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 a mercury barometer which consists of a long tube full of mercury that is turned upside down in a recipient containing mercury. The mercury in the tube falls to a height H above the free surface of mercury. Point C is found on the surface of mercury in the tube. Above C there is vacuum. Point A is found on the free surface of mercury in the recipient (in contact with the atmosphere). Point B is found in the tube at the same horizontal level of A. Point D is found at the bottom of the recipient.
The atmospheric pressure is 102000 Pa.
We denote by ρ the density of mercury and by g the gravitational field strength.

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) Electric water-heater

An electric water heater that can be considered as a resistor of resistance R = 45.2 Ω, is fed by the voltage u of the mains. The voltage of the mains is represented by a waveform which consists of a sine wave of amplitude 4 divisions and of horizontal distance 5 divisions between two consecutive crests.
Take: the vertical scale is S_v= 77 V/div;
the horizontal scale is S_h= 4 ms/div;
$\sqrt{2}$ = 1.4.

1. Study of the voltage u

1.1. Indicate the type of the voltage u.
1.2. Determine the maximum value U_m of u.
Show that its effective value U is 220 V.
1.3. Determine the period T of u.
Show that its frequency is f=50 Hz.

2. Monthly consumption of the water heater

The water heater functions for **5 hours**.
2.1. Determine, in W then in kW, the electric power consumed by the water heater by applying the relation $P= \frac{U^2}{R}$. (1 kW = 1000 W)
2.2. Calculate, in kWh, the electric energy consumed by the water heater.

Exercise 3 (6 points) Rheostat in an electric circuit

An electric circuit 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);

(These components are connected in series)

- a voltmeter (V) connected across the terminals of (L).

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

1.1) What does the indication (12 V) carried by (L) represent?
What does the indication (6 W) carried by (L) represent?

1.2) **Show**, by applying the relation $P = U \times I$, that the electric current flowing in (L) is $I_1 = 0.5$ A.

1.3) Determine, by applying the relation $U_G = U_{rheostat} + U_L$, the voltage across the terminals of the rheostat.

1.4) Show, by applying Ohm's law, that the resistance of the rheostat is $R_1 = 24\ \Omega$.

2) The resistance of the rheostat is now adjusted at $R_2 = 0\ \Omega$.

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.

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) **Show that** the mass m of (B) is m = 0.3 kg. Take g =10 N/kg.

2) A bar magnet is placed below (B). 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. calculate the length of the vector $\vec{F}$ using the scale: 1 cm $\rightarrow$ 0.5 N.