الامتحان الوطني الموحد للبكالوريا
المسالك الدولية
الدورة العادية 2020
- الموضوع –

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

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

- **The use of programmable scientific calculator is not 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 of redox reaction** • **Analysis of a pill of ascorbic acid**	**7 points**
Physics (13 points)	**Exercise 1: Propagation of waves**	**4 points**
	Exercise 2: Nuclear transformation	**2,5 points**
	Exercise 3: • **RC dipole** • **RLC series circuit**	**6,5 points**

scale	Subject

Chemistry (7 points): Temporal monitoring of redox reaction – Analysis of a pill of ascorbic acid

Part 1 and part 2 are independent

Redox and acid-base reactions are two types of chemical transformations of paramount importance in chemistry.

These transformations can be studied by different methods, which allows temporal monitoring of a chemical system, determination of some characteristics and quantities, etc

This exercise aims at:

- ***The temporal monitoring of redox reaction;***
- ***Analysis of a pill of ascorbic acid.***

Part 1: The temporal monitoring of redox reaction

At an instant $t_0 = 0$, we prepare a solution (S_A) by mixing a volume of an aqueous solution of potassium iodide $K^+_{(aq)} + I^-_{(aq)}$ containing $n_1 = 8.10^{-2} mol$ of $I^-_{(aq)}$ ions, and a volume of an aqueous solution of sodium peroxydisulfate $2Na^+_{(aq)} + S_2O^{2-}_{8(aq)}$ containing $n_2 = 2.10^{-2} mol$ of $S_2O^{2-}_{8(aq)}$ ions. The total volume of the solution (S_A) $V = 200mL$. During reaction, diode is formed according to the chemical equation:

$$S_2O^{2-}_{8(aq)} + 2I^-_{(aq)} \rightarrow 2SO^{2-}_{4(aq)} + I_{2(aq)}$$

0,5 **1.** Determine the value of the maximal advancement x_{max}. Deduce the limiting reactant.

2. The curve in the figure on the right shows the variations of amount of matter of formed diode in terms of time: $n(I_2) = f(t)$.



0,75 **2.1.** Calculate in $(mol.L^{-1}.\min^{-1})$ the volumetric rate of reaction of this reaction at $t_0 = 0$.

0,25 **2.2.** The value of the volumetric rate of reaction at $t_1 = 18\min$ is $v_1 = 1,44.10^{-3} mol.L^{-1}.\min^{-1}$. Explain the diminution of the value of the volumetric rate of reaction.

0,25 **2.3.** Cite a kinetic factor allowing increasing the volumetric rate of reaction without changing the initial state.

0,5 **2.4.** Determine graphically the half-life $t_{1/2}$ of this reaction.

Part 2 : Analysis of a pill of ascorbic acid

Ascorbic acid $C_6H_8O_6$, commonly referred to as vitamin C, is present in pharmacy as «Vitamin C 500 ».

1. Study of an aqueous solution of ascorbic acid

An aqueous solution of ascorbic acid $C_6H_8O_{6(aq)}$, of molar concentration $C = 4.10^{-3}\ mol.L^{-1}$ and a volume $V = 100\ mL$ and $pH = 3,25$ at $25°C$. The ascorbic acid reacts with water according to the chemical equation: $C_6H_8O_{6(aq)} + H_2O_{(l)} \rightleftharpoons C_6H_7O^-_{6(aq)} + H_3O^+_{(aq)}$

0,5 **1.1.** Identify the acid/base couples involved in the reaction.

0,5 **1.2.** Draw the advancement table of the reaction using C, V, the advancement x and the advancement at equilibrium x_{eq} of the chemical system.

0,5 **1.3.** 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 final rate of this reaction is:

A	$\tau \approx 0,34$	**B**	$\tau \approx 0,47$	**C**	$\tau \approx 0,55$	**D**	$\tau \approx 0,14$

0,5 **1.4.** 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 final rate of reaction depends on

A	the equilibrium constant K associated to the equation of reaction and the initial composition of the chemical system
B	the initial composition of the chemical system only
C	the equilibrium constant K associated to the equation of reaction
D	the temperature of the chemical system

1 **1.5.** Show that the expression of the equilibrium constant K associated with the equation of reaction is: $K = \frac{C.\tau^2}{1-\tau}$. Calculate the acidity constant K_A of the couple $(C_6H_8O_{6(aq)} / C_6H_7O^-_{6(aq)})$.

2. Verification of the value of the masse of the ascorbic acid contained in a pill

We crash a pill of «Vitamin C 500», and we dissolve it in a volume $V_0 = 200\ mL$ of water. After homogenisation, we obtain a solution (S_A) of concentration C_A.

We take a sample of volume $V_A = 20\ mL$ from the solution (S_A) which we titrate with an aqueous solution of sodium hydroxide $Na^+_{(aq)} + HO^-_{(aq)}$ of molar concentration $C_B = 2,0.10^{-2}\ mol.L^{-1}$.

We obtain the equivalence for a volume $V_{B,E} = 14,2\ mL$.

0,5 **2.1.** Write the chemical equation of the reaction of titration.

0,5 **2.2.** Calculate the molar concentration C_A.

0,75 **2.3.** Deduce the value of the ascorbic acid mass contained in the pill, and explain the indication «Vitamin C 500» . **We give:** $M(C_6H_8O_6) = 176\ g.mol^{-1}$.

Physics (13 points)

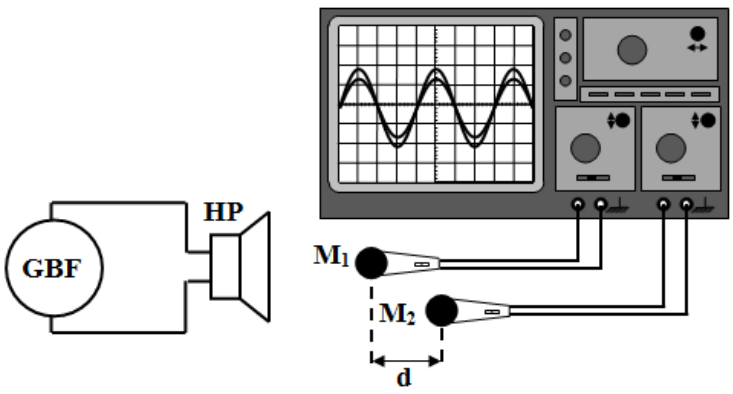
Exercise 1 (4 points):Propagation of waves

The propagation of a waves is a natural phenomenon which can be produced in some mediums. In different conditions, the study of a propagation can lead to informations about the nature of waves, their characteristics and about the propagation medium.

The figure below gives two devices allowing the study of the propagation of a wave in the surface of water and the propagation of sound in the air.



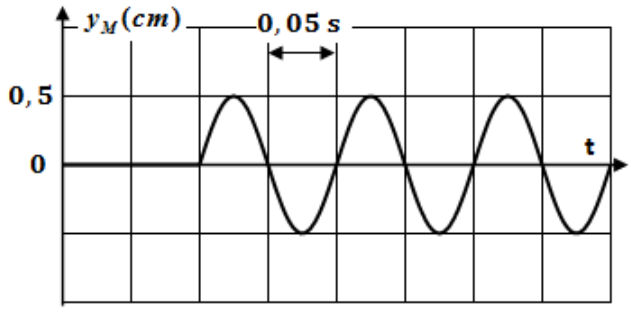
Device (1)



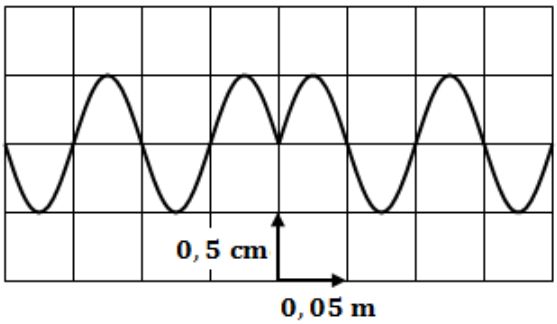
Device (2)

0,5 **1.** What is the nature of the mechanical wave produced respectively by these two devices?

2. In device 1, a vibrator produces a sinusoidal progressive wave of frequency N_1. An experimental study allows to obtain Document (a) representing the elongation of a point M from the water surface in terms of time and Document (b) representing the aspect of water surface at a given instant .



Document (a)



Document (b)

0,25 **2.1.** Which of the two documents (a) and (b) shows a spatial periodicity?

0,5 **2.2.** Determine the frequency N_1 of the wave.

0,5 **2.3.** Calculate the velocity v_1 of propagation of the wave in the water surface.

0,25 **2.4.** 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 elongation of the point M is writing in terms of the elongation of the source S as:

A	$y_M(t) = y_S(t+0,1)$	**B**	$y_M(t) = y_S(t+0,05)$	**C**	$y_M(t) = y_S(t-0,1)$	**D**	$y_M(t) = y_S(t-0,05)$

3. An obstacle with an opening of width $L = 8\,cm$ is interposed on the surface of water. The produced waves on the surface of water by the source propagate through the obstacle from the opening.

0,5 **3.1.** Which phenomenon could you observe after the obstacle? Justify.

0,5 **3.2.** Deduce the wavelength λ_2 and the propagation velocity v_2 of the wave after the obstacle.

4. The loudspeaker of device 2 emits sound waves of frequency $N_2 = 10\,kHz$.

0,25 **4.1.** Can the produced sound waves propagate in vacuum?

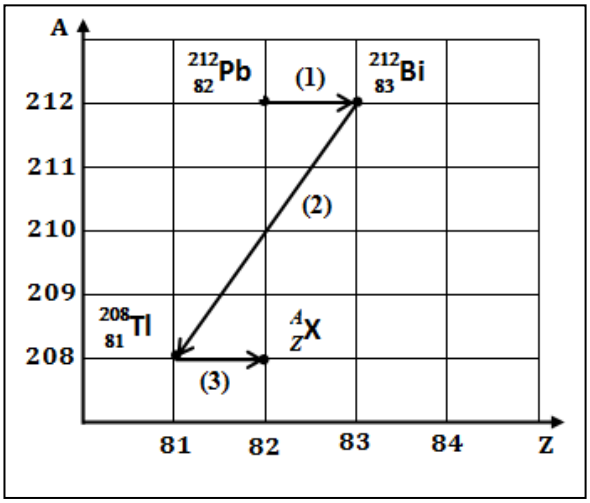
0,75 **4.2.** Two microphones M_1 and M_2 that occupy the same position capture the produced sound waves. The obtained curves are in phase.

When we displace M_2 according to M_1 of a distance $d = 34\,cm$, the two curves are again in phase for the 10^{th} time. Deduce the velocity of propagation of sound in the air.

Exercise 2 (2,5 points): Nuclear Transformations

Radioactivity is a natural and sustainable phenomenon produced by radioactive sources. Due to chain decays, a nuclide can be transformed to others until a stable nuclide is obtained, thus forming a radioactive chain decay. According to their life duration, these sources can have advantages and disadvantages.

The diagram on the right gives some nuclides from the uranium chain decay.



Data:

$m(^{212}_{83}Bi) = 211,94562\ u$;

$m(^{208}_{81}Tl) = 207,93745\ u$;

$m(\alpha) = 4,00150\ u$;

$1u = 931,5\,MeV.c^{-2}$

0,25 **1.** Consider the nuclides $^{212}_{82}Pb$ and $^{212}_{83}Bi$. Are they isotopes? Justify.

0,25 **2.** Identify the type of the disintegration (1) (Figure on the right). Justify.

0,25 **3.** Recognize the nuclide $^{A}_{Z}X$.

0,5 **4**. Determine, in unit (MeV), the value of the released energy $E_{released} = |\Delta E|$ by the disintegration of the nucleus of bismuth $^{212}_{83}Bi$ to thallium $^{208}_{81}Tl$.

5. Consider a radioactive source that contains at an instant $(t_0 = 0)$, a number $N_0 = 28,4.10^{19}$ of radioactive bismuth $^{212}_{83}Bi$. During 15min, a counter records $4,484.10^{19}$ disintegration.

0,25 **5.1**. What is the number of the nucleus of $^{212}_{83}Bi$ present in the source at $t_1 = 15\,min$.

0,5 **5.2**. Determine the radioactive period (Half-life) $t_{1/2}$ of bismuth $^{212}_{83}Bi$.

0,5 **5.3.** Can bismuth $^{212}_{83}Bi$ nuclide be used for radioactive dating ? Justify.

Exercise 3 (6,5 points): RC dipole – RLC series circuit

Capacitors are electronic components that we find everywhere in electric and electronic circuits. They differ by their forms and technologies. They allow energy storage when they are in circuits. This energy is more important for capacitors of large capacities, which will be transferred during different utilisations.

The circuit of Figure 1 is made of:

- An ideal voltage generator of electromotive force E;
- A capacitor of an adjustable capacity C;
- An ohmic conductor of resistance R;
- A coil of inductance L and resistance r;
- A switch K.

Data: $R = 100\ \Omega$; $r = 20\ \Omega$

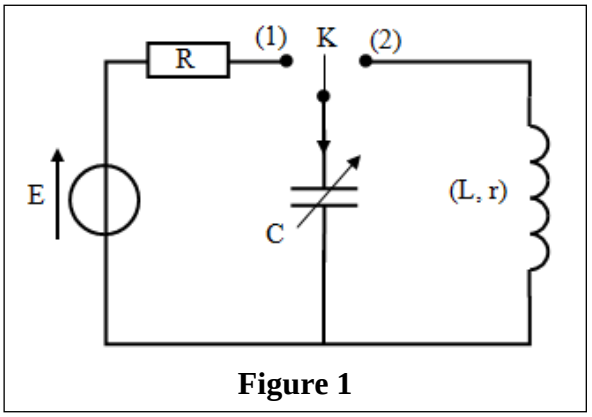


Figure 1

Part 1: Study of charge of a capacitor

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

0,5 **1.** Specify the interest of the circuit in Figure 1.(the switch K is on position (1)).

0,5 **2.** Establish the differential equation verified by the voltage $u_C(t)$ in the terminals of the capacitor.

3. Using a suitable acquisition system, we obtain the curves (1) and (2) in Figure 2 which represent the evolution of the voltage $u_C(t)$ for two capacity values C_1 and C_2.

We nominate τ_1 and τ_1, respectively, time constants relative to the curves (1) and (2).

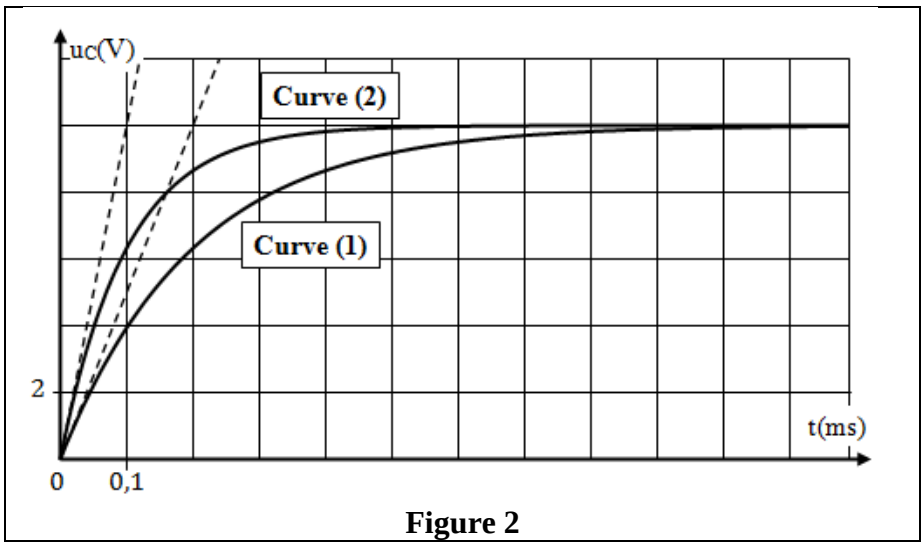


Figure 2

0,5 **3.1.**Determine for curve (2) the duration of the transient state.

0,75 **3.2.** Calculate the values of C_1 and C_2.

0,5 **3.3.** What is the influence of the capacity on charge operation of capacitor?

0,5 **3.4.** Determine the value of the electromotive force E.

0,5 **3.5.** Determine, for the capacitor of capacity C_1, the value of the charge q_1 at instant $t = \tau_1$.

0,5 **3.6.** Using the same generator of electromotive force E, specify in which case (C_1 or C_2), the capacitor will store the greatest energy at the end of discharge? Justify.

Part 2: study of RLC series circuit

The capacitor is set to a capacity $C = 1\mu F$ and completely charged. We realize its discharge trough a coil by switching K in position 2. Using the same acquisition system, we obtain the curve in Figure 3 representing $u_C(t)$.

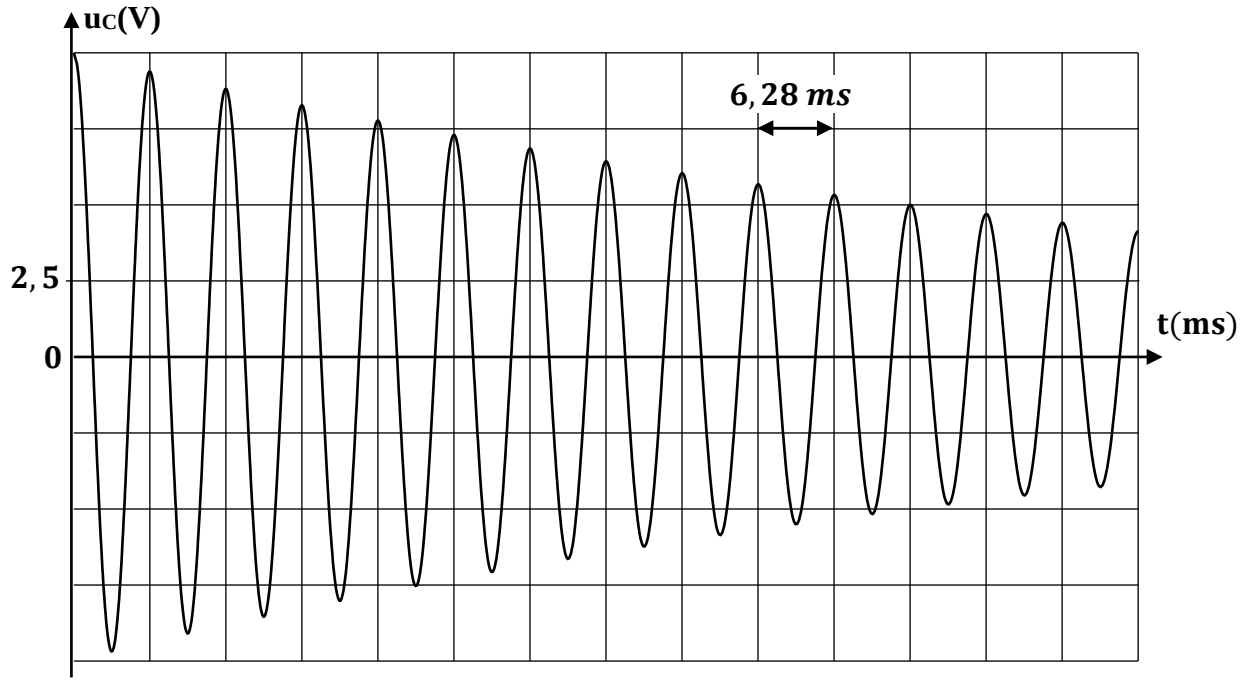


Figure 3

0,5 **1.** Explain, qualitatively, the variation of the oscillation amplitude.

0,25 **2.** What is the value of the pseudo-period T of the oscillation.

0,5 **3.** Deduce the value of the inductance L knowing that the pseudo-period is equal to the period of LC oscillator.

4. To maintain the electric oscillations in RLC circuit, we connect, in series with the coil and capacitor, a generator G delivering a voltage u_g proportional to the electric current intensity $i(t)$ ($u_g = k.i$). (k is positive constant).

0,25 **4.1.** What is the role of the generator G from the energetic point of view?

0,5 **4.2.** Which value should k take to obtain maintained oscillations? Justify.

0,25 **4.3.** What can you say about the form of the maintained oscillations?