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# الامتحان الوطني الموحد للبكالوريا
## المسالك الدولية
الدورة العادية 2022
– الموضوع –

المملكة المغربية
وزارة التربية الوطنية والتعليم الأولي والرياضة
المركز الوطني للتقويم والامتحانات

SSSSSSSSSSSSSSSSSSS-SS | NS 27E

| | | |
|---|---|---|
| المادة | الفيزياء والكيمياء | مدة الإنجاز: 3h |
| الشعبة أو المسلك | شعبة العلوم التجريبية: مسلك علوم الحياة والأرض - خيار أنجليزية | المعامل: 5 |

- **Non-programmable scientific calculator is allowed**
- **Give the literal expressions before every numerical application**

**This exam paper consists of four exercises: one in chemistry and three in physics.**

| | | |
|---|---|---|
| **Chemistry (7 points)** | • **Temporal monitoring – Pentanoic acid** | **7 points** |
| **Physics (13 points)** | **Exercise 1 : Waves propagation** | **3,5 points** |
| | **Exercise 2 : Response of a dipole- Oscillating circuit** | **5,5 points** |
| | **Exercise 3 : Motion of a solid in a horizontal plan** | **4 points** |

| Scale | Subject |
|---|---|

## Chemistry (7 points)

**Part 1 and Part 2 are independents**

**The study of chemical transformations permits the temporal monitoring evolution of chemical systems and determine some caracteristics based on technics or different methods.**
**This exercise aims to:**
- **Study the temporal monitoring of a chemical transformation;**
- **Determine the degree of purity.**

### Part 1: Study of temporal monitoring of chemical transformation

To monitor the reaction between hydrogen peroxide $H_2O_{2(aq)}$ and iodide ions $I^-_{(aq)}$, we realise the oxidation of iodide ions by hydrogen peroxide in acid medium by monitoring the advancement $x$ of the reaction in different experimental conditions.

Three experiments are carried out in the presence of an excess of $H_3O^+_{(aq)}$ ions. The total volume of the mixture is the same in the three experiments $V = 100\ mL$.

The chemical equation modelling the studied chemical transformation is:

$$H_2O_{2(aq)} + 2I^-_{(aq)} + 2H_3O^+_{(aq)} \longrightarrow I_{2(aq)} + 4H_2O_{(l)}$$

The obtained results for different initial conditions shown on the table below are drawn in the curves (1), (2) and (3) of figure (1), highlighting two kinetic factors.

| Experiment | ① | ② | ③ |
|---|---|---|---|
| $[H_2O_2]_0$ $(mol.L^{-1})$ | $10^{-2}$ | $2.10^{-2}$ | $10^{-2}$ |
| $[I^-]_0$ $(mol.L^{-1})$ | $2.10^{-2}$ | $4.10^{-2}$ | $2.10^{-2}$ |
| $\theta$ $(°C)$ | 20 | 20 | 32 |

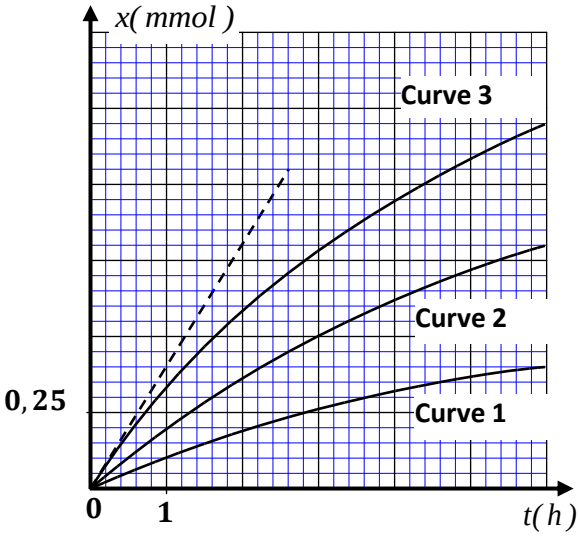



**Figure 1**

**0,5** **1.** Identify the $(Ox/Red)$ couples in this reaction.

**2.** Using the table data:

**0,75** **2.1.** Cite two kinetic factors highlighted and their effects on volumetric rate of reaction.

**0,75** **2.2.** Based on the advancement table, determine for the experiments (1) and (2) the values of final advancement $x_f$.

**0,5** **2.3.** Assign each curve to the corresponding experiment.

**3.** We are interested in the case of curve (3):

**0,5** **3.1.** Determine, in unit $(mol.L^{-1}.h^{-1})$, the value of the volumetric rate of reaction at the instant $(t_0 = 0)$.

**0,5** **3.2.** Give the definition of the half-life of reaction and determine graphically its value.

**Part 2: Determination of degree of purity of valeric acid**

Pentanoic acid, also called valeric acid, isolated from valerian plant (figure 2), is an carboxylic acid of formula $C_4H_9CO_2H$. It is mainly used for the synthesis of aromas, softeners or agrochemicals.



**Figure 2**

**1.** We have an aqueous solution $(S_A)$ of pentanoic acid of concentration $C_A = 1,0.10^{-2}\ mol.L^{-1}$ and $pH = 3,4$.

**0,5** **1.1.** Write the chemical equation modelling the chemical reaction between pentanoic acid and water.

**0,5** **1.2.** Calculate the value of the final rate of reaction $\tau$ of this reaction. Conclude.

**0,5** **1.3.** Express the quotient of reaction at equilibrium of chemical system $Q_{r,eq}$ in terms of $\tau$ and $C_A$.

**0,5** **1.4.** Determine the value of $pK_A$ of the couple $(C_4H_9CO_2H_{(aq)} / C_4H_9CO_{2(aq)}^-)$.

**2.** We have a bottle containing valeric acid. To search the purity of this acid, we take a volume $V_0 = 2\ mL$ of valeric acid which we pour in a volumetric flask of $1000\ mL$. We add water to the line of the Gauge and we stir to prepare an aqueous solution $(S_1)$ of concentration $C_1$.

We titrate the volume $V_1 = 10\ mL$ of $(S_1)$ with an aqueous solution of sodium hydroxide $Na_{(aq)}^+ + HO_{(aq)}^-$ of molar concentration $C_1$. The volume poured at the equivalence is $V_{B,E} = 9\,mL$.

**0,5** **2.1.** Write the equation of reaction during the titration, knowing that it is total.

**0,5** **2.2.** Determine the value of $C_1$.

**0,25** **2.3.** Calculate the value of the amount of matter $n_1$ of valeric acid present in solution $(S_1)$.

**0,25** **2.4.** The amount of matter $n_0$ of the valeric acid in the volume $V_0$ is $n_0 = 1,82.10^{-2} mol$. We note that the degree of purity of an acid is given in % as: $d = 100.\dfrac{n_1}{n_0}$.

Determine the degree of purity of valeric acid contained in the bottle.

## Physics (13 points)

### Exercise 1 (3,5 points): propagation of waves

**Part 1 and Part 2 are independent**

**A wave is considered as a manifestation of propagative behaviour of vibrations affecting a material medium.**
**This exercise aims to study some properties and characteristics of mechanical waves and light.**

**Part 1: Propagation of mechanical wave**

An elastic rope tense horizontally and attached by its terminal $S$ to a vibrating blade which gives it sinusoidal vibrations of frequency $N$. We suppose that there is no reflexion nor attenuation of waves. The motion of $S$ begins at the instant $t_0 = 0$.

Figure (1) (page 4/6) gives the aspect of the rope at an instant $t_1$ and figure (2) (page 4/6) represents the elongation in terms of time of a point $M$ from the rope situated at a distance $d = SM$ from the source $S$.

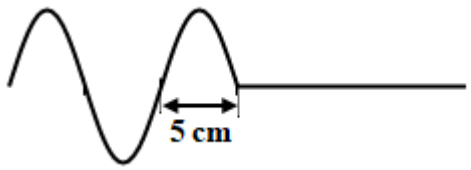



**Figure 1**

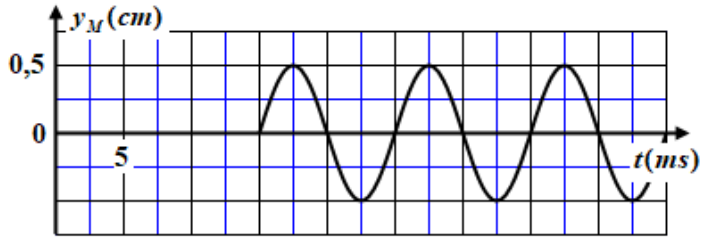



**Figure 2**

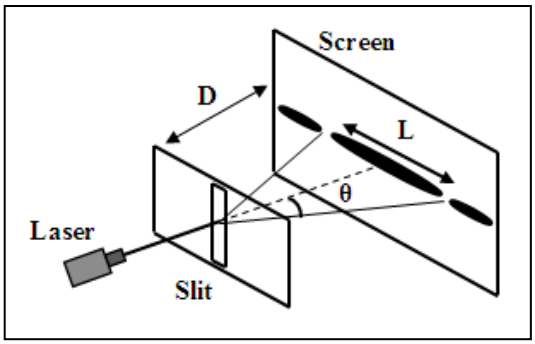
**0,5** **1.** Determine the period $T$ and the wavelength $\lambda$ of the wave.

**0,5** **2.** Deduce the value of the velocity v of the wave.

**0,75** **3.** Determine the value of $t_1$ and the value of $d$.

**Part 2: Propagation of a light wave**

A laser produces a monochromatic light of wavelength $\lambda$ that lights a slit of width $a$. We observe a figure composed of light spots in a screen placed at a distance $D$ from the slit (figure on the right).




**Data:**

$a = 100\,\mu m$ ; $\tan\theta \approx \theta(rad)$

**0,5** **1.** Give the name of this phenomenon. What does this phenomenon prove about the aspect of light?

**0,5** **2.** Copy on your answer sheet the number of the question, and write the letter corresponding to the right option (A,B,C or D).

The expression of the central spot L in the screen is:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | $L = \frac{\lambda.D}{a^2}$ | B | $L = \frac{2\lambda.D}{a}$ | C | $L = \frac{a.D}{\lambda}$ | D | $L = \frac{2\lambda.a}{D}$ |

**0,75** **3.** We replace in the previous apparatus the slit of width $a$ with a wire of diameter $a_f$ without changing the values of the other parameters. We obtain a new figure containing a central spot of length $L_f = \frac{2}{3}.L$.

Determine the value of the diameter $a_f$ of the fil.

## Exercise 2 (5,5 points): Response of a dipole - Oscillating circuit

**Capacitor is an electronic component that forms with other components circuits able to have different behaviours that depend of the initial conditions. The behaviour of such circuits can be identified according to an experimental study, or energetic, or by applying the laws of electricity.**

**This exercise aims to:**

- **Study the response of a dipole RC to a step-voltage;**
- **Study, energetically, an oscillating circuit LC.**

We consider the circuit of figure (1) containing:

- an ideal voltage generator of electromotive force $E$;
- a capacitor of capacity $C$;
- a coil of inductance $L$ and negligible resistance;
- an ohmic conductor of resistance $R$;
- a switch $K$ of two positions.

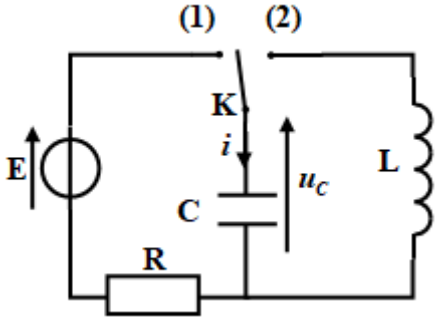



**Figure 1**

## 1. Response of a dipole RC to a step-voltage

At the instant $t_0 = 0$ we place the switch $K$ in position (1).

**0,5** **1.1.** Find out the differential equation verified by the voltage $u_C$ between the terminals of the capacitor.

**0,5** **1.2.** The solution of this differential equation is written as $u_C(t) = E.(1-e^{-\frac{t}{RC}})$.

Copy on your answer sheet the number of the question, and write the letter corresponding to the right option (A,B,C or D).

The expression of the instantaneous current intensity $i(t)$ in this circuit is:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A | $i(t) = \frac{E}{R}.(1-e^{-\frac{t}{RC}})$ | B | $i(t) = -\frac{E}{R}.e^{-\frac{t}{RC}}$ | C | $i(t) = \frac{E}{RC}.e^{-\frac{t}{RC}}$ | D | $i(t) = \frac{E}{R}.e^{-\frac{t}{RC}}$ |

**1.3.** The graphs of figures (2) and (3) represent, respectively, the curves of $i(t)$ and $\mathscr{E}_e(t)$ with $\mathscr{E}_e$ is the electric energy stored in the capacitor.

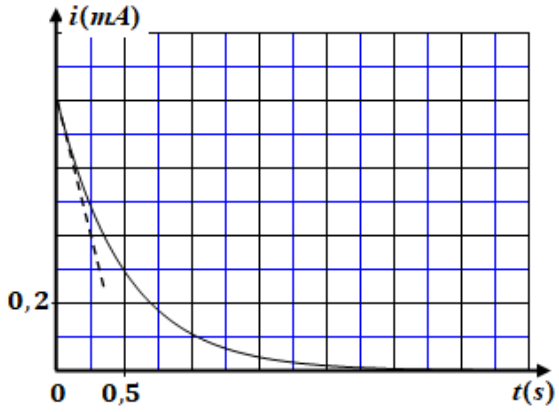



**Figure 2**

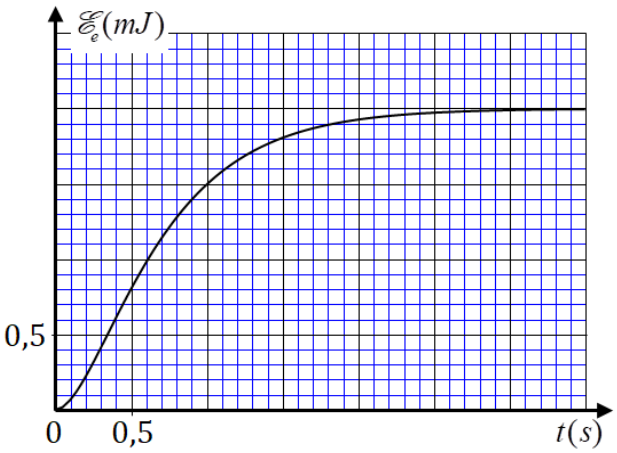



**Figure 3**

By exploiting the two curves:

**0,25** **a.** Determine the value of time constante $\tau$ of the circuit.

**0,5** **b.** Determine the maximal values $I_{max}$ of the current intensity and $\mathscr{E}_{emax}$ of the electric energy.

**0,75** **c.** Verify that the electromotive force $E$ is written as $E = \frac{2\mathscr{E}_{emax}}{\tau.I_{max}}$. Calculate its value.

**0,5** **d.** Determine the value of $R$.

**0,5** **e.** Verify that $C = 40\,\mu F$.

## 2. Study of oscillating circuit LC

Once the capacitor is completely charged, we switch to the position (2) at an instant $t_0 = 0$.

Curves ❶ and ❷ of figure (4) represent the variations of electric energy $\mathscr{E}_e$ stored in the capacitor and the magnetic energy $\mathscr{E}_m$ stored in the coil in terms of time.

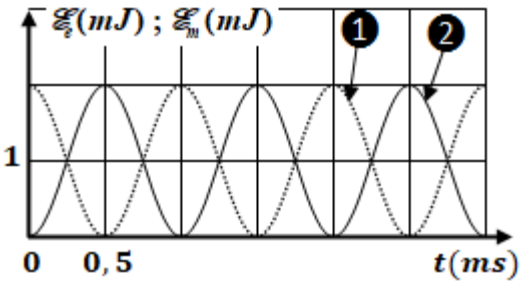



**Figure 4**

**0,5** **2.1.** Indicate, by justification, the curve corresponding to the electric energy $\mathscr{E}_e$.

**0,5** **2.2.** Explain from an energetic point of view the oscillation regime in the circuit.

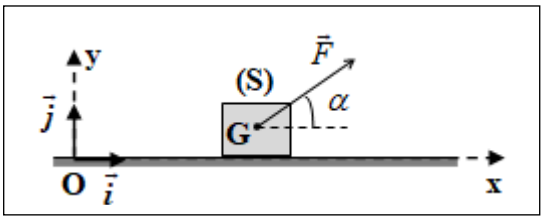
**0,25** **2.3.** Determine the value of the total energy $\mathscr{E}$ of the circuit.

**0,25** **2.4.** Determine the value of the period $T_0$ of the oscillations.

**0,5** **2.5.** Deduce the value of the inductance $L$ (we take $\pi^2 = 10$).

## Exercise 3 (4 points): Motion of a solid in a horizontal plan

**Motion of mechanical systems are generally governed by Newton's laws.**
**The temporal evolution of these systems depends on the referential of study, initial conditions and mechanical actions to which these systems are depending on, which influences the kinetic and dynamic magnitudes characterizing the motion of these systems.**
**This exercise aims to determine some magnitudes during the motion of a solid in a horizontal plan.**




We consider a solid $(S)$ of mass $m$ able to slide without friction in a horizontal plan. At the instant $t_0 = 0$, the solid $(S)$ starts with a horizontal initial velocity $\vec{v}_0$, from position $O$ under the action of a constant motive force $\vec{F}$ which makes an angle $\alpha$ with the horizontal. We model the frictions by a horizontal and constant force $\vec{f}$, parallel with the trajectory and in opposite sense with motion.

We study the motion of the centre of inertia $G$ of the solid $(S)$ in a frame of reference $(O, \vec{i}, \vec{j})$ linked to Earth supposed Galilean (figure on the right). The abscissa of $G$ at $t_0 = 0$ is $x_G = x_0 = 0$.

**Data:** $m = 610$ g ; $f = 0{,}16\ N$ ; $\alpha = 16°$ ; $g = 10\ m.s^{-2}$

**0,75** **1.** By applying Newton's second law, show that the differential equation verified by $x_G$ is written as:

$$\frac{d^2x_G}{dt^2} = \frac{F.\cos\alpha}{m} - \frac{f}{m}.$$

**0,75** **2.** The value of the instantaneous velocity of $G$ at the instant $t_1 = 0{,}61\ s$ is $v_1 = 1{,}52\ m.s^{-1}$ and at the instant $t_2 = 1{,}20\ s$ is $v_2 = 2{,}88\ m.s^{-1}$.

Prove that the value of acceleration is $a_G = 2{,}3\ m.s^{-2}$ .

**0,5** **3.** Determine the value of the initial velocity $v_0$.

**0,75** **4.** Determine the distance $d$ travelled by $(S)$ at the instant $t_2$.

**0,5** **5.** Calculate the intensity of the motive force $\vec{F}$ .

**0,75** **6.** Determine the intensity of the force $\vec{R}$ exerted by the horizontal plan on the solid $(S)$.