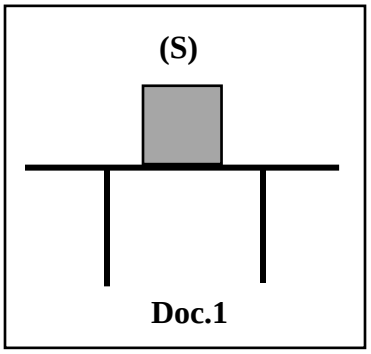
مسابقة في مادة الفيزياء
المدة: ساعة واحدة

الاسم:
الرقم:

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

## Exercise 1 (4 pts) Mechanical action

A solid (S) of mass m = 200 g is placed on a horizontal table as shown in document 1. (S) is in equilibrium under the action of two forces : its weight $\vec{W}$ of magnitude W and the normal reaction of the table $\vec{N}$ of magnitude N.



**Doc.1**

Given: g = 10 N/kg.

The following statements are false. Rewrite them correctly.

**1.** $\vec{W}$ is a contact force and $\vec{N}$ is a force acting from a distance.
**2.** The weight of (S) has a magnitude W = 2000 N.
**3.** $\vec{N}$ is directed vertically downwards.
**4.** (S) is in equilibrium which allows us to write: $\vec{W} = \vec{N}$.

## Exercise 2 (5 pts) Electric stove

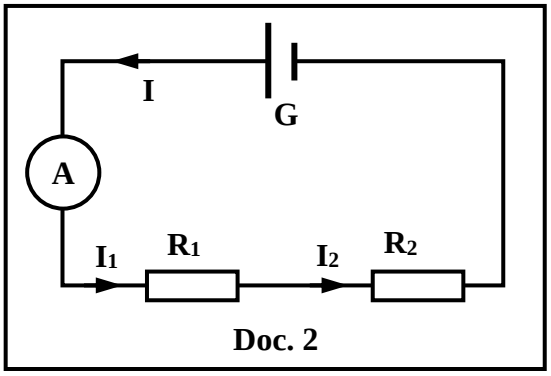
A baker buys an electric stove acting as a resistor. On its rating plate, he reads the following indications: 220 V - 2200 W.

**1.** Give the meaning of each indication written on the plate.
**2.** A resistor converts electrical energy into another form of energy. What is the form of this energy?
**3.** The electric power consumed by a resistor is equal to the product of the voltage U across its terminals, by the current I traversing it: P = U I.
Calculate the current traversing this stove in normal functioning.
**4.** The stove is used at the rate of two hours per day.
**4.1.** Determine, in kWh, the electric energy $E_1$ consumed by this stove in two hours.
**4.2.** Show that the electric energy $E_2$ consumed by this stove during one month (30 days) is 132 kWh.
**4.3.** Calculate the monthly cost to be paid by the baker, knowing that the average price of one kWh is 100 L.L.

## Exercise 3 (5.5 pts) Electric circuit

During a laboratory session, a circuit is constructed as shown in document 2, where:

- (G) is a generator that maintains across its terminals a constant voltage U.
- ($R_1$) is a resistor of resistance $R_1 = 20\ \Omega$.
- ($R_2$) is a resistor of resistance $R_2 = 40\ \Omega$.
- (A) is an ammeter of negligible resistance.



Doc. 2

We designate by I the current sent by (G), $I_1$ the current traversing ($R_1$) and $I_2$ the current traversing ($R_2$).
The ammeter indicates 100 mA.

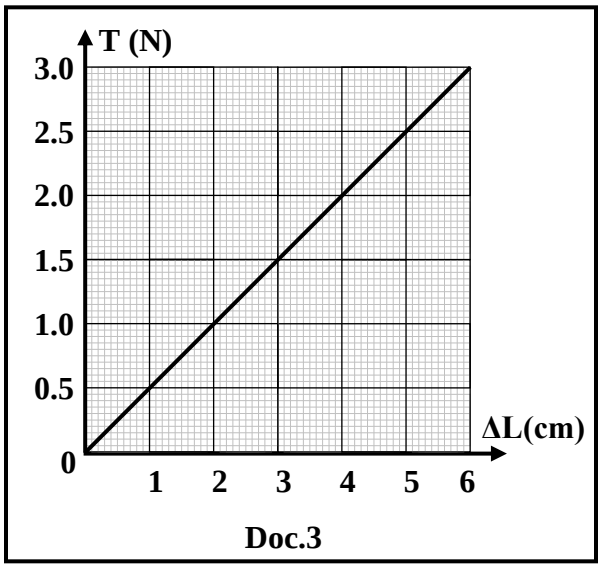
**1.** $I = I_1 = I_2 = 100$ mA. Justify.
**2.** Calculate the resistance $R_e$ of the resistor equivalent to ($R_1$) and ($R_2$).
**3.** Calculate, by applying Ohm's law, the values of the voltages $U_1$ and $U_2$ across the terminals of ($R_1$) and ($R_2$) respectively.
**4.** The voltage across the terminals of (A) is zero. Why?
**5.** Deduce the value of U.

## Exercise 4 (5.5 pts) Calibration curve of a spring

Document 3 represents the calibration curve of an elastic spring of initial length $L_0 = 10$ cm. This curve shows, within the elastic limit of the spring, the tension of the spring T as a function of its elongation $\Delta L$.

**1.** Copy and complete, referring to document 3, the following table :

| T (N) | 0.5 | | 2.5 |
|---|---|---|---|
| $\Delta L$ (cm) | | 3 | |
| $\frac{T}{\Delta L}$ (N/cm) | | | |



Doc.3

**2.** Hooke's law is given by the relation: $T = k\ \Delta L$ where k is a physical quantity of the spring.
**2.1.** Give the name of k.
**2.2.** Deduce its value in S.I.
**3.** The maximum length reached by the spring without losing its elasticity is $L_{max} = 16$ cm.
**3.1.** Calculate the maximum elongation $\Delta L_{max}$ of the spring.
**3.2.** Indicate, graphically, the value of the corresponding tension $T_{max}$.
**3.3.** Verify by calculation the value of $T_{max}$.

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## Exercice 1 (4 pts) Mechanical action

| Partie | Réponses | Note |
|---|---|---|
| 1. | $\overrightarrow{W}$ is a force acting from a distance and $\overrightarrow{N}$ is a contact force. | 1 |
| 2. | The weight of (S) has a magnitude W = 2N. | 1 |
| 3. | $\overrightarrow{N}$ is directed vertically upwards. | 1 |
| 4. | (S) is in equilibrium which allows us to write: $\overrightarrow{W} = - \overrightarrow{N}$. | 1 |

## Exercice 2 (5 pts) Electric stove

| Partie | Réponses | Note |
|---|---|---|
| 1. | 220 V is the rated voltage of the stove ;<br>2200 W is the rated power. | 0,5<br>0,5 |
| 2. | Thermal energy or heat. | 0,5 |
| 3. | $I = \frac{P}{U} = \frac{2200W}{220V} = 10$ A. | 1 |
| 4.1. | The electric power consumed by the stove during the 2 hours is : $E_1 = 2.2 \times 2 = 4.4$ kWh. | 1 |
| 4.2. | The electric power consumed by the stove during 2 months: $E_2 = 4.4 \times 30 = 132$ kWh. | 1 |
| 4.3. | The monthly cost is : 132 x 100 = 13200 LL | 0,5 |

## Exercice 3 (5 ½ pts) Electric circuit

| Partie | Réponses | Note |
|---|---|---|
| **1.** | $I = I_1 = I_2 = 100$ mA due to the law of uniqueness of current in a series circuit. | **1** |
| **2.** | $R_1$ and $R_2$ are connected in series thus $R_e = R_1 + R_2 = 20 + 40 = 60\ \Omega$. | **1** |
| **3.** | By applying Ohm's law :<br>$U_1 = R_1 \times I = 20 \times 0,1 = 2$ V.<br>$U_2 = R_2 \times I = 40 \times 0,1 = 4$ V. | **0.75**<br>**0.75** |
| **4.** | Since (A) has a negligible resistance. | **0,5** |
| **5.** | $U = U_{(A)} + U_1 + U_2$ (Law of addition of voltages)<br>$U = 0 + 2 + 4$ thus $U = 6$V. | **0,5**<br>**1** |

## Exercice 4 (5½ pts) Calibration curve of a spring

| Partie | Réponses | Note |
|---|---|---|
| **1.** | <table><tr><td>T (N)</td><td>0.5</td><td>**1.5**</td><td>2.5</td></tr><tr><td>ΔL (cm)</td><td>**1**</td><td>3</td><td>**5**</td></tr><tr><td>$\frac{T}{\Delta L}$ (N/cm)</td><td>**0.5**</td><td>**0.5**</td><td>**0.5**</td></tr></table> | **1,5** |
| **2.1.** | Spring constant or stiffness. | **0,5** |
| **2.2.** | $k = \frac{T(N)}{\Delta L(m)} = 50$ N/m. | **1** |
| **3.1.** | $\Delta L_{max} = L_{max} - L_0 = 16 - 10 = 6$ cm. | **0,5** |
| **3.2.** | Graphically : When $\Delta L_{max} = 6$ cm, $T_{max} = 3$ N. | **1** |
| **3.3.** | $T_{max} = k \times \Delta L_{max} = 50 \times 0,06 = 3$ N. | **1** |