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

SSSSSSSSSSSSSSSSSS | RS 27E

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

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

- **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)	**Aqueous solution of butanoic acid**	**7 points**
Physics (13 points)	**Exercise 1 : Waves propagation.**	**4 points**
	Exercise 2 : Radon and the quality of air	**2,5 points**
	Exercise 3 : Free Electric oscillations	**6,5 points**

scale	Subject

Chemistry (7 points): Aqueous solution of butanoic acid

Butanoic acid of formula $C_3H_7CO_2H$ is one of the compounds responsible for the strong smell and the pungent taste of some cheeses and rancid butters. It is present in some vegetal oils and fat. This exercise aims at:

- **Study of an aqueous solution of Butanoic acid;**
- **Determination of butanoic acid percentage in butter**

1. Study of an aqueous solution of Butanoic acid

We prepare, at 25°C, an aqueous solution (S_A) of Butanoic acid of molar concentration $C_A = 2,0.10^{-3}\ mol.L^{-1}$ and a volume $V_A = 1,0\ L$. We measure pH of this solution (S_A) and we obtain $pH = 3,76$.

0,75 **1.1.** Write the chemical equation of the reaction between Butanoic acid and water.

0,5 **1.2.** Draw the advancement table of this reaction using C_A, V_A, the advancement x and the advancement at equilibrium x_{eq}.

0,5 **1.3.** Determine the value of the maximal advancement $x_{\max}$.

0,5 **1.4.** Verify that the value of the advancement at equilibrium is $x_{eq} \approx 1,74.10^{-4} mol$.

0,5 **1.5.** Calculate the final rate of reaction τ. Deduce.

0,75 **1.6.** Calculate the value of the equilibrium constant K associated with the equation of this reaction.

0,5 **1.7.** Copy on your answer sheet the number of the question, and write the letter corresponding to the right option (A,B,C or D).

On conditions of the experiment, the equilibrium constant K associated with the equation of reaction:

A	Depends on the initial composition of the chemical system and temperature
B	Depends only on the initial composition of the chemical system
C	Depends only on the pH of the solution
D	Depends only on the temperature of the chemical system

0,5 **1.8.** Calculate the value of $pK_A(C_3H_7CO_2H_{(aq)} / C_3H_7CO_{2\,(aq)}^-)$.

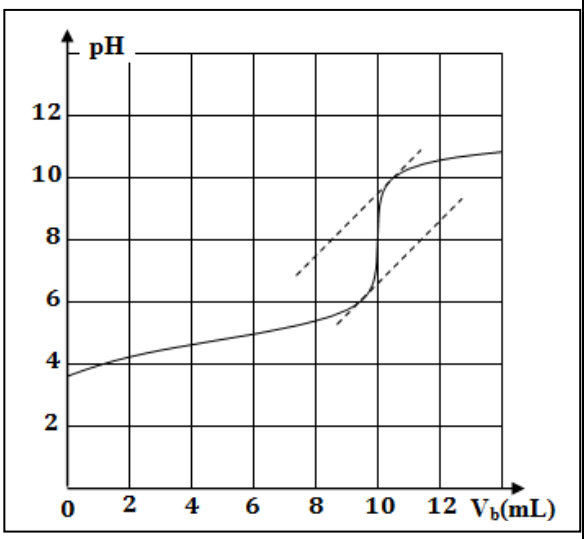
2. Determination of butanoic acid percentage in butter

Butter is considered rancid if the mass percentage of the Butanoic acid contained on the butter is bigger than 4%, that is to say, there are more than $4\ g$ of Butanoic acid in $100\ g$ of butter.

Data: $M(C_3H_7CO_2H) = 88\ g.mol^{-1}$

In a beaker, we introduce $m_b = 10,0\ g$ of melted butter and we add distilled water. We mix to dissolve the totality of Butanoic acid $C_3H_7CO_2H$ present in butter. We obtain an aqueous solution (S) of Butanoic acid of molar concentration C and volume $V_0 = 1,0\ L$.

We titrate the volume $V = 10,0\ mL$ of the solution (S) with an aqueous solution $Na^+_{(aq)} + HO^-_{(aq)}$ of sodium hydroxide of molar concentration $C_B = 4,0.10^{-3}\ mol.L^{-1}$ pH-metric titration permit to obtain the curve $pH = f(V_B)$ (Figure on the right).



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

0,5 **2.2.** Determine, graphically, the volume $V_{B,E}$ added at equivalence.

0,5 **2.3.** Calculate the value of C.

1 **2.4.** Determine the mass of Butanoic acid present in $m_b = 10,0\ g$ of butter. Is the butter rancid? Justify.

Physics (13 points)

Exercise 1 (4 points): waves propagation

During a practical activity, students :

- Study the propagation of a periodic mechanical wave on the surface of water;
- Calculate the velocity of propagation of sound in a room;
- Determine the wavelength of a light monochromatic wave.

1. Propagation of a wave on the surface of water

We produce progressive periodic waves on the surface of water using a plate (P) of a vibrator of frequency $N = 10\ Hz$. Waves propagate without reflexion nor attenuation. Figure (1) shows the aspect of water's surface when the wave arrives to point M.

We give: $d = 6\ cm$

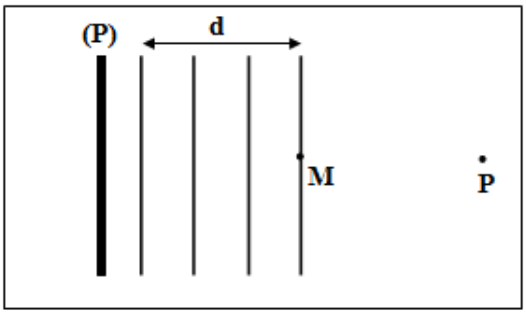


Figure 1

0,5 **1.1.** Determine the value of wavelength λ.

0,5 **1.2.** Deduce the value of velocity of propagation v on the surface of water.

0,5 **1.3.** We consider two points P and M on the surface of water in a distance $MP = 7\ cm$ (Figure 1). Calculate the time delay τ of the vibration of the point P according to M.

2. Experimental determination of sound velocity

To determine the velocity of propagation of sound wave in a room, teacher prepare the experimental apparatus of figure (2) that contains:

- Two microphones M_1 and M_2 separated by a distance d;
- Oscilloscope;
- Loudspeaker;
- GBF of frequency N.

The two oscillograms of figure (3) represent the variations of the voltages when we take $d_1 = 21\ cm$.

The horizontal sensitivity is $S_H = 1,0 .10^{-4}\ s.div^{-1}$.

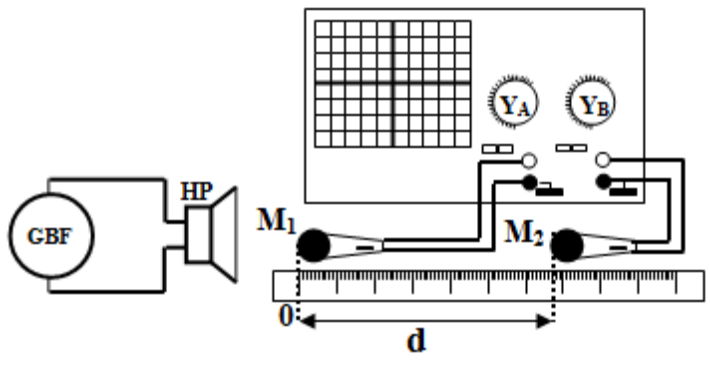


Figure 2

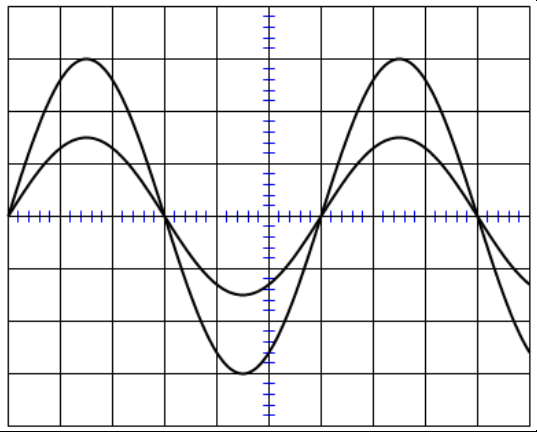


Figure 3

0,5 **2.1.** Determine graphically the value of the period T of sound waves.

2.2. We translate the microphone M_2 until we obtain again, the graphs in phase. The new distance between the microphones is $d_2 = 41,5\ cm$.

0,5 **a.** Determine the wavelength λ of the sound wave.

0,5 **b.** Calculate the velocity v of propagation of sound in air.

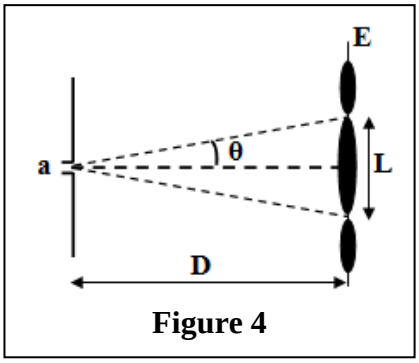


Figure 4

3. Determination of wavelength of monochromatic light wave

To determine the wavelength of a monochromatic light wave, students make the experimental assembly in figure (4). they lighted up a slit of width $a = 5,0.10^{-5} m$ by a monochromatic light. Students observed light spots on a screen in a distance $D = 1,5\ m$ from the slit (Figure 4). They measure the length of the central spot and they find $L = 3,8\ cm$.

0,25 **3.1.** Give the name of the observed phenomenon.

0,75 **3.2.** Give the expression of the wavelength λ in terms of L, D and a. (Consider $\tan\theta \approx \theta(rad)$)
Calculate λ.

Exercise 2 (2,5 points): Radon and the quality of air

The Earth emits in a natural way the gas of radon. This gas propagates easily inside the buildings, and it is radioactive α . It is considered to be one of the principal causes of lung cancer after the cigarette. According to the International Radiation Protection Association (IRPA), the volumetric concentration of the radioactivity of radon gas in air in the locations must not exceed $400\ Bq.m^{-3}$**.**

Data:

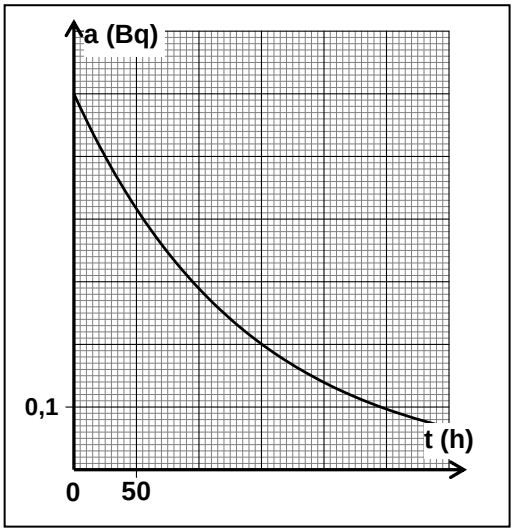
Nucleus	Francium	Radon	Polonium	Helium
Symbol	$^{223}_{87}Fr$	$^{222}_{86}Rn$	$^{218}_{84}Po$	$^{4}_{2}He$
Mass of nucleus in (u)	222,9720	221,9704	217,9628	4,0015
$1u = 931,5 MeV.c^{-2}$				

0,5 **1.** Give the composition of the nucleus of radon $^{222}_{86}Rn$.

0,5 **2.** Write the equation of disintegration of radon $^{222}_{86}Rn$, specify the produced nucleus.

0,5 **3.** Calculate (in MeV), the value of the released energy during the disintegration of a nucleus of radon $^{222}_{86}Rn$.

4. To be sure, of the quality of air inside a building hall, we take a sample of air of volume $V = 1L$ at an instant $t_0 = 0$ and its activity a is determined using adequate tools. The curve on the right represents the variations of the activity a of the sample in function of time.



0,5 **4.1** Determine graphically:
- The value of the activity a_0 of the sample at the instant $t_0 = 0$
- The value of the half-life $t_{1/2}$ of radon $^{222}_{86}Rn$.

0,5 **4.2** Did the air inside the building hall meet the criteria proposed by the (IRPA) at the instant of taking the sample?

Exercise 3 (6,5 points): Free Electric oscillations

Inductors (Coils) and capacitors are often used in the circuits of electric and electronic instruments like children's toys, electric watches, security systems, and instruments of control… The analysis of this circuits can be done by electric or energetic study, which allows to determine some parameters and highlight the energetic exchange.

The aim of this exercise is to:

- **Determine the characteristic quantities $(L;r)$ of an inductor;**
- **Study the free electric oscillations in RLC series circuit.**

Part 1: Determination of the quantities $(L;r)$ of an inductor

A teacher provides his students with the apparatus below:

- A coil (b) of inductance L and resistance r;
- A capacitor of capacitance C;
- An Ohmic conductor of resistance $R = 90\Omega$;
- A generator G_1 of electromotive force $E = 6V$;
- An ideal current generator G_2;
- A switch K;
- An oscilloscope;
- Connection wires.

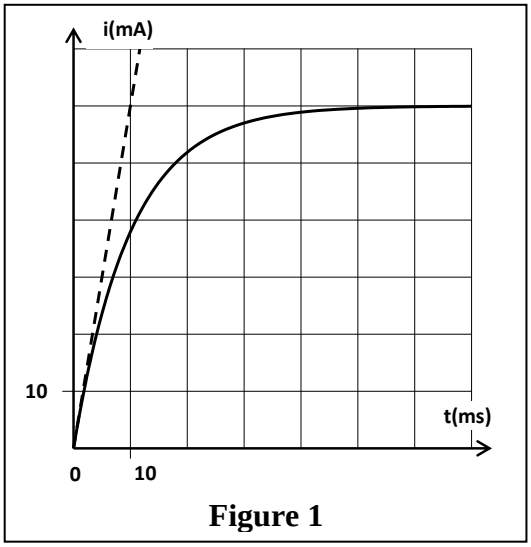


Figure 1

0,5 **1.** Among the previous apparatus, select the ones that are necessary for the realization of a RL circuit for studying the response to a step voltage.

0,25 **2.** What is the role of the coil when you close the circuit?

0,5 **3.** Find out the differential equation verified by the current $i(t)$ in the circuit.

0,5 **4.** Knowing that the solution of the differential equation is written as: $i(t) = \mathrm{I}_0(1 - \mathrm{e}^{\frac{-t}{\tau}})$, determine the expression of I_0 and τ in terms of the circuit parameters.

5. By means of a data acquisition system, the students obtain the curve represented in figure (1)

0,5 **a.** Determine graphically the values of I_0 and τ.

0,5 **b.** Verify that $r = 10\ \Omega$ and $L = 1\ H$.

0,5 **c.** Determine the value of voltage u_b in the terminals of the coil in steady state.

Part 2: free electric oscillations in RLC series circuit.

After totally charging the previous capacitor mentioned on the list, students proceed to its discharge through the coil (b). The curve in Figure (2) represents the variations of the voltage $u_C(t)$ between the terminals of the capacitor during the discharge.

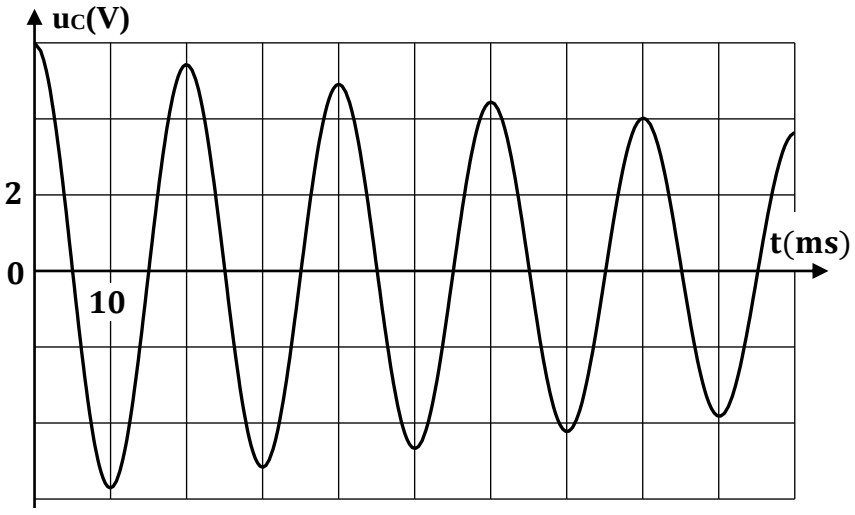


Figure 2

0,5	**1.** Represent the scheme of the experimental circuit allowing the capacitor discharge.
0,75	**2.** Determine graphically the value of the pseudo-period T . And deduce the value of C (consider that the value of the pseudo-period is equal to the proper period T_0 of the oscillator (LC) , and we take $(\pi^2 = 10)$.
0,25	**3.** Interpret, energetically, the shape of the curve.
0,5	**4.** What is the form of the energy stored in the circuit at $t = \frac{T}{4}$? Justify.
0,75	**5.** Calculate the variation of the total energy ΔE of the circuit between the instances $t_0 = 0$ and $t_1 = 4T$.
	6. To maintain the electric oscillations, we add to the (RLC) circuit, a generator G delivering a voltage u_G proportional to the current intensity $(u_G = k.i)$.
0,25	**a.** Indicate the role of the generator G from an energetic point of view.
0,25	**b.** Determine the value of k so that the circuit becomes a set of maintained electric oscillations.