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

- ✓ *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 ethanoic acid

- Part 2: Temporal monitoring of the evolution of the reaction of disproportionation of oxygenated water

Exercise 2: Waves+Nuclear transformations (4 points)

- Part 1: Waves on the surface of water

- Part 2: The plutonium 238 in the medical field

Exercise 3: Electricity (4 points)

- RL, RC dipoles and RLC circuit

Exercise 4: Mechanics (5 points)

- **Part 1**: Vertical fall

- Part 2: Motion of a physical pendulum

Exercise 1: Chemistry (7 points)

Part 1 and part 2 are independent

Part 1 : Study of an aqueous solution of ethanoic acid

This part aims to study:

- An aqueous solution of ethanoic acid.
- The titration of an aqueous solution of ethanoic acid.

1- We prepare an aqueous solution (S_A) of ethanoic acid CH_3COOH of volume V and molar concentration $C_A = 10^{-2} mol.L^{-1}$. The pH of this solution is: $pH = 3,4$.

1-1- Write the equation of the chemical reaction between the ethanoic acid and water.**(0,25pt)**

1-2- Show that the reaction between the ethanoic acid and water is a non-complete reaction. **(0,25pt)**

1-3- In the case where $\left[H_3O^+\right] \langle\langle C_A$, check out that the pK_A of the pair CH_3COOH/CH_3COO^- can be written as: $pK_A \simeq 2pH + \log(C_A)$. Compute pK_A. **(0,75pt)**

2- We propose to check the value of C_A and that of pK_A, by pH-metric titration, for this we introduce in a beaker a volume V_e of pure water and a volume $V_A = 20mL$ of the solution (S_A). We titrate the obtained solution by an aqueous solution (S_B) of sodium hydroxide $Na^+_{(aq)} + HO^-_{(aq)}$ of molar concentration $C_B = 2.10^{-2} mol.L^{-1}$.

2-1- Write the equation of the chemical reaction occurring during this titration. **(0,25pt)**

2-2- The monitoring of pH-metric titration allowed obtaining the curve representing the evolution of the pH of the reaction mixture as function of the volume V_B of the solution of sodium hydroxide added $pH = f(V_B)$ (figure 1).

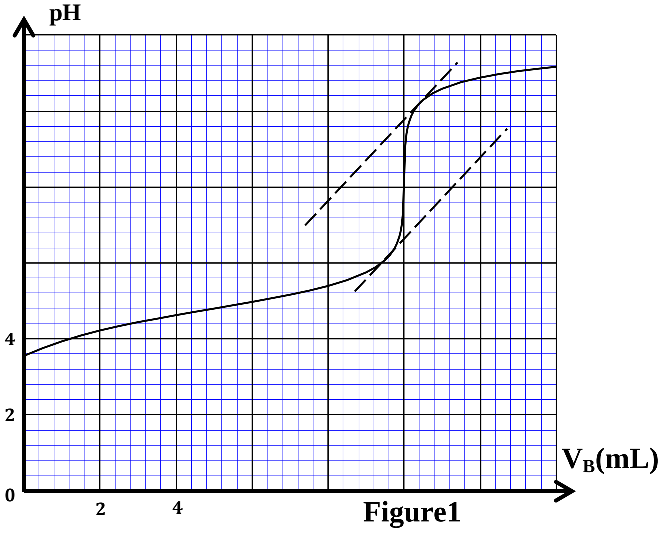


Figure1

2-2-1- For an added volume $V_B = 7,2mL$:

a- Establish the expression: $K_A = \dfrac{V_B.10^{-pH}}{V_{BE} - V_B}$ then check out the value of the pK_A . **(0,5pt)**

b- Establish the expression of the final progress rate of the reaction: $\tau = \dfrac{V_{BE}}{V_B(1+10^{pK_A - pH})}$. Compute its value and conclude.**(1pt)**

2-2-2-Verify the value of C_A.**(0,25pt)**

2-2-3- Determine V_e . **(0,5pt)**

2-2-4- We give the table below:

Indicator	Color of the acid form	Color of the base form	pH-range
Thymolphtaleine	Colorless	Blue	9,4 - 10,6
cresol Red	Yellow	Red	7,4 - 9

Choose the appropriate indicator for this titration and deduce the color that the solution would have at the beginning of the titration. **(0,5pt)**

Part 2 : Temporal monitoring of the evolution of the reaction of disproportionation of oxygenated water

The commercial oxygenated water is an aqueous solution of hydrogen peroxide H_2O_2 used as a wound disinfectant, or as a bleaching agent…

In the presence of a platinum wire, the hydrogen peroxide H_2O_2 reacts with itself, in a slow and complete reaction called "reaction of disproportionation " of chemical equation: $2H_2O_{2(aq)} \rightarrow O_{2(g)} + 2H_2O_{(\ell)}$.

To study the temporal monitoring of this reaction, at an instant considered as origin of time t=0, we introduce into a two-necked flask connected to a pressure gauge, a platinum wire and a volume $V_0 = 10mL$ of a solution of oxygenated water H_2O_2 of molar concentration $C_0 = 1,2.10^{-1} mol.L^{-1}$.

The flask is closed hermetically and we assume that the volume of the solution and the temperature remain constant during the transformation.

The graph of figure 2 represents the evolution of the pressure of the produced dioxygen in the flask as function of time: $p_{O_2} = f(t)$.

(T)is the tangent to the curve at the point of abscise t=10min.

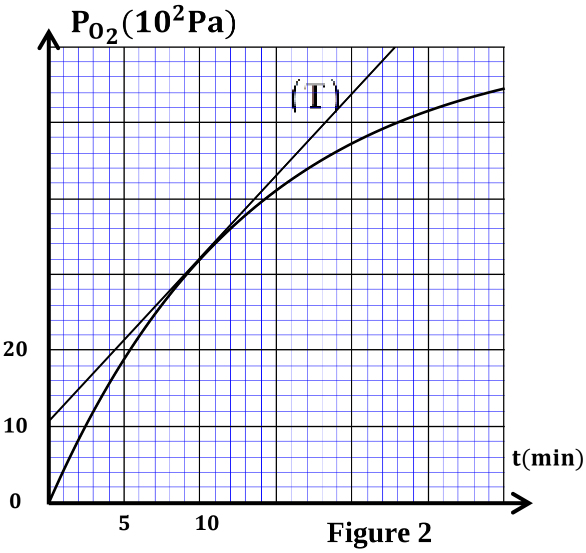


Figure 2

Given :

- The capacity of the flask : $V = 250mL$;
- We assume that the gas is an ideal gas;
- The equation of state of ideal gas : $P.V = n.R.T$;
- The ideal gas constant : $R = 8,31(S.I)$;
- Temperature: $T = 293K$.

1- Write the two electronic half-equations of the reaction of disproportionation of H_2O_2. **(0, 5pt)**

2- Compute the maximal progress of the reaction. **(0,25pt)**

3- Show that the progress of the reaction x(t) is given by the relationship: $x(t)=\frac{V-V_0}{RT}p_{O_2}(t)$. **(0, 5pt)**

4- Find out,at the point of abscisse $t = 10\,min$, the value of the volumetric rate of the reaction (in $mol.L^{-1}.min^{-1}$). **(0,75pt)**

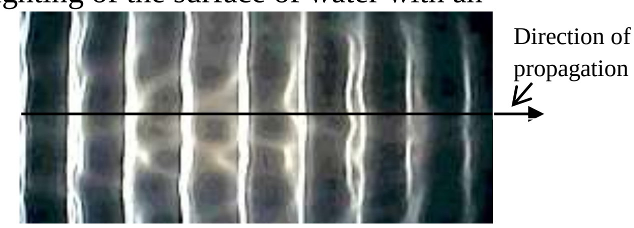
5- Determine the half-life of a reaction $t_{1/2}$. **(0,75pt)**

Exercise 2 : waves + Nuclear transformations (4 points)

Part 1 and part 2 are independent

Part 1 : Propagation of waves on the surface of water

In a ripple tank, we generate on the free surface of water, by using a vibrating rule of an adjusted frequency N , a linear sinusoidal progressive wave. The lighting of the surface of water with an appropriate device allowed obtaining on the screen of the ripple tank a magnified image of the appearance of the surface of water, made up by a succession of dark and light areas reflecting the troughs and crests of the wave (figure on the right).



Given: When we place, in the medium of the tank, an object of length ℓ=10mm , we obtain on the screen a magnified image of length $L = 20mm$.

1- We adjust the frequency of the wave to the value $N_1=20Hz$. We observe, in the direction of propagation of the wave, that two points A and B separated by a distance $D=40mm$ on the screen, are respectively on the first and third crest.

1-1- Compute the wavelength λ_1 of the wave on the surface of water. **(0,5pt)**

1-2- Check out that the speed of this wave is: $V_1=0,2m.s^{-1}$. **(0,25pt)**

2- We place in the medium of the tank a barrier made up of two vertical plates parallel to the vibrating rule and separated by a small opening of length a, such that $\frac{\lambda_1}{a}>1$.

What is the shape of the wave beyond the opening? Justify. **(0,5pt)**

3- We take off the two vertical plates from the tank and we adjust the frequency of the wave to the value $N_2=30Hz$.

We notice, this time, that the two points A and B vibrate in opposition to phase.

The distance separating two points M and N vibrating in opposition to phase is: $MN=(2k+1).\frac{\lambda}{2}$ with k is a natural number.

3-1- We admit that the speed V_2 belongs to the interval $\left[2.10^{-1}m.s^{-1}\ -\ 3.10^{-1}m.s^{-1}\right]$

Show that : $V_2=\frac{2N_2.\ell.D}{5L}$. Compute V_2. **(0,75pt)**

3-2- Deduce if water is a dispersive medium or non-dispersive. Justify **(0,5pt)**

Part 2 : The plutonium 238 in the medical field

A pacemaker is a small device that we plant in the chest of patient. This devise generates weak electrical impulses that excite the heart muscle and regulate the heartbeat.

The first pacemakers operated with a battery whose lifespan was too limited.

To overcome this defect, one of solutions is the exploitation of the released energy by the disintegration of nuclei of the plutonium 238.

This part aims to study the normal operation of a pacemaker powered by the released energy of the disintegration of nuclei of the plutonium 238.

The plutonium $^{238}_{94}Pu$ is radioactive; it spontaneously disintegrates by giving the uranium $^{234}_{92}U$ with emission of a particle $^{A}_{Z}X$.

Given :

- Mass of some nuclei or particles:

Nucleus or particle	$^{238}_{94}Pu$	$^{234}_{92}U$	$^{A}_{Z}X$
Mass in u	237,99799	233,99048	4,00153

- Atomic mass unit: $1u=931,5MeV.c^{-2}$;
- Atomic molar mass of plutonium 238 : $M=238g.mol^{-1}$;
- Avogadro constant: $N_A=6,02.10^{23}mol^{-1}$;
- The half-life of plutonium 238: $t_{1/2}=87,8$ year .
- 1year = $3,1536.10^7s$.

1- Write the equation of the disintegration of the nucleus of the plutonium 238 by identifying the type of this disintegration. **(0,25pt)**

2- Compute, in MeV, the released energy $|\Delta E|$ by this disintegration. **(0,25pt)**

3- A pacemaker contains a sample of plutonium 238, of mass $m_0=130mg$.

This device operating normally as long as the activity of the sample remains greater or equal to $a_c = 5,76.10^{10}\,Bq$. We consider that the activity of the device is due only to the disintegration of plutonium 238.

3-1- Compute, in Becquerel, the initial activity a_0 of the device. **(0,5pt)**

3-2- Compute, in year, the duration Δt of the normal operating of the device. **(0,5pt)**

Exercise 3 : Electricity (4 points)

This exercise aims:

- The determination of the capacitance of a capacitor;
- The determination of quantities characterizing an inductor;
- The study of forced oscillations in RLC series circuit.

1- Determination of the capacitance of a capacitor

We perform the experimental mounting shown in figure 1 which consists of :

- A generator of current delivering a current of a constant intensity I ;
- A resistor of resistance R ;
- A capacitor of capacitance C, whose initial voltage between its terminals is U_0 ;
- A switch K .

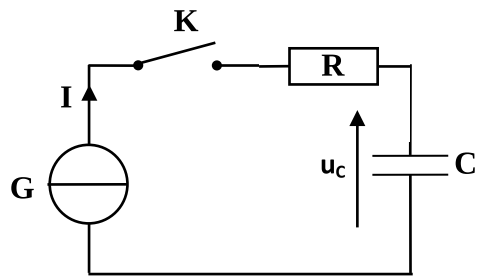


Figure 1

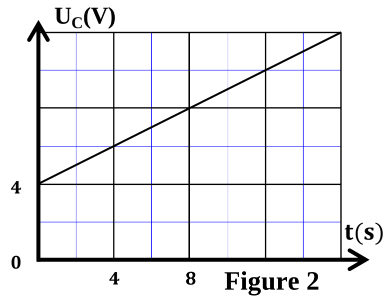


Figure 2

At an instant of time chosen as an origin of dates $(t=0)$, we close the switch K. A current of intensity $I = 2\mu A$ flows in the circuit.

The curve of figure 2 represents the evolution of the voltage u_C between the terminals of the capacitor as function of time.

1-1- Find out the expression of the voltage u_C in terms of C, U_0, I and t .**(0,25pt)**

1-2- Determine the value of C and that of U_0. **(0,5pt)**

1-3- Compute Ee the electrical energy stored in the capacitor at the instant of date $t_1 = 20s$. **(0,25pt)**

2- Determination of quantities characterizing an inductor

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

- A generator of voltage of electromotive force E ;
- A resistor of resistance $R = 30\Omega$;
- An inductor (b) of inductance L and of resistance r ;
- A switch K .

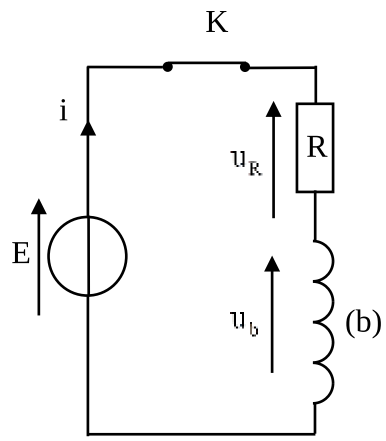


Figure 3

2-1- The differential equation verified by the voltage u_R between the terminals of a resistor is written as: $\frac{du_R}{dt} + \frac{u_R}{\tau} = \beta$.

Find out the expression of τ and that of β in terms of the parameters of the circuit. **(0,5pt)**

2-2- The solution of the differential equation is written as : $u_R(t)=A.(1-e^{-t/\tau})$, find out the expression of A in terms of the parameters of the circuit.**(0,5pt)**

2-3- Show that the expression of the voltage $u_b(t)$ between the terminals of the inductor is written as:

$u_b(t)=\frac{E}{R+r}.(r+R.e^{-t/\tau})$ **(0,5pt)**

2-4- The curve of figure 4 represents the evolution of the voltage u_b as function of time. (T) represents the tangent of the curve at the point of abscise $t=0$.

Show that $r=10\Omega$ and $L=10mH$. **(0,5pt)**

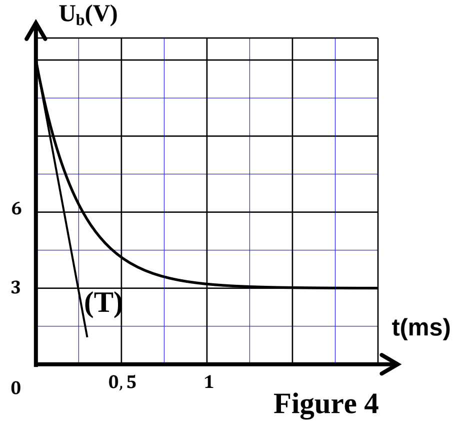


Figure 4

3-Study of forced oscillations in RLC series circuit

We perform the mounting sketched in figure 5, which consists of :

- A low frequency generator (GBF) ;
- The previous inductor (b);
- The resistor of resistance $R=30\,\Omega$;
- The previous capacitor of capacitance C.

The generator delivers a sinusoidal alternating voltage $u(t)=U.\sqrt{2}.\cos(2\pi N.t)$ of adjusted frequency N and an effective voltage U .

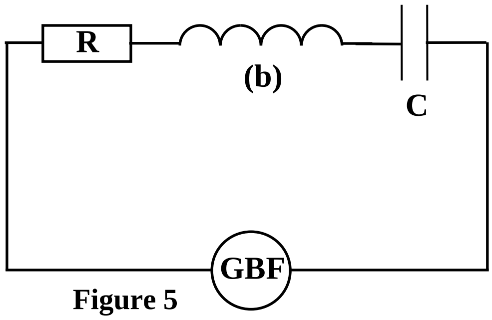


Figure 5

The experimental study of this circuit allowed obtaining the curve $Z=f(N)$ by maintaining U constant, Z being the impedance of the circuit (figure 6).

3-1- By using the curve of figure 6, show that the circuit is on the electric resonance. **(0,25pt)**

3-2- For a certain frequencies the current intensity is: $I=\frac{I_0}{\sqrt{2}}$, with I_0 is the effective intensity of the current at the resonance. Verify in this case that $Z\simeq 56,5\,\Omega$. **(0,25pt)**

3-3- Determine graphically ΔN the width of the passband at -3dB and deduce the quality factor Q. **(0,5pt)**

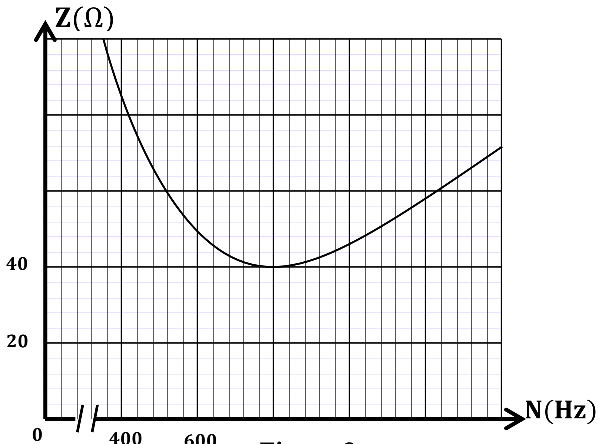


Figure 6

Exercise 4 : Mechanics (5points)

Part 1 and part 2 are independent

Part 1 : The vertical fall

All solids in motion in fluid obey to the Archimedes' force and to frictional fluids forces.

This part aims studying the vertical motion of a homogenous ball in an oil of an engine and in the air.

Given :

- The density of the matter constituting the homogenous ball: $\rho_B=680kg.m^{-3}$;
- The radius of the ball: $R=2,5cm$;
- The density of the oil: $\rho_H=900kg.m^{-3}$;

- The gravitational field strength : $g=9,8 N.kg^{-1}$;
- The volume of the ball R : $V=\frac{4}{3}.\pi.R^3$.

1- The ball is held at the bottom of a tube filled with the oil (figure 1).
We let go the ball go from the point O at an instant of time t=0 and we study the motion of its center of inertia G in the frame of reference $R(O;\vec{k})$ directed upwards and linked to terrestrial reference frame assumed Galilean.
During its motion in the oil, in addition to its weight, the ball obeys to
-a frictional fluids force: $\vec{f}=-6\pi.\eta.R.v.\vec{k}$ where η is the viscosity of the oil and v is the velocity of G at an instant t;
- The Archimedes' force $\vec{F}=-\rho_H.V.\vec{g}$ where V is the volume of the ball.

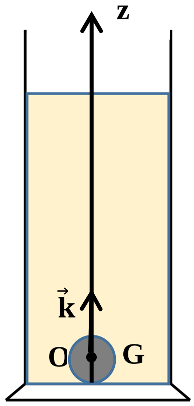


Figure 1

1-1- Justify the direction of the motion of the ball. **(0,5pt)**
1-2- Show that the differential equation verified by the velocity v of G is written as: $\frac{dv}{dt}+\frac{9\eta}{2\rho_B.R^2}.v=g.(\frac{\rho_H}{\rho_B}-1)$. **(0,5pt)**
1-3- The curve of figure (2) represents the variation of the acceleration $\frac{dv}{dt}$ of G as function of v.
Determine V_l the value of the terminal velocity of the ball that could rich, deduce the value of η **(0,5pt)**

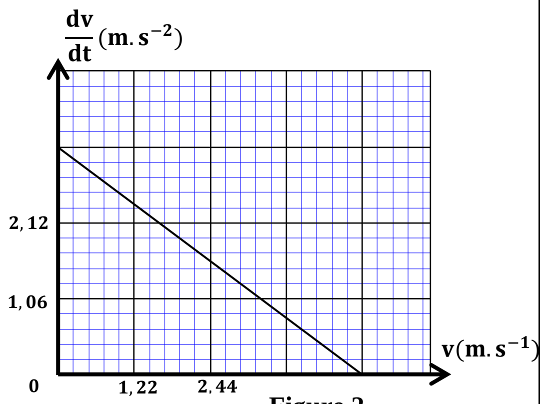


Figure 2

1-4- The solution of the differential equation allowed tracing the curves of figure 3 representing the variation of the velocity v and that of coordinate z as function of time as long as the ball is in the oil.

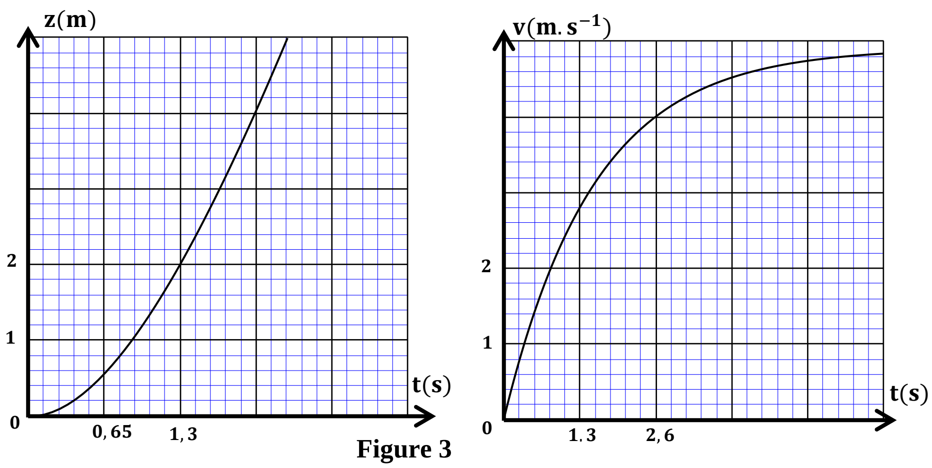


Figure 3

Knowing that at the instant (t=0) G is at the depth H=2m in the oil, determine the velocity of G at the instant when it leaves the oil. We assume that the disturbances due to the change of the medium do not affect the motion of the ball when leaving the oil. **(0,5pt)**

2- After G comes out of the oil, we assume that the ball obeys just to its weight.
We take the instant when G comes out of the oil as new origin of date t=0 and we study its motion in the frame of reference $R(O;\vec{k})$.

By applying Newton's second law, determine the maximum height h_m relative to the free surface of the oil that G could reach. **(0,5p)**

Part 2 : Study of the motion of a physical pendulum

We consider a physical pendulum, of center of inertia G and of mass m, consists of a rod and solid (S). The pendulum can make a rotational motion around a horizontal fixed axis (Δ) passing through the terminal O of the rod (figure 1).

We denote by J_Δ the moment of inertia of the physical pendulum about the axis (Δ) and L the distance separating G of the axis (Δ).

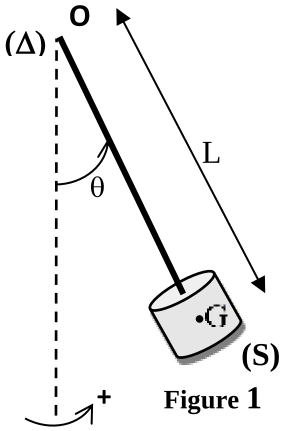


Figure 1

Given :

- $g = 9{,}8 m.s^{-2}$; $m = 400g$; $L=50cm$; $\pi^2=10$
- For small angles, we take: $\sin\theta \simeq \theta$ and $\cos\theta \simeq 1-\frac{\theta^2}{2}$ where θ expressed in radian.
- Assuming the gravitational potential energy of the pendulum to be zero $(E_{pp} = 0)$ on the horizontal plane passes through G at the rest position (reference level), and the frictions are negligible, and we neglect all frictions.

We move the pendulum from its rest position, in the positive direction, with a small angle θ_m, and then we liberate it without initial velocity at an instant $t = 0$.

We locate the position of the pendulum at one instant of time by the angular displacement θ (figure1).

The experimental study as well as the processing of the data with appropriate software, allowed obtaining the curve representing the evolution of the angular displacement θ as a function of time (figure 2).

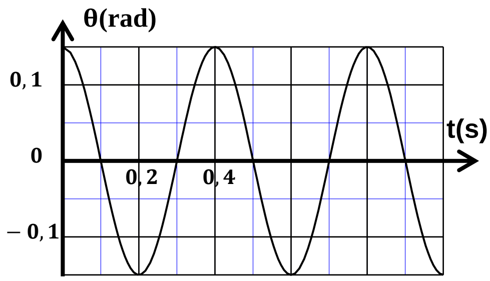


Figure 2

1- By applying the fundamental relationship of dynamics in the case of the rotation, establish the differential equation verified by the angular displacement θ . **(0,5 pt)**

2- Determiner the expression of the natural period T_0 of the pendulum in terms of m , g , L and J_Δ knowing that $\theta(t)=\theta_m.\cos(\frac{2\pi}{T_0}.t)$ is the solution of the differential equation. **(0,5 pt)**

3- Determine the value of J_Δ . **(0,25 pt)**

4- Compute the value of the linear velocity v_G and the acceleration a_G of the center G when passing through the rest position. **(0,5 pt)**

5- Determine the expression of the kinetic energy of the oscillator in terms of θ , θ_m , L , g and m . Deduce its value when the oscillator passes through its rest position. **(0,75 pt)**

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الامتحان الوطني الموحد للبكالوريا

المسالك الدولية

الدورة الاستدراكية 2024

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

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عناصر الإجابة

RR 30E

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

Exercise 1 : chemistry (7points)

	Question	Answers	Marking scale	Question reference in the framework
Part 1	**1-1**	Equation of the reaction	**0,25**	- Write the equation of the acid-base reaction and identify the two pairs involved. - Calculate the final progress of the reaction that occurs between an acid and water taking into consideration the value of both the concentration and this acid's pH aqueous solution; then, compare it with the maximum progress. - Define the final progress rate of a reaction, and determine it using experimental data. - Write and use the expression of the acid dissociation constant K_A associated with the reaction of an acid with water. - Write the equation of titration reaction (use only one arrow). - Determine the equilibrium constant associated to the equation of acid-base reaction using the acid dissociation constants of existing pairs. . - Know that, for a given transformation, the final progress rate depends on the equilibrium constant and the initial state of the chemical system - Exploit the curve or the results of the titration - Determine and exploit the point of equivalence. - Justify the choice of a suitable indicator to determine the equivalence.
	1-2	$\tau \simeq 3,98\%$, The reaction is non complete	**0,25**	
	1-3	Method $pK_A \simeq 4,8$	**0,5** **0,25**	
	2-1	Equation of the reaction with one arrow	**0,25**	
	2-2-1/a	Method Verification	**0,25** **0,25**	
	2-2-1/b	Method $\tau \simeq 1$ reaction is complete	**0,5** **0,25** **0,25**	
	2-2-2	Verification	**0,25**	
	2-2-3	Method, $Ve \simeq 30mL$	**0,25** **0,25**	
	2-2-4	Cresol red, Yellow color	**0,25** **0,25**	
Part 2	**1**	Two half-equations of the reaction	**0,25** **0,25**	-Write the equation of the reaction associated with a redox (oxidation-reduction) transformation, and identify the two pairs involved - Exploit the different curves of time-evolution of the following: the amount of substance of a chemical specie, its concentration, the progress of a reaction, conductivity, conductance, pressure and volume - Draw the progress table of a reaction and exploit it - Know the expression of the volume rate of reaction. -Determine graphically the value of the volumetric rate of reaction. - Define the half-life $t_{1/2}$ of a chemical reaction.. -Determine the half-life of the chemical reaction graphically or through exploiting the experimental results
	2	$x_{max} = 6.10^{-4} mol$	**0,25**	
	3	Demonstration	**0,5**	
	4	$v(t) = \frac{1}{V_0} . \frac{V-V_0}{R.T} . \frac{dP_{O_2}}{dt}$ $v(t) = 2,15.10^{-3} mol.L^{-1}.min^{-1}$	**0,5** **0,25**	
	5	Method $t_{1/2} = 9min$	**0,5** **0,25**	

Exercise 2 : Waves + Nuclear transformations (4 points)

	Question	Answers	Marking scale	Question reference in the framework
Part 1	**1-1**	$\lambda_1 = 1cm$	**0,5**	- Exploit the relationship between time delay, distance and wave speed; - Know (Recall) and use the relationship $\lambda = v.T$. - Know the condition to have the diffraction phenomenon: aperture/slit length is less or equal wavelength. - Define a dispersive medium.
	1-2	Verification	**0,25**	
	2	Circular waves. Diffraction Phenomena	**0,25** **0,25**	
	3-1	Method $V_2 = 0{,}24 m.s^{-1}$	**0, 5** **0.25**	
	3-2	Dispersive medium, V depends of N .	**0,25** **0,25**	
Part 2	**1**	Equation of disintegration. α - decay	**0,25**	- Know and exploit the two laws of conservation. -Define the radioactivity α , β^+ , β^- and γ radiation . -Write the equation of a nuclear reaction by applying the two conservation laws. - Recognize the type of radioactivity using the equation of a nuclear reaction. - Define the time constant τ and the half time $t_{1/2}$ - Calculate the energy released (produced) by a nuclear reaction: : $E_{pro} = \|\Delta E\|$. -Know and exploit the law of the radioactive decay, and exploit its curve.
	2	$\|\Delta E\| = 5{,}5703\, MeV$.	**0,25**	
	3-1	$a_0 = 8{,}23.10^{10} Bq$	**0,5**	
	3-2	$\Delta t = 45{,}22 an$	**0,5**	

<table>
<tr><th colspan="4">Exercise 3 : Electricity (4 points)</th></tr>
<tr><th>Question</th><th>Answers</th><th>Marking scale</th><th>Question reference in the framework</th></tr>
<tr><td>1-1</td><td>$u_C = U_0 + \frac{I.t}{C}$</td><td>0,25</td><td rowspan="11">- Know and exploit the relationship $i=\frac{dq}{dt}$ for a capacitor in receiver convention.
- Know and exploit the relationship q = C.u.
- Determine the capacitance of a capacitor graphically or by calculation.
-Find out the expression of the electric energy stored in a capacitor.
- Know and exploit the expression of the electric energy stored in a capacitor.
- Find out the differential equation and verify its solution when the RL dipole is submitted to a step voltage.
- Know and exploit the voltage expressio $u_L=r.i+L.\frac{di}{dt}$ between the inductor (coil) terminals using the receiver convention.
-Exploit experimental documents in order to determine the time-constant
- Know and exploit the time-constant expression.
- Recognize the electric resonance phenomenon and its characteristics.

-Know and exploit the impedance expression $Z=\frac{U}{I}$ of a circuit.
- Exploit experimental documents in order to determine the width of the passband.

- Know and exploit the quality factor expression $Q=\frac{N_\circ}{\Delta N}$</td></tr>
<tr><td>1-2</td><td>$C = 4\mu F$
$U_0 = 4V$.</td><td>0,25
0,25</td></tr>
<tr><td>1-3</td><td>$Ee(t_1) = 0,39mJ$</td><td>0,25</td></tr>
<tr><td>2-1</td><td>$\tau = \frac{L}{R+r}$
$\beta = \frac{E.R}{L}$</td><td>0,25
0,25</td></tr>
<tr><td>2-2</td><td>$A = \frac{E.R}{R+r}$</td><td>0,5</td></tr>
<tr><td>2-3</td><td>Demonstration</td><td>0,5</td></tr>
<tr><td>2-4</td><td>Demonstration
Demonstration</td><td>0,25
0,25</td></tr>
<tr><td>3-1</td><td>Demonstration</td><td>0,25</td></tr>
<tr><td>3-2</td><td>Demonstration</td><td>0,25</td></tr>
<tr><td>3-3</td><td>$\Delta N \simeq 620Hz$
$Q \simeq 1,3$</td><td>0,25
0,25</td></tr>
</table>

Exercise 4 : Mechanics (5 points)				
	Question	**Question reference in the framework**	**Marking scale**	**Answers**
Part 1	**1-1**	$F \rangle P$ - The motion is in the positive direction	**0,25** **0,25**	- Know and exploit the two models of frictional fluids (viscous forces): : $\vec{F}=-k.v.\vec{i}$ and $\vec{F}=-k.v^2.\vec{i}$. - Apply Newton's second law to determine the kinetic quantities G v and G a and dynamic quantities and exploit them. - Exploit the curve $v_G=f(t)$ to determine the terminal speed v_l ; - Apply Newton's second law to find out the differential equation of a solid's centre of inertia motion in vertical free fall and solve it. - Know and exploit the characteristics of the uniformly accelerated straight line motion and its parametric equations (t is the parameter).
	1-2	-Demonstration	**0,5**	
	1-3	$V_\ell = 4,88 m.s^{-1}$ $\eta = 6,13.10^{-2} (S.I)$	**0,25** **0,25**	
	1-4	$v = 2,8 m.s^{-1}$	**0,5**	
	2	$h_m = 40cm$	**0,5**	
Part 2	**1**	$\ddot{\theta} + \frac{m.g.L}{J_\Delta}.\theta = 0$	**0,5**	- Apply the fundamental relationship of dynamics, in the case of rotation, on a physical pendulum to establish the differential equation of the motion with the small oscillation amplitude in the negligible friction case. - Establish the expression of the natural period for the physical pendulum. -Know and exploit the expression of the natural period and the natural frequency for the physical pendulum in the small oscillation amplitude case. - Exploit the diagrams $\theta(t)$, $\dot{\theta}(t)$ and $\ddot{\theta}(t)$ to determine the characterizing quantities of the torsional pendulum motion. . - Exploit the expression of the gravitational potential energy and the expression of the kinetic energy to determine the mechanical energy of the physical pendulum in the small oscillations case.
	2	Method $T_0 = 2\pi\sqrt{\frac{J_\Delta}{m.g.L}}$	**0,25** **0,25**	
	3	$J_\Delta = 7,84.10^{-3} kg.m^2$	**0,25**	
	4	$v_G = 1,178 m.s^{-1}$ $a_G = 2,775 m.s^{-2}$	**0,25** **0,25**	
	5	$Ec = \frac{1}{2} m.g.L(\theta_m^2 - \theta^2)$ $Ec = 0,022J$	**0,5** **0,25**	