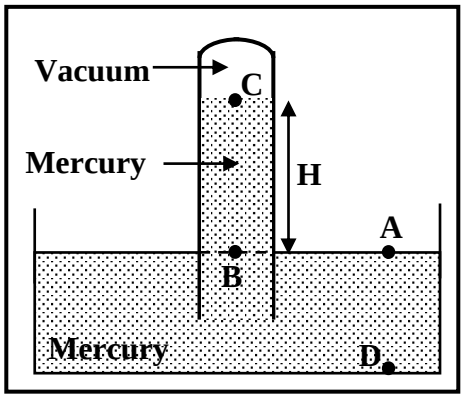
مسابقة في مادة الفيزياء
المدة: ساعة واحدة

الاسم:
الرقم:

This exam is formed of four obligatory exercises in two pages
Non programmable calculators are allowed

Exercise 1 (3 points) Mercury barometer

Consider the mercury barometer shown in the document 1.
The atmospheric pressure is 102000 Pa.
We denote by ρ the density of mercury and by g the gravitational field strength.



(Doc. 1)

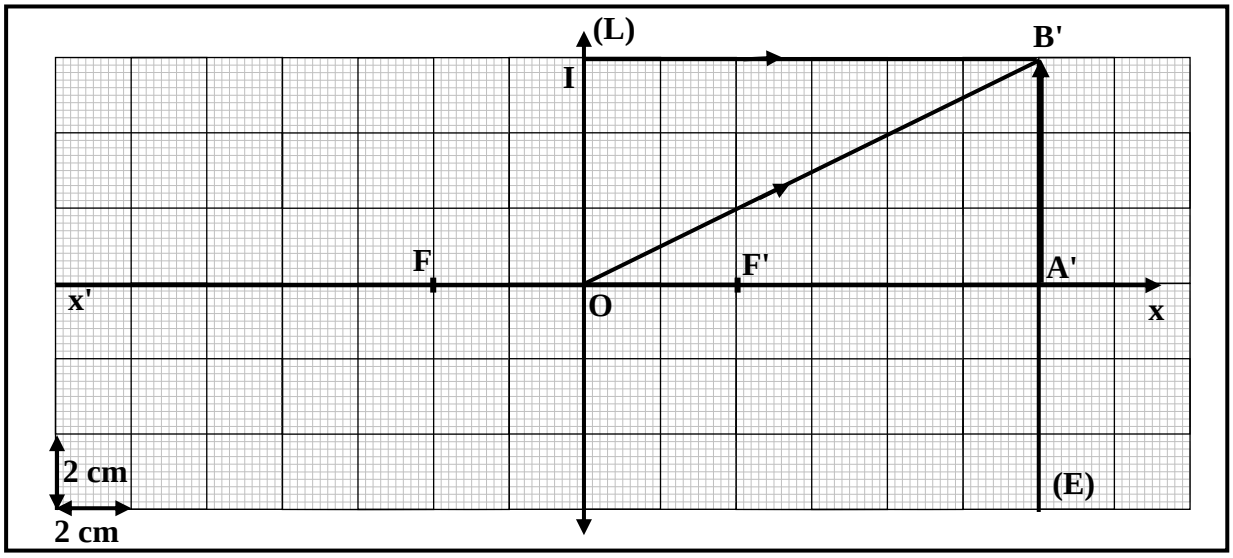
Copy and complete the statements below:

1) The pressure P_C at C is …….. Pa.
2) The pressure P_A at A is …….. Pa.
3) The pressure exerted by the column of mercury at B is given by the relation P_B = …×…×... .
4) The pressures at A and B are equal because A and B belong to the same liquid at rest, and are at the same …….. …….. .
5) The pressure at B is …….. than that at D.

Exercise 2 (6 points) The slide projector

The slide projector is an apparatus used to give for an object a magnified image collected on a screen.
The document 2 shows:

- a converging lens (L), its optical axis x'x, its image focus F' and its object focus F;
- the image (A'B') of an object (AB) given by (L) and collected on the screen (E);
- two emergent rays IB' and OB' corresponding to two incident rays issued from B.



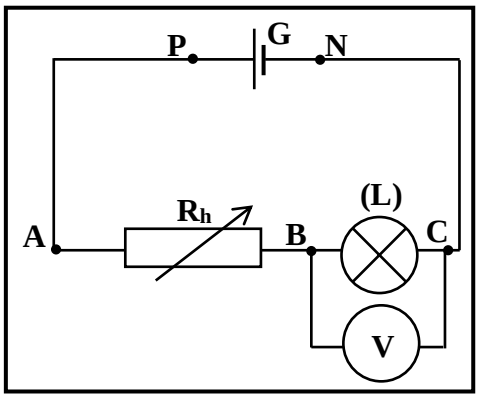
(Doc. 2)

1) Redraw the document 2 with the same scale.
2) Determine the focal length f of (L).
3) Specify the nature of (A'B').
4) Determine the size A'B' of (A'B').
5) Draw the incident rays corresponding to the emergent rays IB' and OB'.
6) Construct the object (AB).
7) (L) acts as a slide projector. Why?

Exercise 3 (6 points) Rheostat in an electric circuit

The electric circuit of the document 3 consists of:

- a generator (G) of constant voltage U_{PN} = 24 V;
- a rheostat (R_h) of variable resistance;
- a lamp (L) acting as a resistor and carrying the indications (12 V; 6 W);
- a voltmeter (V) connected across the terminals of (L).



(Doc. 3)

1) The resistance of the rheostat is adjusted such that the lamp functions normally.

1.1) What does each of the indications carried by (L) represent?

1.2) Show that the electric current flowing in (L) is I_1 = 0.5 A.

1.3) Determine, by applying the law of addition of voltages, the voltage U_{AB} across the terminals of the rheostat.

1.4) Show that the resistance of the rheostat is R_1 = 24 Ω.

2) The resistance of the rheostat is now adjusted at R_2 = 0 Ω.

2.1) The voltmeter reads 24 V. Justify.

2.2) The lamp burns out. Explain.

Exercise 4 (5 points) Magnetic force

An iron ball (B), of mass m and of center of gravity G, is suspended to the free extremity of a spring balance which indicates 3 N as shown in the document 4.

1) (B) is at equilibrium under the action of two forces.

1.1) Give the name of each force.

1.2) Indicate, for each force, whether it is a contact force or force acting from a distance.

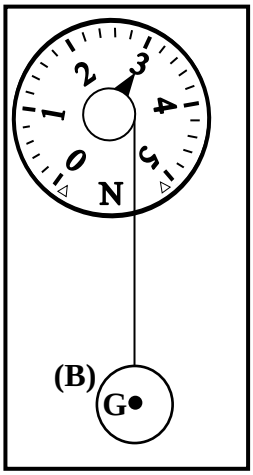
1.3) Write the vector relation between these two forces.

1.4) Determine the mass m of (B). Take g =10 N/kg.

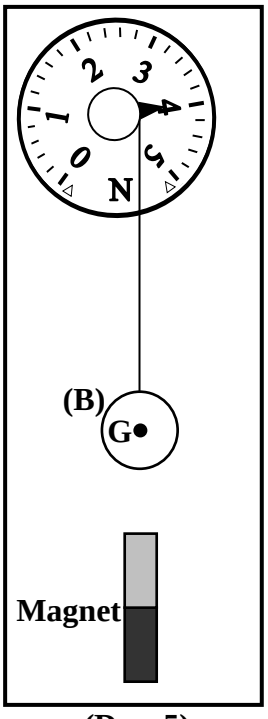
2) A bar magnet is placed below (B) as shown in document 5. The indication of the spring balance increases due to the magnetic force $\vec{F}$ exerted by the magnet on (B).

2.1) Indicate the line of action and the direction of $\vec{F}$.

2.2) The magnitude F of $\vec{F}$ is 1 N. Represent $\vec{F}$ at G using the scale: 1 cm → 0.5 N.



(Doc. 4)



(Doc. 5)

Part of the Q 1.	Answer	Mark 3pts
1	The pressure P_C at C is **0** Pa	0.5
2	The pressure P_A at A is **102000** Pa.	0.5
3	The pressure exerted by the column of mercury is at B is given by the relation $\mathbf{P_B = \rho \times g \times H}$	0.5
4	The pressures at A and B are equal because A and B belong to the same liquid at rest, and are at the same **horizontal level**.	0.5 + 0.5
4	the pressure at B is **smaller** than that at D	0.5

Part of the Q 2.	Answer	Mark 6pts
1	See figure	1
2	f = OF' = 2 x 2 = 4 cm	1
3	The nature of the image is real since it appears on the screen	1
4	The size of A'B' = 3 x 2 = 6 cm	0.5
5	See figure	1
6	The point of intersection of the incident rays is the object B. The foot of the perpendicular issued from B on the optical axis the object A.	1
7	Since it gives real and magnified image.	0.5

Part of the Q 3.	Answer	Mark 6pts
1.1	12 V is the rated voltage 6 W is the rated power	0.5 0.5
1.2	$I = \frac{P}{U} = \frac{6}{12} = 0.5$ A.	1
1.3	$U_{AB} = U_{PN} - U_L = 24 - 12 = 12$ V	1
1.4	$R_1 = \frac{U_{AB}}{I} = \frac{12}{0.5} = 24\ \Omega$	1
2.1	$U_{AB} = 0$ V when $R_2 = 0\ \Omega$ ($U_{AB} = R_2 \times I_2 = 0$ V) then $U_{BC} = U_{PN} - U_{AB} = 24 - 0 = 24$ V.	1
2.2	since $U_{BC} = 24$ V > U_{rated} =12 V	1

Part of the Q 4.	Answer	Mark 5pts
1.1	The Tension $\vec{T}$ of the spring balance. The weight $\vec{W}$ of the ball.	0.5 0.5
1.2	$\vec{T}$: contact force. $\vec{W}$: force acting from a distance.	0.25 0.25
1.3	$\vec{T}+\vec{W} = \vec{0}$ or $\vec{T} = -\vec{W}$	0.5
1.4	T = W = m×g = 3 N $m = \frac{W}{g} = \frac{3}{10} = 0.3$ kg	1
2.1	Line of action of $\vec{F}$: vertical Direction of $\vec{F}$: downward	0.5 0.5
2.2	$\left\{\begin{matrix}1\text{ cm} \rightarrow 0.5\text{ N} \\ X \rightarrow 1\text{ N}\end{matrix}\right\} \Rightarrow X = 2$ cm See figure	0.5 0.5