مسابقة في مادة الفيزياء	الاسم:
المدة ساعة	الرقم:

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).

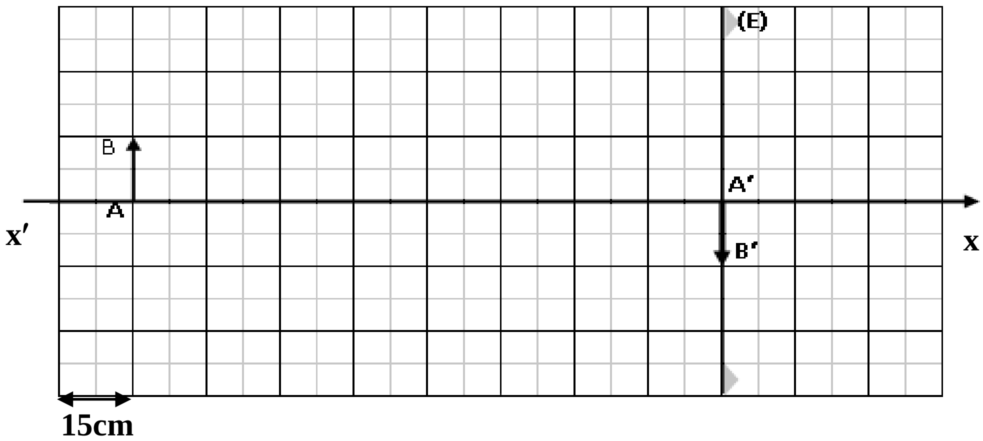
We adjust the values of p and p′ in such a way that the image (A'B') of (AB) is formed sharply on (E) and

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)?

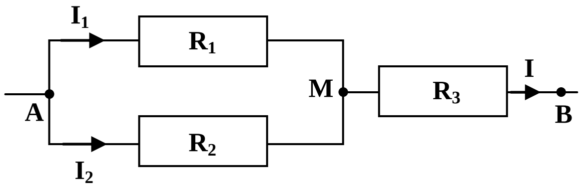
e) Determine graphically p and p′.

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: $R_1 = 60\ \Omega$; $R_2 = 30\ \Omega$; $R_3 = 20\ \Omega$; $I_1 = 1$ 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 $I_2 = 2$ 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

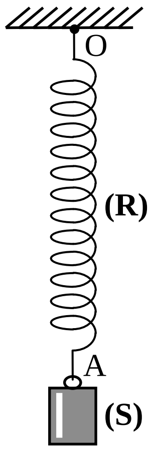
1) Calculate the resistance R' of the resistor equivalent to R_1 and R_2.
2) Show that the resistance equivalent to R' and R_3 is $R_e = 40\ \Omega$.
3) Calculate the electric power P_e consumed by R_e.

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 N/m and a solid (S) of mass M.
Take g = 10 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 $\Delta\ell_1 = 12$ 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 kg.

Second experiment:
The same experiment is performed on the Moon's surface. At equilibrium, the elongation of (R) is $\Delta\ell_2 = 2$ 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 $g_M = \frac{1}{6}g$.

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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)	$p = 4\times15 = 60$ cm , $p' = 4\times15 = 60$ cm	**1**
3.f)	$p = p' = 60$ cm . since $p = p' \Rightarrow p = 2f$.	**1**
3.g)	$f = \frac{p}{2}$ then $f = 30$ cm	**0.5**

Second exercise (7 points)

Part of the Q	Answer	Mark
I. 1)	$U_{AM} = R_1.I_1 = 60\times1 = 60$ V	**1**
I.2)	$U_{AM} = R_2.I_2 \Rightarrow I_2 = \frac{U_{AM}}{R_2} = \frac{60}{30} = 2$ A	**0.5**
I.3)	Law of addition of currents: $I = I_1 + I_2 \Rightarrow I = 3$ A	**0.5**
I.4)	$P_1 = R_1.I_1^2 = 60.1^2 = 60$ W $P_2 = R_2.I_2^2 = 30\times2^2 = 120$ W $P_3 = R_3.I_3^2 = 20\times3^2 = 180$ W	**1.5**
I.5)	$P_{total} = P_1 + P_2 + P_3 = 360$ W	**0.75**
II. 1)	$\frac{1}{R'} = \frac{1}{R_1} + \frac{1}{R_2} \Rightarrow R' = \frac{60\times30}{60+30} = 20\ \Omega$	**1**
II.2)	$Re = R' + R_3 \Rightarrow Re = 40\ \Omega$	**0.5**
II.3)	$Pe = Re.I^2 = 40\times3^2 = 360$ W	**0.75**
II.4)	$Pe = P_{total}$	**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	$T = k.\ \Delta\ell_1$ (Hooke's law) $\Rightarrow T = 50\text{x}0.12 = 6$ N since the system at equilibrium $W = T = 6$ N	**1.5**
I.4	$W = M.g \Rightarrow M = 0.6$ kg	**1**
II.1	$T' = k.\ \Delta\ell_2 = 1$ N $\Rightarrow W' = T' = 1$ N	**1**
II.2	$W' = M.g_M$ thus $g_M = 1.66$ N/kg	**0.5**
II.3	$\frac{g}{6} = 1.66$ then $g_M = \frac{g}{6}$	**1**