الامتحان الوطني الموحد للبكالوريا
الدورة العادية 2024
-الموضوع-

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المملكة المغربية
وزارة التربية الوطنية والتعليم الأولي والرياضة
ⵜⴰⴳⵍⴷⵉⵜ ⵏ ⵍⵎⵖⵔⵉⴱ
ⵜⴰⵎⴰⵡⴰⵙⵜ ⵏ ⵜⵙⴳⵎⵉ ⵜⴰⵏⴰⵎⵓⵔⵜ
ⴷ ⵓⵙⵍⵎⴷ ⴰⵎⵣⵡⴰⵔⵓ ⴷ ⵜⵓⵏⵏⵓⵏⵜ
المركز الوطني للتقويم والامتحانات

المادة	الفيزياء والكيمياء	مدة الإنجاز	4h
الشعبة المسلك	شعبة العلوم الرياضية (أ) و (ب) (خيار إنجليزية)	المعامل	7

- ✓ *The use of the **non-programmable** scientific calculator is allowed.*
- ✓ *The literal formula must be given before the numerical application and the result must be accompanied by its unit.*
- ✓ *The exercises can be treated separately according to the choice of the candidate.*

The subject includes four exercises: one in Chemistry and three in Physics.

Exercise 1: Chemistry (7 points)

- **Part 1:** Study of an aqueous solution of a carboxylic acid
- **Part 2:** Study of a Nickel-Cobalt electrochemical cell

Exercise 2: Waves + Nuclear transformations (4 points)

- **Part 1:** Study of a diffraction of light
- **Part 2:** The radioactivity of the polonium.

Exercise 3: Electricity (4 points)

- **Part 1:** Study of an RC dipole
- **Part 2:** Study of forced oscillations in an RLC series circuit

Exercise 4: Mechanics (5 points)

- **Part 1:** Motion of a mechanical system
- **Part 2:** Motion of an elastic pendulum

Exercise 1: Chemistry (7 points)

Part 1 and part 2 are independent

Part 1: Study of an aqueous solution of a carboxylic acid

In a school laboratory, there is a bottle containing a solution (S_0) of a pure carboxylic acid, denoted AH of general formula $C_nH_{2n+1}COOH$ where n is a natural number.

We want to determine the chemical formula of this carboxylic acid and the pK_A of the pair AH/A^- in order to study its reaction with an aqueous solution of sodium methanoate $Na^+_{(aq)} + HCOO^-_{(aq)}$.

Given :

- Molar mass: $M(C)=12g.mol^{-1}$; $M(O)=16g.mol^{-1}$; $M(H)=1g.mol^{-1}$.

1-Determination of the pK_A of the pair AH/A^- and the chemical formula of the acid AH

We prepare a solution (S_A) of the acid AH by dissolving in a distilled water a mass $m = 1,5\ g$ of this pure acid. The volume of the solution obtained is $V=500mL$. We take a volume $V_A = 20mL$ of the solution (S_A) that we titrate it by an aqueous solution (S_B) of sodium hydroxide $Na^+_{(aq)} + HO^-_{(aq)}$ of molar concentration $C_B = 3,4.10^{-2}\ mol.L^{-1}$. The pH-metric monitoring allowed obtaining the curve $pH=f(V_B)$ representing the evolution of the pH of the reaction mixture as function of V_B the volume of sodium hydroxide added (Figure 1).

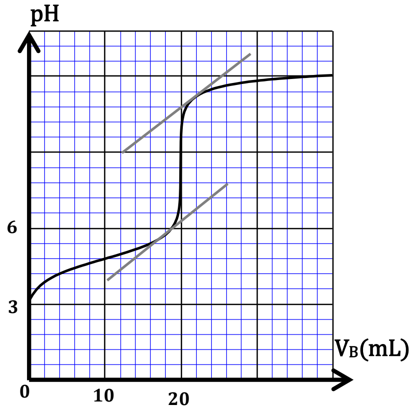

Figure 1

1-1- Write the equation of the reaction of the titration. **(0,25pt)**

1-2- By using the progress table of the reaction, show that the expression of the volume V_B is written as : $V_B = \frac{V_{BE}.10^{pH-pK_A}}{1+10^{pH-pK_A}}$, with V_{BE} the volume of the sodium hydroxide added at the equivalence point and $0 \langle V_B \langle V_{BE}$. **(0,75pt)**

1-3- Find out the relationship between V_B and V_{BE} so that the relationship $pH = pK_A$ is verified. Deduce graphically the value of the pK_A . **(0,5pt)**

1-4- Determine C_A the molar concentration of the solution (S_A) . **(0,5pt)**

1-5- Find out the value of n and deduce the chemical formula of the acid AH studied. **(0,75pt)**

2- Study of the reaction of the acid AH with méthanoate ions $HCOO^-$.

We mixture a volume $V_1 = 50\,mL$ of an aqueous solution of the acid AH of molar concentration $C=1,0.10^{-2}mol.L^{-1}$ and a volume $V_2 = V_1$ of an aqueous solution of sodium methanoate $Na^+_{(aq)} + HCOO^-_{(aq)}$ of same molar concentration C. we model the occurring transformation by the chemical reaction of equation: $AH_{(aq)} + HCOO^-_{(aq)} \rightleftarrows A^-_{(aq)} + HCOOH_{(aq)}$

Given:

The ion	Na^+	$HCOO^-$	A^-
The molar ionic conductivity $(mS.m^2.mol^{-1})$	5,01	5,46	3,58

We neglect the contribution of the ions H_3O^+ and HO^- in the conductivity of the solution.

The expression of the conductivity σ of an ionic solution is: $\sigma = \sum_i \lambda_{X_i}.[X_i]$ where $[X_i]$ is the effective molar concentration of the ionic species present in the solution and λ_{X_i} its molar ionic conductivity.

2-1- Show that the expression of the conductivity σ of the reaction mixture at an instant of time t in terms of the progress of the reaction x is written as : $\sigma = 52,35 - 1,88.10^4.x$ with σ expressed in $mS.m^{-1}$ and x in mol. **(0,75pt)**

2-2- We measure the conductivity of the reaction mixture at the equilibrium state, we find: $\sigma_{eq} = 50,092\ mS.m^{-1}$.

2-2-1- Check out that the value of the equilibrium constant K associated to the equation of the reaction is $K \simeq 0,1$. **(0,5pt)**

2-2-2- Deduce the value of the pK_A' of the pair $HCOOH / HCOO^-$. **(0,5pt)**

Part 2: study of a nickel – cobalt electrochemical cell

The electric battery is an electrochemical dispositive that produces the electricity by converting a part of the chemical energy to electric energy through the oxidation-reduction reactions.

We consist the nickel – cobalt electrochemical cell, by immersing a blade of nickel in a beaker containing a volume $V = 100\,mL$ of an aqueous solution of nickel (II) sulfate: $Ni^{2+}_{(aq)} + SO^{2-}_{4(aq)}$ of initial molar concentration $C_1 = \left[Ni^{2+}\right]_i = 10^{-2}\,mol.L^{-1}$, and a blade of cobalt in another beaker containing a volume $V = 100\,mL$ of an aqueous solution of cobalt (II) sulfate: $Co^{2+}_{(aq)} + SO^{2-}_{4(aq)}$ of initial molar concentration $C_2 = \left[Co^{2+}\right]_i$. A salt bridge links the two solutions.

We mount in series with this electrochemical cell a resistor, an ammeter and a switch. At an instant t=0 we close the circuit. An electric current of intensity I, considered as constant, flows in the circuit.

Given :

-Molar mass of the cobalt: $M(Co) = 58,9\,g.mol^{-1}$;

- The faraday Constant: $1F = 9,65.10^4\,C.mol^{-1}$.

-The equilibrium constant associated to the equation of the reaction: $Co^{2+}_{(aq)} + Ni_{(s)} \underset{(2)}{\overset{(1)}{\rightleftarrows}} Ni^{2+}_{(aq)} + Co_{(s)}$ is $Q_{r.e} = K$ at 25°C.

The curve of figure 2 represents the temporal evolution of the quotient of reaction Q_r .

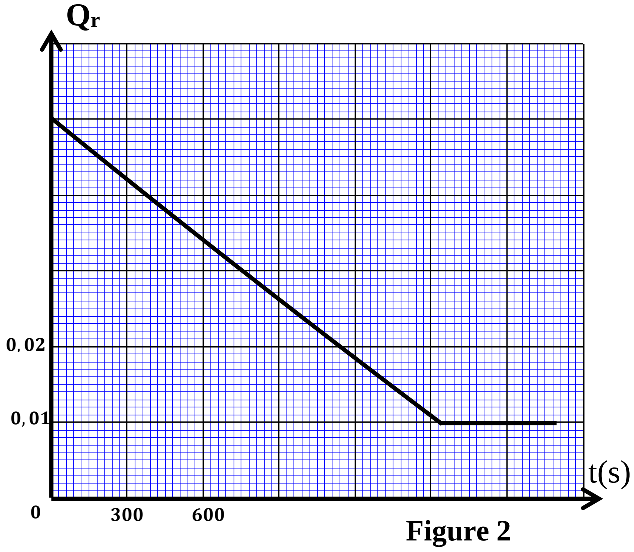

Figure 2

1- By using the curve $Q_r(t)$, choose the correct statement, from the following statements: **(0,5pt)**

a- The direction of spontaneous evolution of a chemical system consisting the electrochemical cell is the direction (1) of the equation of the reaction.

b- The electrode of the cobalt is the cathode.

c- The diagram of the electrochemical cell studied is: ⊖ $Ni/Ni^{2+}//Co^{2+}/Co$ ⊕ .

d- The conventional direction of the electric current outside the electrochemical cell is from the electrode of nickel to the electrode of cobalt.

2- Determine C_2. **(0,5pt)**

3-Find out the expression of the intensity I of the electric current in terms of K , F , C_1 , C_2 , V and t_{eq}, with t_{eq} the instant of time when the equilibrium of the chemical system is reached. Check out that $I \simeq 0,1A$. **(0,75pt)**

4-Compute Δm the variation of the mass of the electrode of cobalt between the instants t=0 and $t = t_{eq}$.**(0,75pt)**

Exercise 2 : Waves + Nuclear transformations (4points)

Part 1: Study of the diffraction of the light.

The phenomenon of diffraction allows highlighting the wave aspect of the light.
A source of laser producing a monochromatic light of wavelength $\lambda = 750\text{nm}$ lights up a circular diaphragm of an adjusted diameter d. We observe, on the screen placed at the distance D from the diaphragm, a circular light spot of a diameter L surrounded by a dark and light alternatives rings. (Figure 1)
We vary d, and we denote the value of corresponding L.

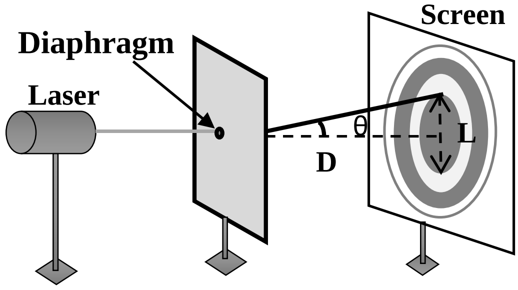

Figure 1

The curve of figure 2 represents the curve $L = f(\frac{1}{d})$.

Given :
- The distance diaphragm-screen: D = 1,50 m
- The law associated of the diffraction with the circular diaphragm has the expression: $\theta = \frac{\alpha \cdot \lambda}{d}$ with θ the angular deviation expressed in radian and α a coefficient of correction linked to the circular shape of the slit.

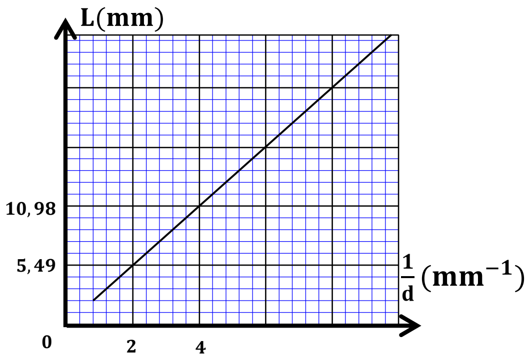

Figure 2

1- Show in the case of small angular deviations, where $\tan(\theta) \simeq \theta(\text{rad})$ that: $L = \frac{2\alpha.\lambda.D}{d}$. **(0,5pt)**

2-Verify that $\alpha = 1,22$. **(0,5pt)**

3- We replace the diaphragm with an opaque plate pierced with a hole of an unknown diameter d', the diameter of the central spot obtained is : L'=1,5cm **.**

3-1- Determine d'. (**0.5pts)**

3-2- We replace the source of laser with a source of white light, we observe on the screen, a central iridescent spot consisted with a white central part of diameter L_B . Knowing that the wavelength λ of visible spectrum in the vacuum is $\lambda_1 = 0,4\mu m < \lambda < \lambda_2 = 0,8\mu m$.

3-2-1- Indicate between λ_1 and λ_2 , the wavelength corresponding to the red radiation. **(0,25pt)**

3-2-2- Determine L_B . **(0,75pt)**

Part 2: The radioactivity of the polonium.

The nucleus of polonium $^{210}_{84}Po$ spontaneously decays into a nucleus of lead $^{206}_{82}Pb$ with emission of a particle α .
In this part, we propose to study the energy balance of this transformation and the evolution during time of this transformation.
On the diagram of figure 1 are placed the values of the mass of the following systems: (the nucleus of polonium 210); (separated nucleons) ; (the nucleus f lead 206 + α).

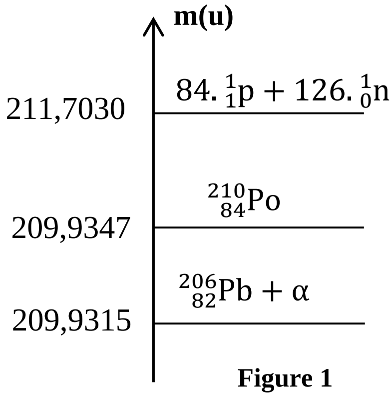

Figure 1

Given :

- The molar mass of polonium 210 : $M=210g.mol^{-1}$;
- Atomic mass unit: $1u=931,5MeV.c^{-2}$.
- Avogadro constant: $N_A=6,02.10^{23}mol^{-1}$.

1- Choose the correct statement from the following statements : **(0,25pt)**

a- The $\alpha - decay$ corresponds to the emission of a neutron.

b- The $\alpha - decay$ concerns light nuclei.

c- The half-life $t_{1/2}$ of a sample is the duration after which 63% of the sample disintegrated.

d- The binding energy per nucleon of lead 206 is greater than that of polonium 210.

2- By exploiting the diagram of figure 1:

2-1- Compute, in $MeV/nucleon$, the binding energy per nucleon of the nucleus $^{210}_{84}Po$. **(0,25pt)**

2-2- Compute, in MeV , the energy $|\Delta E|$ released by the disintegration of a mass $m=1mg$ of polonium 210. **(0,25pt)**

3- We denote by N_D the number of nuclei of polonium disintegrated at an instant t and N_0 the number of nuclei of polonium 210 contained in the sample at $t=0$. The curve of figure 2 represents the variations of $\frac{N_D}{N_0}$ as function of time.

3-1- By exploiting the curve of figure 2, determine in day The half-life $t_{1/2}$ of the polonium 210. **(0,25pt)**

3-2- Let t_1 the instant at which we have: $\frac{N_D}{N}=3$, with N the number of nuclei of the polonium remaining at the same instant. Find out in day the value of t_1 . **(0,5pt)**

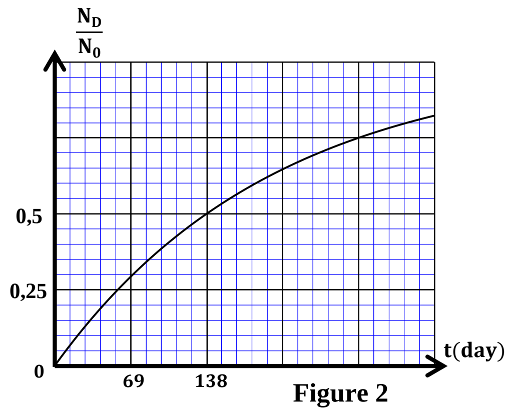

Figure 2

Exercise 3 : Electricity (4 points)

Part 1 and part 2 are independent

This exercise aims to study:

- The response of the RC dipole to a step of voltage.
- Forced oscillations in RLC series circuit.

<u>Part1: Study of RC dipole</u>

We perform the electric circuit of figure 1 which consists of:

- An ideal generator of voltage of e.m.f E ;
- A resistor of resistance R_0 ;
- Two capacitors (C_1) and (C_2) without initial charge, respectively of capacitances $C_1=5\mu F$ and $C_2 \rangle C_1$;
- A switch K.

We close the switch K at an instant $t=0$,

1-1- Express u_1 the voltage between terminals of (C_1) in terms of C_1, C_2 and u_2 the voltage between terminals of (C_2) . **(0,25pt)**

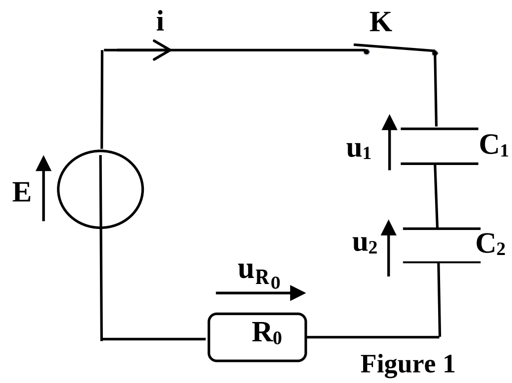

Figure 1

1-2- Show that the differential equation verified by u_2 is written as : $u_2+\frac{R_0 .C_1.C_2}{C_1+C_2}.\frac{du_2}{dt}=\frac{C_1.E}{C_1+C_2}$. **(0,5pt)**

1-3- Knowing that solution of differential equation is written as: $u_2(t)=A(1-e^{-\alpha t})$

Find out the expression of the constant A and that of α in terms of the parameters of the circuit. **(0,5pt)**

2- The curves of figure 2 represent the evolution during the time of voltages u_1 , u_2 and u_{R_0} the voltage between terminals of the resistor.

(T) represents the tangent of the curve 3 at the point of abscise $t=0$.

2-1-Associate the voltage $u_2(t)$ with the corresponding curve. **(0,25pt)**

2-2- Determine the value of C_2 and that of R_0. **(0,5pt)**

2-3- Calculate Ee the total electric energy stored in both capacitors when the steady state is established. **(0,25pt)**

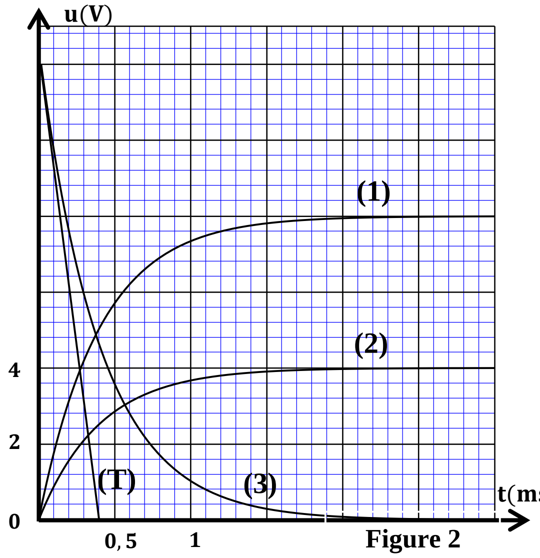

Figure 2

Part 2: Study of forced oscillations in RLC series circuit

We perform the electric circuit of figure 3, which consists:

- A low frequency generator (GBF), which delivers a sinusoidal alternating voltage of a constant frequency N and a constant maximal voltage U_m ;
- A capacitor of capacitance $C_o=10\mu F$;
- An inductor (b) of inductance $L=86mH$ and of resistance r ;
- A resistor of resistance $R=20\Omega$.

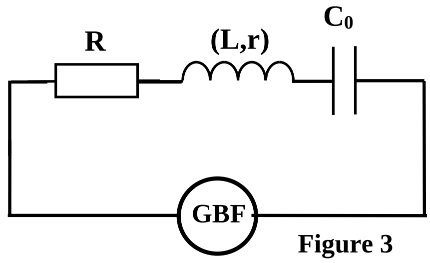

Figure 3

The generator applies a voltage $u(t)=U_m.\cos(2.\pi.N.t+\varphi)$, an electric current of intensity $i(t)=I_m.\cos(2.\pi.N.t)$ flows in the circuit.

We visualize, with the help of an adequate computing system, the voltage $u_R(t)$ between the terminals of the resistor and the voltage $u(t)$ between the terminals of the generator.

We obtain the oscillogram represented in figure 4.

1- Determine the value of φ and that of the impedance Z of the circuit.**(0,5pt)**

2- Compute the average power P dissipated by Joule effect in the circuit and deduce the value of r . **(0,5pt)**

3- To obtain the electric resonance, we mount a capacitor of capacitance C with capacitor of the capacitance C_o .

3-1- Determine the value of C . We take $\pi^2=10$. **(0,5pt)**

3-2- Compute the intensity of the effective current in the circuit.**(0,25pt)**

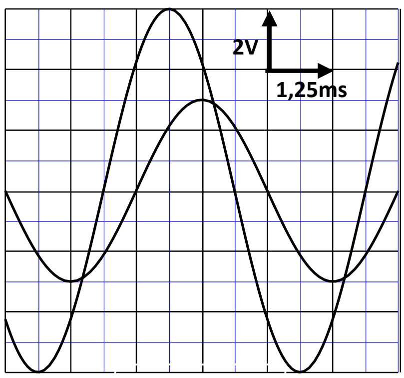

Figure 4

Exercise 4 : Mechanics (5 points)

Part 1 and part 2 are independent

Part 1: Motion of mechanical system

We consider a pulley (P) of radius $r = 5cm$ susceptible to rotate in a vertical plane around an horizontal fixed axis (Δ) passing through its center I and whose the moment of inertia about this axis is J_Δ .

We wrap an inextensible wire of negligible mass around the pulley (P), on the other end of the wire is attached a solid (S) of mass $m = 100g$ and of center of inertia G. During the motion, the wire does not slip on the pulley (figure1).

We consider a point M on the circumference of the pulley.

The point M initially starts from the position M_0 belonging on the vertical line passing through point I and the center of inertia G of the solid (S) starts from a position of coordinate z=0 in the frame of reference $(O,\vec{k})$.

We locate, at any instant of time, the position of the center of inertia G by the z coordinate and the position of the point M by the angular displacement $\theta = (\overrightarrow{IM_0}, \overrightarrow{IM})$.

We take the gravitational field strength g=10m.s^{-2}

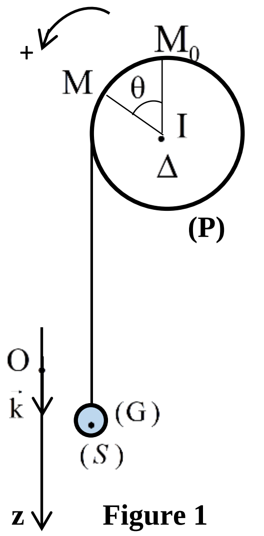

Figure 1

1- We neglect all frictions. The curve of figure (2) represents the evolution of the angular velocity $\dot{\theta}$ of the pulley as function of time.

1-1- Determine, by justifying your answer, the nature of motion of the pulley (P) and calculate its angular acceleration $\ddot{\theta}$. **(0,5 pt)**

1-2- At the instant $t_1 = 3s$, compute the value of the tangential acceleration a_t and that of normal acceleration a_n of the motion of M . **(0,5 pt)**

1-3- By using a dynamic study, show that $J_\Delta = 10^{-3} kg.m^2$. **(0,5 pt)**

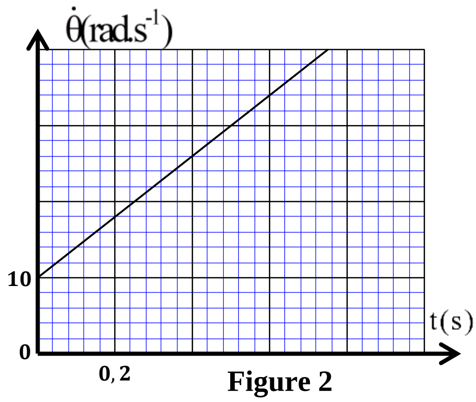

Figure 2

2- At the instant $t_1 = 3s$ the wire is cut and the solid (S) continues its fall.

We consider that the frictional fluids force applied by air is written as: $\vec{f} = -\mu.v^2\vec{k}$ with μ is the coefficient of friction and v the velocity of G.

We neglect the Archimedes' force in front of other forces.

2-1- Compute the velocity of (S) at the instant $t_1 = 3s$.**(0,25 pt)**

2-2- Establish the differential equation verified by the velocity v when $t \geq t_1$ **(0,25 pt)**

2-3- The curve of figure 3 represents the variations of $\frac{dv}{dt}$ as function of v^2.

Determine the value of the terminal velocity V_L of the solid (S), and that of the coefficient μ . **(0,5pt)**

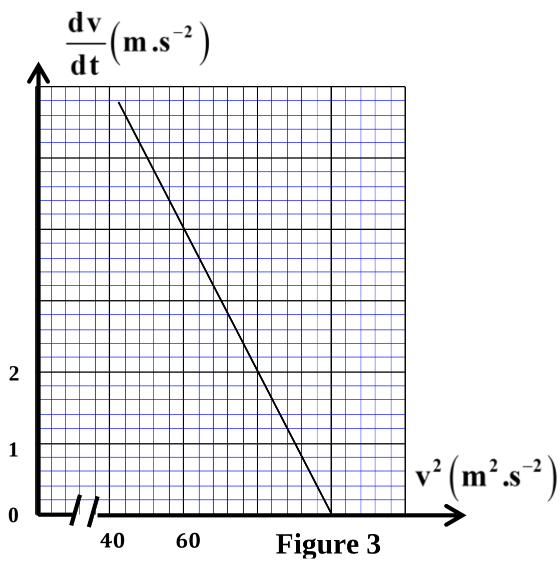

Figure 3

Part 2 : Motion of an elastic pendulum.

The elastic pendulum is a mechanical system performing an oscillating motion around its rest position. This part aims to determine some quantities of this oscillator.

The pendulum studied consists of a solid (S), of center of inertia G and of mass $m = 100g$, which is attached to the end of a spring with non-contiguous turns, of a negligible mass and spring constant K. We fix the other end of the spring to a fixed stand. The solid (S) slides without friction on the inclined plane at an angle $\alpha = 30°$ to the horizontal plane.

We study the motion of the center of inertia G of the solid in frame of reference $R(O, \vec{i}, \vec{j})$ linked to the earth assumed Galilean.

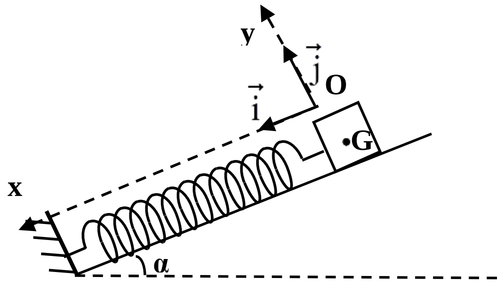

Figure 4

We locate the position of G at an instant t by the displacement x on the x-axis $(O, \vec{i})$.

At the rest position, the displacement x of G is zero in the frame of reference (figure 4).

Given:

- The intensity of the gravitational acceleration: $g = 10m.s^{-2}$;
- We take $\pi^2 \simeq 10$

1- Show that the expression of the extension Δl_0 of the spring at the rest position is written as :

$\Delta l_0 = -\dfrac{mg.\sin(\alpha)}{K}$. **(0,25pt)**

2- We displace (S) from its rest position, and we release it at an instant of date t = 0 with an initial velocity $\vec{V_0} = V_0.\vec{i}$.

The curve of figure 5 represents the evolution during time of the component v_x of the velocity vector of G.

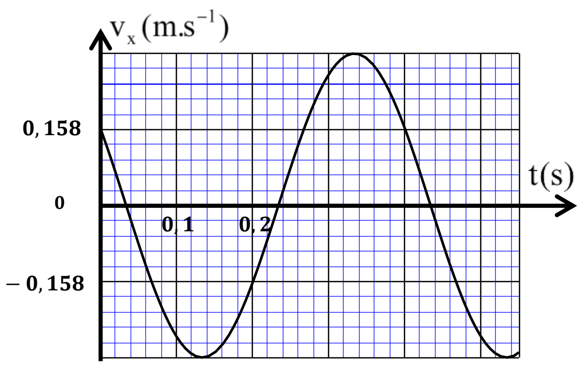

Figure 5

2-1- Applying the Newton's second law, Establish the differential equation of the motion verified by the displacement x of G. **(0,5pt)**

2-2- The solution of the differential equation is written as:

$x(t) = X_m.\cos\left(\dfrac{2\pi}{T_0}t + \varphi\right)$, with T_0 the natural period of the oscillator.

Find out the value of X_m, of φ and that of K. **(0,75pt)**

2-3- Deduce the vectorial expression of the resultant of the forces applied to (S) as function of time. **(0,25pt)**

2-4- We choose as reference level the elastic potential energy $(Epe = 0)$ when the spring is not deformed and as reference level of the gravitational potential energy $(Epp = 0)$ the horizontal plan passes through G at the rest position.

2-4-1- Show that the expression of the mechanical energy of the oscillating system is written as:

$E_m = \frac{1}{2}m\dot{x}^2 + \frac{1}{2}K(x^2 + \Delta l_0^2)$. **(0,5pt)**

2-4-2- Compute the value of E_m. **(0,25pt)**

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

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عناصر الإجابة

NR 30E

4h	مدة الإنجاز	الفيزياء والكيمياء	المادة
7	المعامل	شعبة العلوم الرياضية (أ) و (ب) (خيار إنجليزية)	الشعبة أو المسلك

Exercise 1 : Chemistry (7 points)

	Question	Answers	Marking scale	Question reference in the framework
Part 1	1-1	Equation of titration reaction with one arrow	0,25	Write the equation of titration reaction (use only one arrow) . -Define the final progress rate of a reaction, and determine it using experimental data. -Determine and exploit the point of equivalence. -Write and use the expression of the acid dissociation constant K_A associated with the reaction of an acid with water. - Justify the choice of a suitable indicator to determine the equivalence. - Give and use the expression of the reaction quotient Q_r through the reaction equation. . --Know that the ionic product of water K_W, is the equilibrium constant associated with the equation of the reaction of water autoprotolysis (self-ionization of water). -Determine the nature of aqueous solution (acid, basic or neutral) based on its pH value. -Determine the pH for an aqueous solution.
	1-2	Demonstration	0,75	
	1-3	$V_B = \frac{V_{Be}}{2}$ $pK_A = 4,8$	0,25 0,25	
	1-4	$C_A = 3,4.10^{-2} mol.L^{-1}$.	0,5	
	1-5	$n = 3$ C_3H_7COOH	0,5 0,25	
	2-1	Demonstration	0,75	
	2-2-1	Verification	0,5	
	2-2-2	$pK'_A = 3,8$	0,5	
Part 2	1	-d-	0,5	- Draw a cell diagram / diagram of an electrochemical cell (battery) -Establish the relationship between the amount of substance of chemical specie produced or consumed, the current intensity and the operating duration of a battery. Use this relationship to determine other quantities (quantity of charge, progress of the reaction, .change of the mass...)
	2	Method $C_2 = 0,2 mol.L^{-1}$	0,25 0,25	
	3	$I = \frac{2F.V.(C_1 - K.C_2)}{(1+K).t_{eq}}$; $I \simeq 0,1A$	0,5 0,25	
	4	$\Delta m \simeq -46,7mg$	0,75	

Exercise 2 : waves + Nuclear transformations (4 points)

	Question	Answers	Marking scale	Question reference in the framework
Part 1	**1**	Demonstration	**0,5**	- Know that light has a wave aspect, based on the diffraction phenomenon. -Know the influence of the size of the slit (opening) or of the obstacle on the diffraction phenomenon - Exploit a document or a diffraction pattern in the case of light waves. -Know (Recall) and exploit the relationship: $\lambda = c / \nu$. -Know the boundaries of wavelengths and their colours for the visible spectrum in the vacuum. - Know the frequency of a monochromatic radiation does not change as it passes from one transparent medium to another. - Know that the transparent media are more or less dispersive. - Know (Recall) and exploit the relationship $n = \frac{c}{v}$.
	2	Verification	**0,5**	
	3-1-	Method $d'=1,83.10^{-4}m$	**0,25** **0,25**	
	3-2-1	$\lambda_2=0,8\mu m$	**0,25**	
	3-2-2	Method $L_B = 8.10^{-3} m$	**0,5** **0,25**	
Part 2	**1**	d	**0,25**	- Define a radioactive nucleus - Know and exploit the two laws of conservation. -Define the radioactivity α ,β^+ ,β^- and the γ -radiation . -Write the equation of a nuclear reaction by applying the two conservation laws. -Recognise the type of radioactivity using the equation of a nuclear reaction. -Know and exploit the law of the radioactive decay, and exploit its curve. - Know that 1Bq is equal to one decay per second. -Define the time constant τ and the half-life $t_{1/2}$. -Exploit the relationships between τ , λ and $t_{1/2}$. - Define and calculate the mass defect and the binding energy. -Define and calculate the binding energy per nucleon and exploit it. -Use different units of mass, energy and the relationships between their units. - Exploit the binding energy per nucleon curve (Aston curve) to identify the most stable nucleus. -Know the relationship of the mass-energy equivalence; and calculate the energy of mass.
	2-1	7,83MeV/nucleon	**0,25**	
	2-2	$\lvert\Delta E\rvert = 8,54.10^{18}\,MeV$	**0,25**	
	3-1	$t_{1/2} = 138\,jour$	**0,25**	
	3-2	$t_1 = 276\,jour$	**0,5**	

Exercise 3 : Electricity (4 points)

	Question	Answers	Marking scale	Question reference in the framework
Part 1	**1-1**	$u_1 = \frac{C_2}{C_1}.u_2$	**0,25**	- Know and exploit the relationship $i = \frac{dq}{dt}$ for a capacitor in receiver convention. -Know and exploit the relationship q = C.u. -Know the capacitance of a capacitor, its unit F et ses sous multiples and their submultiples $\mu F, nF\ et\ pF$. -Determine the capacitance of a capacitor graphically or by calculation. - Know the capacitance of the equivalent capacitor in series or in parallel assemblies; and recall the interest of each one. - Find out the differential equation and verify its solution when theRC dipole is submitted to a step voltage. - - Determine the voltage expression $u_C(t)$ between cpacitor terminals when the RC C ut between capacitor terminals when the RC dipole is submitted to a step voltage, and deduce both the expression of the intensity current in the circuit and the capacitor charge
	1-2	Demonstration	**0,5**	
	1-3	$A=\frac{C_1.E}{C_1+C_2}$, $\alpha=\frac{C_1+C_2}{R_0.C_1.C_2}$	**0,25** **0,25**	
	2-1	**(2)** corresponds to u_2	**0,25**	
	2-2	$C_2 = 10\mu F$; $R_0 = 120\Omega$	**0,25** **0,25**	
	2-3	$Ee = 2,4.10^{-4} J$	**0,25**	
Part 2	**1**	$\varphi = \frac{\pi}{4}$ $Z = 40\Omega$	**0,25** **0,25**	Know the role of the driver and the resonating system. -Know and exploit the expressio $\lvert\varphi\rvert = \frac{2.\pi.\tau}{T}$ of the phase of physical quantity relative to another. -Know and exploit the impedance expression $Z = \frac{U}{I}$ of a circuit. - Know the unit of the impedance (Ω) . - Recognise the electric resonance phenomenon and its characteristics. - Know the instantaneous power in the alternating sinusoidal state. - Find out and exploit the average power expression $P = U.I.\cos\varphi$ - Know the power factor.
	2	$P = 0,318W$ $r = 8,26\Omega$	**0,25** **0,25**	
	3-1	method $C \simeq 26,6\mu F$	**0,25** **0,25**	
	3-2	$I = 0,15A$	**0,25**	

Exercise 4 : Mechanics (5 points)				
	Question	**Answers**	**Marking scale**	**Question reference in the framework**
Part 1	**1-1**	M.R.U.V ; $\ddot{\theta} = 40 rad.s^{-2}$	**0,25** **0,25**	- Know the angular acceleration expression and its unit. - Know and exploit the expressions of the two components a_N and a_T in terms of angular quantities. - Know and apply the fundamental relationship of dynamics in the case of rotation around a fixed axis in order to establish the differential equation of the motion, and solve it. - Know the unit of the moment of inertia. - Know and exploit the characteristics of a uniformly varied rotational motion and its parametric equations . - Apply Newton's second law and the fundamental relationship of dynamics on a mechanical system consisting of two solids, one in straight translational motion and the other in rotational motion, to establish the differential equation and to determine kinetic and dynamic quantities. - Exploit the curve v=f(t) to determine: * the terminal speed; * the characteristic time τ ; * the initial state and the steady state. . - Apply Newton's second law to find out the differential equation of a solid's centre of inertia motion in frictional vertical fall. - Know and apply the Euler's method to solve approximately differential equation
	1-2	$a_t = 2 m.s^{-2}$ $a_n = 845 m.s^{-2}$	**0,25** **0,25**	
	1-3	Demonstration	**0,5**	
	2-1	$v(t_1) = 6,5 m.s^{-1}$	**0,25**	
	2-2	Method	**0,25**	
	2-3	$V_L = 10 m.s^{-1}$ $\mu = 10^{-2} (S.I)$	**0,25** **0,25**	
Part 2	**1**	Demonstration	**0.25**	-Know the characteristics of the restoring force exerted by a spring on a solid in motion. -Exploit the curves: $x_G(t)$, $v_G(t)$ and $a_G(t)$. -Apply Newton's second law to the oscillating system (solid-spring) to establish the differential equation of motion and verify its solution when the oscillating system vibrates in the following situations: horizontal, inclined or vertical. - Determine the type of motion of the oscillating system (solid-spring); write the equations: $x_G(t)$, $\dot{x}$ and $\ddot{x}$ and exploit them. Know the meaning of the physical quantities involved in the expression of the parametric equation of the oscillating system (solid-spring) and determine them using the initial conditions. Establish the expression of the natural period of the oscillating system (solid-spring). Know and exploit both the expression of the natural period and that of the natural frequency of the oscillating system (solid-spring). . Know and exploit the expression of the elastic potential energy. Know and exploit the expression of the mechanical energy of a solid-spring system . -Exploit the conservation and the non-conservation of the mechanical energy of a solid-spring system .
	2-1	$\ddot{x} + \frac{K}{m} x = 0$	**0,5**	
	2-2	$X_m = 2cm$ $\varphi = -\frac{\pi}{6}$ $K = 25 N.m^{-1}$	**0.25** **0.25** **0.25**	
	2-3	$\sum \vec{F}_{ext} = -0,5\cos(5\pi t - \frac{\pi}{6}).\vec{i}$	**0,25**	
	2-4-1	Demonstration	**0,5**	
	2-4-2	$E_m = 10 mJ$	**0,25**	