

الاسم:
الرقم:

مسابقة في مادة الفيزياء
المدة: ساعة واحدة

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

Exercise 1: (4 points)

A resistor (D_1), of resistance R_1 , is subjected to a constant voltage of adjustable value U .

Choose the correct answer. Justify.

- 1) The voltage U across the terminals of (D_1) and the current I through it are:
a. inversely proportional b. proportional c. equal
- 2) (D_1) receives during a certain time t an electrical energy of 3000 J. The thermal energy furnished by (D_1) during t is:
a. practically equal to 3000 J b. greater than 3000 J c. less than 3000 J
- 3) By decreasing the voltage U , the resistance R_1 :
a. increases b. remains the same c. decreases
- 4) (D_1) is connected in series with another resistor (D_2) of resistance R_2 greater than R_1 . The resistance R of the resistor equivalent to (D_1) and (D_2) is:
a. smaller than R_1 b. greater than R_2 c. between R_1 and R_2

Exercise 2: (5 points)

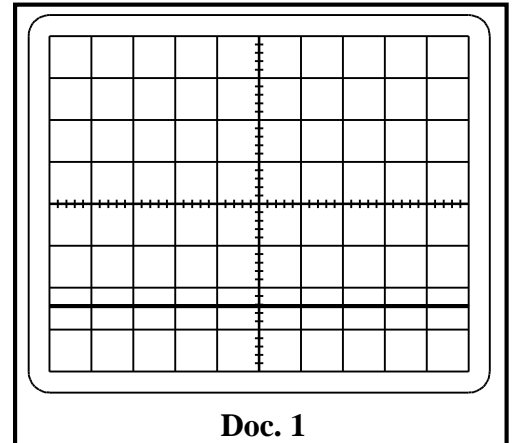
Studying a voltage using an oscilloscope

Document 1 represents the waveform of a voltage U supplied by a voltage source (G).

In the absence of any voltage, the horizontal luminous line passes through the center of the screen of the oscilloscope.

The vertical sensitivity of the oscilloscope is: $S_V = 5 \text{ V/div}$.

- 1) U is a DC voltage. Justify.
- 2) Name a source of voltage that may deliver such type of voltage.
- 3) Determine the value of the voltage U .
- 4) Indicate, with justification, which of the terminals P (positive) or N (negative) of (G) is connected to the ground of the oscilloscope.
- 5) The connections of the oscilloscope across (G) are reversed.
Indicate the direction of displacement of the luminous line.

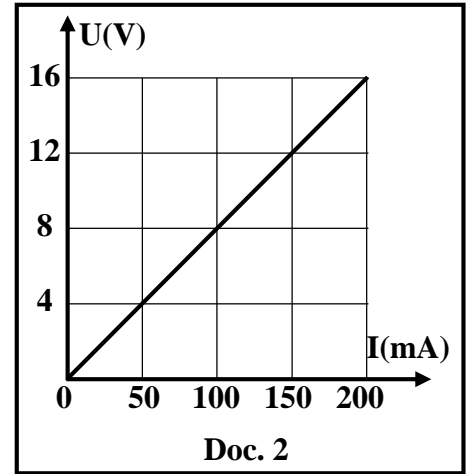


Exercise 3: (5 points)

Maximum power

Document 2 represents the characteristic current-voltage curve of a resistor (D) of resistance R.

- 1) Referring to document 2:
 - 1.1) Indicate the value of the current I through (D) when the voltage across its terminals is $U = 12 \text{ V}$.
 - 1.2) Deduce that $R = 80 \Omega$.
- 2) P is the electric power consumed by (D).
 - 2.1) Give the expression of P in terms of U and I.
 - 2.2) Show that $P = RI^2$.
- 3) Calculate the maximum power P_{\max} that (D) can withstand, knowing that the maximum current that may pass through (D) is $I_{\max} = 0.25 \text{ A}$,



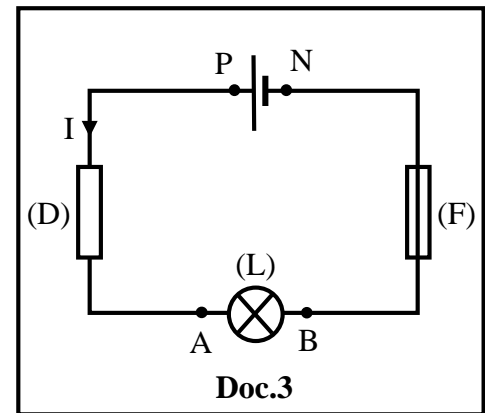
Exercise 4: (6 points)

Role of a fuse

The circuit of document 3 is formed of the following electric components:

- a battery that maintains across its terminals a constant voltage U_{PN} ;
- a lamp (L) carrying the indications (6 V; 100 mA);
- a convenient fuse (F) of negligible resistance;
- a resistor (D) of resistance $R = 30 \Omega$.

- 1) Give the significance of each of the indications carried by (L).
- 2) The voltage U_{BN} across (F) is null. Justify.
- 3) (L) glows normally.
 - 3.1) The current in the circuit is $I = 100 \text{ mA}$. Justify.
 - 3.2) Calculate the voltage U_{PA} across the terminals of (D).
 - 3.3) Show that $U_{PN} = 9 \text{ V}$.
- 4) The terminals P and A of (D) are connected by a connecting wire of negligible resistance.
 - 4.1) Just after short-circuiting (D), the voltage across the terminals of (L) becomes 9 V. Justify.
 - 4.2) The lamp (L) may burn out. Why?
 - 4.3) In fact, (L) turns off and doesn't burn out. Explain.



Exercise 1: (4 pts)

Resistor (Ohmic conductor)

Question	Answer key	Mark
1	b. According to Ohm's law $U = R \times I$.	0.5 0.5
2	a. The resistor converts the electric energy totally into thermal energy.	0.5 0.5
3	b. The resistance is the ratio $\frac{U}{I}$ which is constant and independent of the values of U and I. Or : the resistance is a characteristic of the resistor which remains constant while U or I varies.	0.5 0.5
4	b. Since $R = R_1 + R_2$ Or : when resistors are grouped in series, the equivalent resistance is greater than the greatest which is R_2 in this case.	0.5 0.5

Exercise 2: (5 points)

Studying a voltage using an oscilloscope

Question	Answer key	Mark
1	Since the displayed waveform is a horizontal luminous line. or : The voltage remains constant with respect to time.	1
2	Dry cell, battery, accumulator, ...	1
3	$U = y \times S_v = -2.4 \times 5 = -12V$.	1
4	P is connected to the ground of the oscilloscope since the visualized voltage is negative.	1
5	Displaced upwards.	1

Exercise 3: (5 points)**Maximum power**

Question	Answer key	Mark
1.1	$I = 150\text{mA}$	0.5
1.2	$R = \frac{U}{I} = \frac{12}{0.15} = 80\Omega.$ Or any other point graphically Or $R = \frac{\Delta U}{\Delta I}$	1.5
2.1	$P = UI.$	0.5
2.2	$P = UI$ and $U = RI$ then $P = RI \times I = RI^2.$	1
3	$P_{\max} = RI_{\max}^2 = 80 \times 0.25^2 = 5\text{W}$	1.5

Exercise 4: (6 points)**Role of a fuse**

Question	Answer key	Mark
1	6 V : rated voltage; 100 mA : rated current.	0.5 0.5
2	$U_{BN} = 0\text{V}$ the fuse is of negligible resistance.	0.5
3.1	Because (L) glows normally, then $I = 100\text{ mA}.$	0.5
3.2	$U_{PA} = R \times I = 30 \times 0.1 = 3\text{V}$ (Ohm's law).	1.25
3.3	$U_{PN} = U_{PA} + U_{AB} + U_{BN}$ (law of addition of voltages in series) then $U_{AB} =$ rated voltage of (L) = 6V since (L) shines normally. $U_{PN} = 3 + 6 + 0 = 9\text{V}.$	1.25
4.1	$U_{PN} = U_{PA} + U'_{AB} + U_{BN}$ (law of addition of voltages in series) $9 = 0 + U'_{AB} + 0$ donc $U'_{AB} = 9\text{V}.$	0.5
4.2	(L) may burn out since the voltage across its terminals becomes greater than its rated voltage.	0.5
4.3	Since the fuse melts thus protecting the lamp.	0.5