Moon (6 points)

The aim of this exercise is to verify experimentally the relation between the values of the gravitational field strength g_M on the Moon's surface and the gravitational field strength g on the Earth's surface. For this, we consider a spring (R) of stiffness $k = 50 \, \text{N/m}$ and a solid (S) of mass M .

Take $g = 10 \, \text{N/kg}$.

First experiment:

On the Earth's surface, we fix the extremity O of (R) to a support and we suspend the solid (S) to its free extremity A.

At equilibrium, the elongation of the spring (R) is $\Delta \ell_1 = 12 \, \text{cm}$.

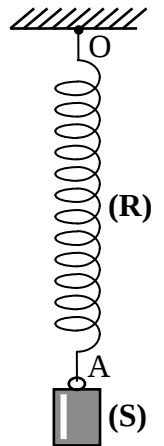
(S) is submitted to two forces.

- 1) Give the name of each force.
- 2) Write the vector relation between these two forces.
- 3) Determine the magnitude of each force.
- 4) Deduce that $M = 0.6 \, \text{kg}$.

Second experiment:

The same experiment is performed on the Moon's surface. At equilibrium, the elongation of (R) is $\Delta \ell_2 = 2 \, \text{cm}$.

- 1) Determine the new magnitude of each of the two forces acting on (S).
- 2) Knowing that the mass of (S) remains the same, deduce the value of g_M .
- 3) Verify that $g_M = \frac{1}{6} g$.



First exercise (7 points)

Part of the Q	Answer	Mark
1	The image is real since it is collected on the screen.	0.5
2	Since (A'B') is real	0.5
3.a)	Reproduction.	0.5
3.b)	Join B and B' the intersection between BB' and the optical axis is O because any ray passes through the optical center emerges without deviation. Or (B,O and B' are collinear) + tracing of BB' and representation of L	2
3.c)	Tracing	0.5
3.d)	M represents the image focus of (L).	0.5
3.e)	$p = 4 \times 15 = 60 \text{ cm}$, $p' = 4 \times 15 = 60 \text{ cm}$	1
3.f)	$p = p' = 60 \text{ cm}$. since $p = p' \Rightarrow p = 2f$.	1
3.g)	$f = \frac{p}{2}$ then $f = 30 \text{ cm}$	0.5

Second exercise (7 points)

Part of the Q	Answer	Mark
I. 1)	$U_{AM} = R_1 \cdot I_1 = 60 \times 1 = 60 \text{ V}$	1
I.2)	$U_{AM} = R_2 \cdot I_2 \Rightarrow I_2 = \frac{U_{AM}}{R_2} = \frac{60}{30} = 2 \text{ A}$	0.5
I.3)	Law of addition of currents: $I = I_1 + I_2 \Rightarrow I = 3 \text{ A}$	0.5
I.4)	$P_1 = R_1 \cdot I_1^2 = 60 \cdot 1^2 = 60 \text{ W}$ $P_2 = R_2 \cdot I_2^2 = 30 \cdot 2^2 = 120 \text{ W}$ $P_3 = R_3 \cdot I_3^2 = 20 \cdot 3^2 = 180 \text{ W}$	1.5
I.5)	$P_{\text{total}} = P_1 + P_2 + P_3 = 360 \text{ W}$	0.75
II. 1)	$\frac{1}{R'} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R' = \frac{60 \times 30}{60 + 30} = 20 \Omega$	1
II.2)	$R_e = R' + R_3 \Rightarrow R_e = 40 \Omega$	0.5
II.3)	$P_e = R_e \cdot I^2 = 40 \times 3^2 = 360 \text{ W}$	0.75
II.4)	$P_e = P_{\text{total}}$	0.5

Third exercise (6 points)

Part of the Q	Answer	Mark
I.1	$\vec{W}$: weight of (S) $\vec{T}$: tension of the spring	0.5
I.2	$\vec{W} + \vec{T} = \vec{0}$	0.5
I.3	$T = k \cdot \Delta \ell_1$ (Hooke's law) $\Rightarrow T = 50 \times 0.12 = 6 \text{ N}$ since the system at equilibrium $W = T = 6 \text{ N}$	1.5
I.4	$W = M \cdot g \Rightarrow M = 0.6 \text{ kg}$	1
II.1	$T' = k \cdot \Delta \ell_2 = 1 \text{ N} \Rightarrow W' = T' = 1 \text{ N}$	1
II.2	$W' = M \cdot g_M$ thus $g_M = 1.66 \text{ N/kg}$	0.5
II.3	$\frac{g}{6} = 1.66$ then $g_M = \frac{g}{6}$	1

