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# الامتحان الوطني الموحد للبكالوريا
## المسالك الدولية – خيار أنجليزية
## الدورة الاستدراكية 2018
## -الموضوع-

RS27E

المملكة المغربية
وزارة التربية الوطنية والتكوين المهني والتعليم العالي والبحث العلمي

المركز الوطني للتقويم والإمتحانات والتوجيه

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

- **The use of the 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: Ethanoic acid and its utilizations** **(7 points)**
- **Physics:** **(13 points)**
  - **Exercise 1: Uranium-Thorium dating method** **(3 points)**
  - **Exercise 2: Studying the response of a dipole** **(5 points)**
  - **Exercise 3: Studying the motion of a cyclist in a circuit** **(5 points)**

| scale | Subject |
|---|---|

## Chemistry (7 points): Ethanoic acid and its utilizations

**The Ethanoic acid of formula $CH_3COOH$ represents the principal constitutent of commercial vinegar after water. It is used as a reactive in a few organic syntheses, like the one that leads to the Ethyl ethanoate. The degree of acidity of vinegar is given by degree (°).**

***This exercise consists of 3 different parts, and aims at:***

- ***Studying an aqueous solution of ethanoic acid;***
- ***Determining of the degree of acidity of commercial vinegar;***
- ***Studying the synthesis of Ethyl ethanoate from the ethanoic acid.***

**Data:**

- The degree of acidity of vinegar is equal to the mass, in grams, of the pure acid that contains $100\ mL$ of vinegar.
- $pK_A(CH_3COOH(aq)/CH_3COO^-(aq)) = 4,8$ at $25°C$; $M(CH_3COOH) = 60\ g.mol^{-1}$

**<u>Part 1</u>: Studying an aqueous solution of ethanoic acid**

The measurement of pH of an aqueous solution of ethanoic acid, at $25°C$, gives $pH = 3,0$.

**0,5** **1.** Write the chemical equation of the transformation between the ethanoic acid and water.

**0,5** **2.** Determine the predominant substance of the pair $(CH_3COOH(aq)/CH_3COO^-(aq))$ in this solution. Justify

**1** **3.** Determine the value of the reaction quotient $Q_{r,eq}$ at the equilibrium of the chemical system.

**0,5** **4.** Will the value of $Q_{r,eq}$ be modified if we dilute the solution of the ethanoic acid? Justify.

**<u>Part 2</u>: The determination of the degree of acidity of commercial vinegar**

The tag of a bottle of commercial vinegar indicates $6°$. The molar concentration of ethanoic acid in this vinegar is $C_0$.

We intend to make a pH-titration of this vinegar to determine its degree of acidity. For this, we prepare an aqueous solution $(S_1)$ with $10$ times dilution of the commercial vinegar, and we take a volume $V_A = 25\ mL$ of the diluted solution $(S_1)$ of molar concentration $C_A$ $\left(C_A = \frac{C_0}{10}\right)$ which we titrate with an aqueous solution $(S_2)$ of Sodium Hydroxide $Na^+_{(aq)} + HO^-_{(aq)}$ of molar concentration $C_B = 2,5.10^{-1} mol.L^{-1}$.

At the equivalence, the volume added of the solution $(S_2)$ is $V_{B,E} = 10\ mL$.

**0,5** **1.** Write the equation of reaction of titration (supposed total).

**0,75** **2.** Calculate the value of $C_A$. And deduce the value $C_0$.

**0,75** **3.** Verify the value of the degree of acidity of vinegar indicated in the tag of the bottle.

**<u>Part 3</u>: Studying the synthesis of Ethyl ethanoate from the ethanoic acid.**

In a round-bottom flask, we pour an equimolar mixture of $n_1 = 0,3\ mol$ of ethanoic acid and $n_2 = 0,3\ mol$ of ethanol, and some drops of concentrated sulfuric acid. At the equilibrium of the chemical system, the amount of matter of Ester formed is: $n_f(ester) = 0,2\ mol$.

The synthesis of the Ethyl ethanoate is described in the equation of reaction:

$$CH_3COOH_{(\ell)} + C_2H_5OH_{(\ell)} \rightleftharpoons CH_3COOC_2H_{5(\ell)} + H_2O_{(\ell)}$$

**0,75** **1.** Identify the organic functional groups of the organic molecules present in the equation of synthesis.

**0,25** **2.** Give the characteristics of this reaction.

**0,5** **3.** Determine the value of the yield of this synthesis.

**0,5** **4.** Determine the value of the equilibrium constant K associated to the chemical equation of esterification.

**0,5** 5. To synthetize the Ethyl ethanoate in a fast and total transformation, it is possible to replace the ethanoic acid by one of its derivatives.
Give the displayed formula (semi-developed) of this derivative.

## Physics (13 points)

### Exercise 1 (3 points): Uranium-Thorium dating method

***The marine sediments contain the thorium*** $^{230}_{90}Th$ ***and the uranium*** $^{234}_{92}U$ ***with different percentages according to their ages. The thorium*** $^{230}_{90}Th$ ***present in these sediments comes from the spontaneous disintegration of the uranium*** $^{234}_{92}U$ ***during time.***

***The aim of this exercise is to study the disintegration of uranium*** $^{234}_{92}U$ **.**

**Data:**

- The energies of mass of the nuclei and the nucleus of uranium 234:

| | 92 protons | 142 neutrons | Nucleus $^{234}_{92}U$ |
|---|---|---|---|
| Energy of mass (MeV) | 86321,9 | 133418,5 | 218009,1 |

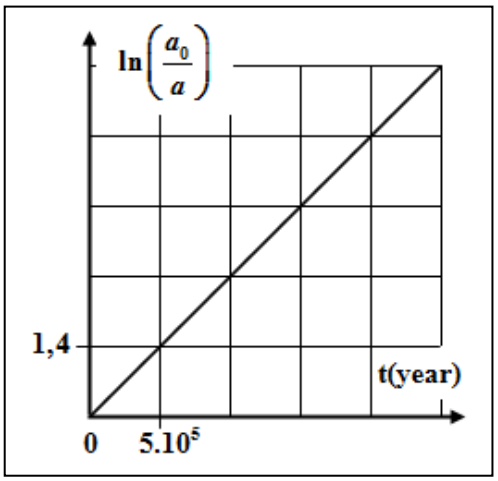
**0,5** **1.** Give the composition of the nucleus of thorium $^{230}_{90}Th$.

**0,75** **2.** Write the equation of disintegration of $^{234}_{92}U$. Identify the type of this disintegration.

**0,75** **3.** 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 binding energy of uranium $^{234}_{92}U$ is:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **A** | $1,65.10^3\,MeV$ | **B** | $1,73.10^3\,MeV$ | **C** | $1,85.10^3\,MeV$ | **D** | $1,98.10^3\,MeV$ |

**4.** We consider a sample of a marine sediment which was formed at an instant $t_0 = 0$. This sample contains $N_0$ nucleus of uranium (without thorium nucleus).
We name $a_0$ the radioactivity of the sample at an instant $t_0 = 0$ and $a$ the radioactivity of the sample at an instant $t$.
The curve on the right represents the variations of $ln\left(\frac{a_0}{a}\right)$ in function of time.




**0,5** **4.1.** Determine, graphically , the value of the radioactivity constant $\lambda$ of uranium 234 with the unit $(year^{-1})$.

**0,5** **4.2.** The study of the sample at an instant $t_1$ (the age of the sample) shows that $\frac{a_0}{a} = \sqrt{2}$.
Determine the value of $t_1$ the age of the sample with the unit (year).

### Exercise 2 (5 points): Studying the response of a dipole

***Electric circuits or electronic circuits contain capacitors and inductors which have different behaviors according to their use.***

***The aim of this exercise is to:***

- ***Study of the response of RC dipole to a step voltage.***
- ***Study of free electric oscillations and the energy exchange in RLC series.***

We realize the electric assembly representing in figure (1), which is constituted from the following elements:

- Ideal voltage generator of electromotor force $E$;
- A capacitor of capacitance $C$, initially not charged;
- An inductor $(L, r = 0)$;
- Two ohmic conductors of resistances respectively $R_1 = 6\ k\Omega$ and $R_2$;
- Switch $K$.

**1. Response of RC dipole to a step voltage**

At an instant $t_0 = 0$, we place the switch K on the position (1). Figure (2) represents the variation of the voltage $u_C(t)$ between the capacitor terminals.

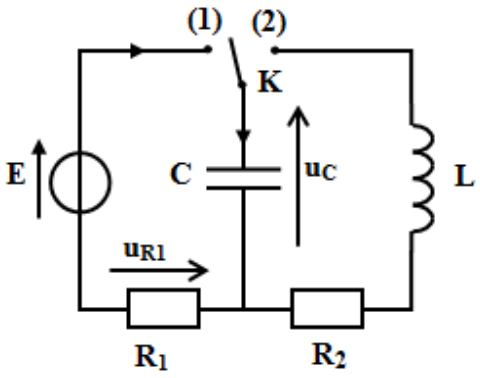


Figure (1)

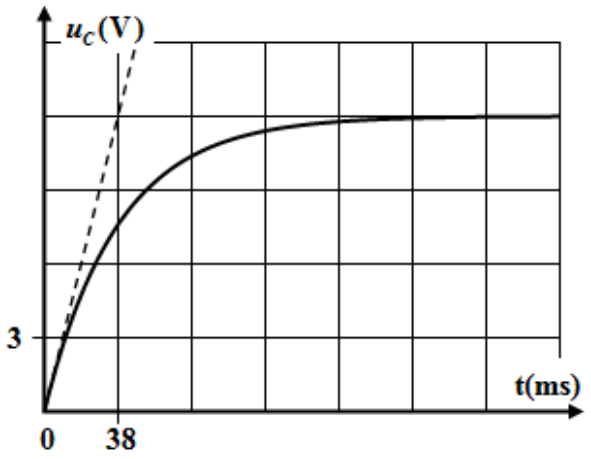


Figure (2)

**0,75** **1.1.** Prove that the differential equation verified by $u_C$ is written as: $\frac{du_C}{dt} + \frac{1}{\tau}.u_C = \frac{E}{\tau}$ where $\tau$ is a positive constant. Give the expression of $\tau$.

**0,75** **1.2.** Determine, graphically, the values of $E$ and $\tau$.

**0,25** **1.3.** Verify that $C \simeq 6,3\ \mu F$.

**2. Study of free electric oscillations and the energy exchange in RLC series**

When the permanent state is reached, we permute the switch $K$ to the position (2) at an instant $t_0 = 0$.

The curve in figure (3) represents the variation of the voltage $u_C(t)$ between the capacitor terminals.

**0,5** **2.1.** Justify the nature of the electric oscillations in the circuit.

**0,5** **2.2.** Determine the value of the charge $Q_0$ of the capacitor at the instant $t_0 = 0$.

**0,25** **2.3.** Determine, graphically, the value of the pseudo-period $T$ of the oscillations.

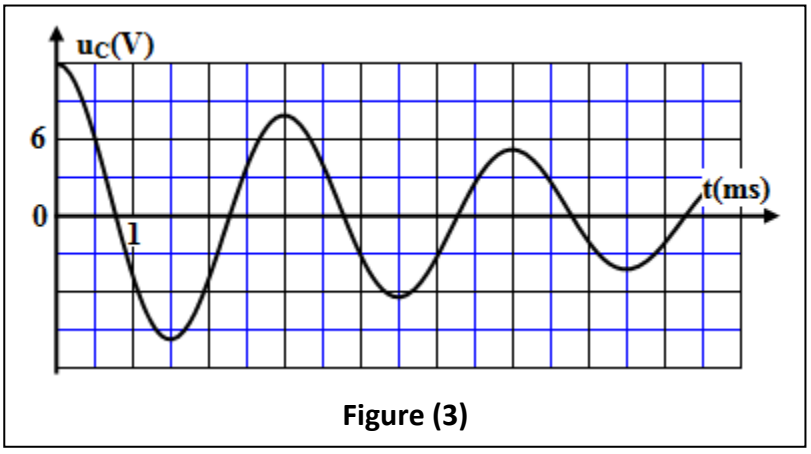


Figure (3)

**0,5** **2.4.** We consider that the pseudo-period $T$ is equal to the proper period of the $(LC)$ oscillator. Determine the value of the inductance L of the inductor (we take $\pi^2 = 10$ ).

**2.5.** The curves in figure (4) represent the variations in function of time the electric energy stored in the capacitor $\mathscr{E}_e$, the magnetic energy stored in the inductor $\mathscr{E}_m$ and the total energy $\mathscr{E}$ of the circuit, where $\mathscr{E} = \mathscr{E}_e + \mathscr{E}_m$.

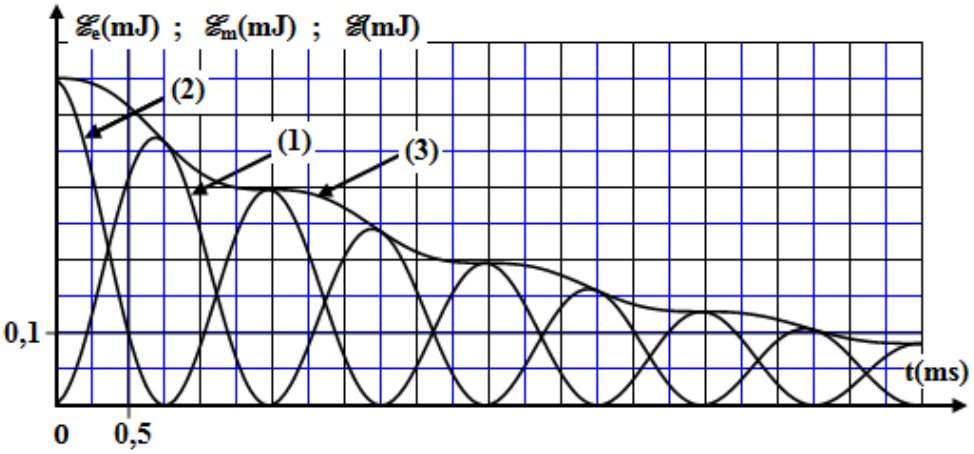



**Figure (4)**

**0,5** **2.5.1.** Identify, by justification, the curve corresponding to the magnetic energy $\mathscr{E}_m$.

**1** **2.5.2.** Determine, between the instants $t_0 = 0$ and $t_1 = 3\ ms$, the variation $\Delta\mathscr{E}$ of the total energy.

## Exercise 3 (5points): Studying the motion of a cyclist in a circuit

***Bicycle race in closed circuits has became a popular sport. So many competitions are organized every year in closed circuits that contain obstacles.***
***This exercise aims to studying the motion of the center of inertia of a system {Cyclist - Bicycle} in a circuit in the Atlas area (figure 1).***

During its participation in a race in a circuit (represented in figure (1)), a cyclist travels a part of the circuit constituted of a rectilinear horizontal section AB, a curvilinear section BC opened to a trench of length L and a horizontal section DE (figure 2).


**Figure (1)**

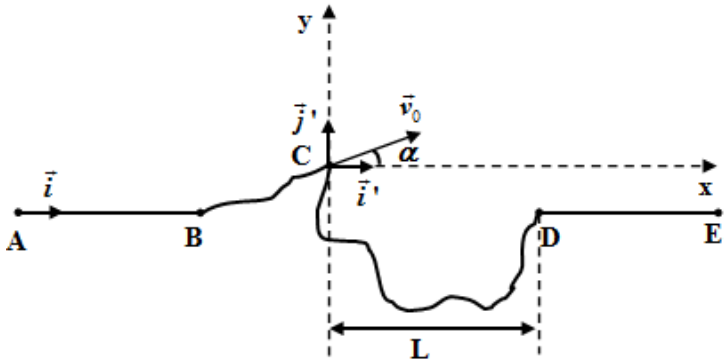



**Figure (2)**

The motion in the section AB is with frictions modeled by a frictional force $\vec{f}$ constant of opposite sense with velocity. We take m the mass of the system {Cyclist - Bicycle}.
We notice that $G$ is the center of inertia of the studied system.

**1. Motion of the cyclist in the section AB**

The cyclist exerts an effort, between A and B, modeled by a horizontal force $\vec{F}$ supposed constant in the same sense of the motion of $G$.

The cyclist starts off without initial velocity from position A. To study the motion of $G$, we choose the frame of reference $(A,\vec{i})$ linked to the Earth and supposed Galilean. We choose at $t_0 = 0$, $x_G = x_A = 0$.

**Data:**

$m = 70\ kg$ ; $g = 10\ m.s^{-2}$ ; $F = 180\ N$ ; $f = 80\ N$ ; $AB = 60\ m$

**1** **1.1.** Applying Newton's second law, prove that the expression of the acceleration of motion of $G$ is written as: $a = \dfrac{F - f}{m}$.

**0,5** **1.2.** Determine, by justification, the nature of the motion of $G$.

**0,5** **1.3.** Calculate the value of the $t_B$ the instant when $G$ passes by $B$.

**0,5** **1.4.** Determine the value of the speed $v_B$ of $G$ when it passes by $B$.

**0,75** **1.5.** Determine the magnitude of $\vec{R}$, the force exerted by the plane on the system during its motion in section $AB$.

**2. Motion of the cyclist during the jump**

The cyclist leaves the section BC in C with a velocity $\vec{v}_0$ which makes an angle $\alpha$ with the horizontal plane (see figure (2)- page 5/6).

During the jump, the system {Cyclist – Bicycle} is submitted to its weight only. We study the motion of $G$, in an orthonormal frame of reference $(C,\vec{i}',\vec{j}')$ linked to the Earth and supposed Galilean. We choose the instant when $G$ passes by C like a new origin of time $t_0 = 0$.

The parametric equations of motion of $G$ during the free-fall are written as:

$$x_G(t) = (v_0.\cos\alpha).t \quad ; \quad y_G(t) = -\frac{1}{2}g.t^2 + (v_0.\sin\alpha).t$$

During its motion, $G$ achieves the summit of the trajectory at the instant $t_S = 0{,}174\ s$ and then the system falls on the ground at the instant $t_P = 1\ s$.

**Data:** $\alpha = 10°$ ; $L = 8\ m$ ; $g = 10\ m.s^{-2}$

**0,5** **2.1.** Prove that $v_0 = 10\ m.s^{-1}$.

**0,5** **2.2.** Does the cyclist exceed the trench? Justify.

**0,75** **2.3.** Determine the coordinates of the vector velocity $\vec{v}_P$ of $G$ at the instant $t_P$.

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## الدورة الاستدراكية 2018
## -عناصر الإجابة-

RR27E

المملكة المغربية
وزارة التربية الوطنية والتكوين المهني والتعليم العالي والبحث العلمي
المركز الوطني للتقويم والامتحانات والتوجيه

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

## Chemistry (7 points)

| Exercise | | Question | Answer elements | Scale | Reference of the question in the Reference Framework |
|---|---|---|---|---|---|
| Chemistry (7 points) | Part 1 | 1. | $CH_3-COOH(aq)+H_2O(\ell) \rightleftharpoons CH_3-COO^-(aq)+H_3O^+(aq)$ | 0,5 | - Write the equation of the acid-base reaction and identify the two pairs involved. |
| | | 2. | The predominant chemical species $CH_3COOH$ ;<br>Justification | 2x0,25 | - Indicate the predominant chemical species taking into consideration pH of aqueous solution and $pK_A$ of pair acid/base. |
| | | 3. | Method ; $Q_{r,eq}=1,58.10^{-5}$ | 0,75+0,25 | -Give and exploit the expression of the reaction quotient $Q_r$ through the reaction equation.<br>-Calculate the value of the quotient of reaction $Q_r$ of a chemical system in given state. |
| | | 4. | No; Justification | 2x0,25 | - Know that the reaction quotient in equilibrium $Q_{r,eq}$, associated with the reaction equation of a chemical system, takes a value independent of concentrations, called equilibrium constant K. |
| | Part 2 | 1. | $CH_3-COOH(aq)+HO^-(aq) \rightarrow CH_3-COO^-(aq)+H_2O(\ell)$ | 0,5 | -Write the equation of titration reaction (use only one arrow) |
| | | 2. | Get through : $C_A=0,1\ mol.L^{-1}$ et $C_0=1\ mol.L^{-1}$ | 0,5 + 0,25 | -Determine and exploit the point of equivalence. |
| | | 3. | Verification of the value | 0,75 | |

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| | Part 3 | **1.** | Functional groups : $-COOH$ ; $-OH$ ; $-COO-$ | **3x0,25** | -Recognise in the formula of a chemical compound the organic functional groups:<br>- -OH (hydroxyl); -$CO_2H$ (carboxyl) ; -$CO_2R$ (ester);<br>-CO-O-CO- (acid anhydride). |
| | | **2.** | Slow and limited (non-complete) transformation | **0,25** | -Know the characteristics of esterification and hydrolysis: non- complete and slow transformations. |
| | | **3.** | Get through : $r = 66,7\%$ | **0,5** | -Calculate the yield of a chemical transformation. |
| | | **4.** | Expression of K ; $K = 4$ | **2x0,25** | -Write and exploit the expression of the equilibrium constant K corresponding to the equations of the esterification and hydrolysis reactions. |
| | | **5.** | Structural formula | **0,5** | -Write the equation of the reaction of an acid anhydride with an alcohol and that of the basic hydrolysis of an ester.<br>-Know the characteristics of the reaction of an acid anhydride with an alcohol: fast and complete. |

## Physics (13 points)

| Exercise | Question | Answer elements | Scale | Reference of the question in the Reference Framework |
|---|---|---|---|---|
| Exercise 1 (3 points) | **1.** | 90 protons and 140 neutrons | **2x0,25** | -Know the meaning (significance) of the symbol ${}^{A}_{Z}X$ and give the corresponding composition of the nucleus. |
| | **2.** | Equation of disintegration ; type $\alpha$ | **0,5 + 0,25** | -Write the equation of a nuclear reaction by applying the two conservation laws.<br>- Recognise the type of radioactivity using the equation of a nuclear reaction. |
| | **3.** | B | **0,75** | - Define and calculate the mass defect and the binding energy. |
| | **4.1.** | $\lambda = 2,8.10^{-6}\,year^{-1}$ | **0,5** | - Know and exploit the law of the radioactive decay, and exploit its curve. |
| | **4.2.** | Get through : $t_1 \simeq 1,24.10^{5}\,year$ | **0,5** | |

| Exercise | Question | Answer elements | Scale | Reference of the question in the Reference Framework |
|---|---|---|---|---|
| Exercise 2 (5 points) | **1.1.** | Establish the differential equation;<br>$\tau = R_1 C$ | **0,5**<br>**0,25** | - Find out the differential equation and verify its solution when the RC dipole is submitted to a step voltage. |
| | **1.2.** | $E = 12$ V ; $\tau \simeq 38$ ms | **0,25+0,5** | -Recognise and represent the variation curves of $u_C(t)$ between the capacitor terminals and different physical quantities associated to it, and exploit them.<br>-Exploit experimental documents in order to:<br>* recognise the observed voltages;<br>* highlight the influence of R and C on the charging and the discharging processes;<br>*determine the time-constant and charge duration;<br>*determine the state type (transient or steady) and the time interval for each one. |
| | **1.3.** | Verify the value of C | **0,25** | - Know and exploit the time-constant expression. |
| | **2.1.** | Justify the nature of oscillations | **0,5** | - Recognise the undamped (periodic), the underdamped (pseudo-periodic) and the overdamped (non-periodic) states. |
| | **2.2.** | Method ; $Q_0 = 7,56.10^{-5}$C | **2x0,25** | - Know and exploit the relationship q = C.u.<br>-Recognise and represent the variation curves of the voltage between the capacitor terminals in terms of time for the three states mentioned above; and exploit them. |
| | **2.3.** | $T = 3$ ms | **0,25** | - Exploit experimental documents in order to:<br>* recognise the observed voltages;<br>* recognise the damping states;<br>* highlight the influence of R, L and C on the oscillation phenomenon;<br>* determine the values of the period and the natural period. |
| | **2.4.** | Get through : L=3,57.$10^{-2}$ H | **0,5** | - Know and exploit the natural period expression. |
| | **2.5.1.** | $\mathscr{E}_m$ : Curve 1 ; justification | **2x0,25** | - Know and exploit the energetic diagrams. |

| | | | | |
|---|---|---|---|---|
| | **2.5.2** | Method ; $\Delta \mathscr{E} = -2,5.10^{-4}$ J | **1** | - Know and exploit the expression of the electric energy stored in a capacitor.<br>- Know and exploit the expression of the magnetic energy stored in an inductor.<br>- Know and exploit the expression of the total energy in the circuit. |

| Exercise | Question | Answer elements | Scale | Reference of the question in the Reference Framework |
|---|---|---|---|---|
| **Exercise 3 (5points)** | **1.1.** | Establish the differential equation | **1** | Apply Newton's second law to find out the differential equation of a system's centre of inertia motion in horizontal or inclined plane and determine the characteristics of kinetic and dynamic quantities of motion. |
| | **1.2.** | straight line ( rectilinear) uniformaly variable; justification | **2x0,25** | -Know and exploit the characteristics of the uniformly accelerated straight line motion and its parametric equations (t is the parameter). |
| | **1.3.** | Method ; $t_B \simeq 9,16$ s | **2x0,25** | |
| | **1.4.** | Method ; $v_B \simeq 13,1$ m.s$^{-1}$ | **2x0,25** | |
| | **1.5.** | Method ; $R \simeq 704,6$ N | **0,5+0,25** | - Apply Newton's second law to find out the differential equation of a system's centre of inertia motion in horizontal or inclined plane and determine the characteristics of kinetic and dynamic quantities of motion. |
| | **2.1.** | Method | **0,5** | - Exploit a document representing the path (trajectory) of a projectile in a uniform gravitational field to:<br>* determine the type of the motion (plane);<br>* represent the velocity and the acceleration vectors;<br>* determine the initial conditions and some parameters characterizing motion. |
| | **2.2.** | Yes ;<br>$x_P \simeq 9,85$ m ; $x_P > L$ | **0,25**<br>**0,25** | |
| | **2.3.** | Method :<br>$v_{Px} \simeq 9,85$ m.s$^{-1}$ ; $v_{Py} \simeq -8,26$ m.s$^{-1}$ | **0,5**<br>**0,25** | - Know and exploit expressions of the instantaneous velocity vector and the acceleration vector. |