الامتحان الوطني الموحد للبكالوريا
المسالك الدولية
الدورة العادية 2021
- الموضوع -

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

4h	مدة الإنجاز	الفيزياء والكيمياء	المادة
7	المعامل	شعبة العلوم الرياضية (أ) و (ب) (خيار إنجليزية)	الشعبةأو 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 depending on the choice of the candidate.*

The exam paper contains five exercises; one in Chemistry and four in Physics.

Exercise 1 : Chemistry (7points)

-Part I:*About a formic acid*

-Part II: *lead-iron electrochemical cell*

Exercise 2 : Waves (2 points)

-Verification of the purity of oil

Exercise 3 :Nuclear transformations (1,5points)

-Stability of nuclei – fission reaction

Exercise 4 : Electricity (5 points)

- Charging of a capacitor and its discharging through an inductor

- Amplitude modulation and demodulation of an electromagnetic wave

Exercise 5: Mechanics (4,5 points)

-Part I :*Motion of a sled*

-Part II :*Motion of a beam of protons in a uniform electrostatic field*

Exercise 1 : Chemistry (7points)

Part I and part II are independent

Part I: About a formic acid

The simplest carboxylic acid is the methanoic or formic acid HCOOH. In nature, it's found in nettles and in the venom of several insects such as bees and ants.

When an ant stings, it injects, with each bite, about $V_i = 6,00.10^{-3} cm^3$ *of a solution* S_1, which represents the majority of the total of stinging solution available in the abdomen of a "typical ant". The volume of methanoic acid contained in the solution S_1 represents 50 % of V_i.

Given :- Density of methanoic acid : $\rho = 1,22 g.cm^{-3}$;

- Molar mass: $M(HCOOH) = 46,0 g.mol^{-1}$; $M(NaHCO_3) = 84,0 g.mol^{-1}$;
- Pairs acid/base: $(CO_2, H_2O)_{(aq)} / HCO^-_{3(aq)}$; $HCOOH_{(aq)} / HCOO^-_{(aq)}$.

1- Show that the amount of the methanoic acid that a typical ant injects with each bite is $n_i \simeq 7,96.10^{-2}$ mmol .**(0,5pt)**

2- The sodium hydrogen carbonate $HCO^-_{3(aq)} + Na^+_{(aq)}$ is often used to treat the bites of ants.

2-1- Write the equation of the reaction between the sodium hydrogen carbonate and the methanoic acid (this reaction is assumed as complete).**(0,5pt)**

2-2- Determine the mass of the sodium hydrogen carbonate needed to completely neutralize the bite of this ant.**(0,75pt)**

3- Once the solution is injected, it dilutes in the water of the body to produce an aqueous solution of methanoic acid S_2 . We consider that the solution injected dissolves immediately in 1,00 mL of the water of the body. We neglect the volume of methanoic acid in the calculation.

The pH of the solution S_2 is $pH = 2,43$.

3-1- Determine the percentage of the reacted molecules of methanoic acid in the solution S_2 . Then write the equation of the reaction of methanoic acid with water.**(0,5pt)**

3-2-Show that the pK_A of the pair $HCOOH_{(aq)} / HCOO^-_{(aq)}$ is $pK_A \simeq 3,74$.**(0,5pt)**

4- We prepare an aqueous solution S_3 of methanoic acid of the same molar concentration as the solution S_2 .

4-1- We add 50,0 mL of distilled water to 25,0 mL of the solution S_3 .

Find out the value of the pH of the obtained solution.**(0,5pt)**

4-2- We add 7,50 mL of an aqueous solution of sodium hydroxide $Na^+_{(aq)} + HO^-_{(aq)}$ of molar concentration $C_b = 0,1 mol.L^{-1}$ to 10,0 mL of the solution S_3 .

4-2-1- Write the equation of the reaction that occurs.**(0,5pt)**

4-2-2- Determine the value of the pH of the reaction mixture.**(0,75pt)**

Part II: Study of the electrochemical cell of lead-iron

We study the lead-iron electrochemical cell, which involves the two ox/red pairs: $Pb^{2+}_{(aq)} / Pb_{(s)}$ and $Fe^{2+}_{(aq)} / Fe_{(s)}$

We constitute it of two half-cells connected with a salt bridge.

The first half-cell consists of a blade of lead immersed in a volume $V=100\ mL$ of an aqueous solution of lead nitrate $Pb^{2+}_{(aq)} + 2NO^{-}_{3(aq)}$ of initial molar concentration $\left[Pb^{2+}_{(aq)}\right]_i = 1,0.10^{-3}\ mol.L^{-1}$.

The second half-cell consists of a blade of iron immersed in a volume $V=100\ mL$ of an aqueous solution of iron (II) chloride $Fe^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$ of initial molar concentration $\left[Fe^{2+}_{(aq)}\right]_i = 4,0.10^{-2}\ mol.L^{-1}$.

The immersed part of the blade of iron in the solution is in excess.

Given :

- The faraday constant: $1F = 9,65.10^4\ C.mol^{-1}$;
- Molar mass of lead: $M(Pb) = 207\ g.mol^{-1}$.

We mount in series with the electrochemical cell a conductor (D), an ammeter (A) and a switch K.

At an instant of date $t_0 = 0$, we close the circuit; the ammeter indicates the flow of an electric current of intensity I_0 considered as constant.

We neglect the oxidation of the ions $Fe^{2+}_{(aq)}$ by the dioxygen dissolved in water.

During the functioning of the electrochemical cell, the mass of the blade of lead is increased by $2,07\ mg$ after a period of operation $\Delta t = t_1 - t_0$.

1-Give the number of the false statements among the following statements: **(0,5pt)**

a- The reduction occurs at the electrode of iron.

b- The oxidation occurs at the electrode of lead.

c- The blade of iron represents the cathode and it is the negative pole of the electrochemical cell.

d- The blade of lead represents the anode and it is the negative pole of the electrochemical cell.

2-Write the overall equation during the functioning of the electrochemical cell.**(0,5 pt)**

3- Determine at the instant t_1 the reaction quotient during the functioning of the electrochemical cell.**(0,75 pt)**

4-Knowing that the intensity of the current is $I_0 = 2\ mA$,find out the value of the instant t_1 .**(0,75 pt)**

***Exercise 2 : Waves (2 points)*: Verification of the purity of oil**

The speed of sound in a vegetable oil depends on its purity. The value of the speed V_h of sound in a pure oil of olive is between $1595\ m.s^{-1}$ and $1600\ m.s^{-1}$.

To test an oil of olive in the laboratory, we use the mounting in figure 1, which allows comparing the times of travel of the ultrasonic wave in different mediums.

The emitter E of the ultrasounds simultaneously generates two bursts of waves. Receivers A and B are linked to an acquisition interface which starts the recording of signals once the receiver B detects the ultrasounds. The oil under test is placed in a tube of glass between emitter E and receiver B, while air separates emitter E from receiver A(figure 1).

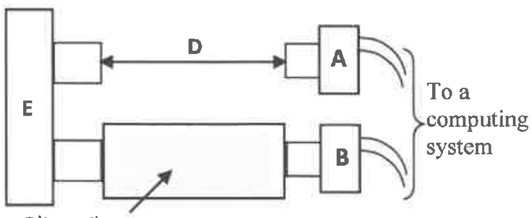

Figure 1

For each value D of the length of the tube we measure, through a computing system, the time Δt elapsed between the two signals received at A and B.

From these measurements we obtain the curve in figure 2 representing the variations of Δt in function of D: $\Delta t = f(D)$.

1- Are the ultrasonic waves longitudinal or transversal waves? Justify. **(0,5pt)**

2 - The ultrasounds used in the previous experiment have a frequency of 40 kHz. Their speed in the air is $V_a = 340\,m.s^{-1}$.
Calculate the distance traveled by those ultrasounds in the air during a period. **(0,5pt)**

3- Find out the Expression of Δt in terms of D, V_h and V_a .**(0,5pt)**

4- Is the tested oil pure? Justify.**(0,5pt)**

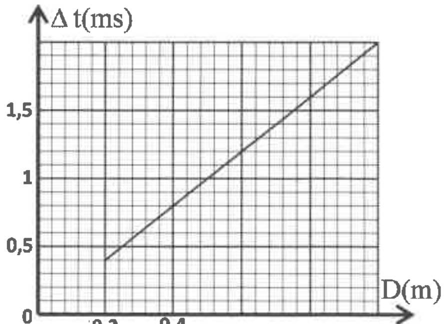

Figure 2

Exercise 3 :Nuclear transformations (1,5points) **:Stability of nuclei – Reaction of fission.**

Given :- Mass of the particles : $m(\alpha)=4,001506\,u$; $m(^{10}_{5}B)=10,012938\,u$; $m(^{A}_{Z}Li)=7,016005\,u$;

- The binding energy of the particle α : $E_\ell = 28,295244\,MeV$; $1u = 931,5\,MeV.c^{-2}$;

-Mass of the neutron: $m_n = 1,008665\,u$;Mass of the proton : $m_p = 1,007276\,u$.

1- A Segré diagram

The figure1 on the right represents the Segré diagram (Z,N) in which the stable nuclei corresponds to the gray boxes in the diagram.
Give the number of correct statements: **(0,5pt)**

a- The instability of a nucleus can be due to the large number of nucleons it contains.

b- The stability of a nucleus can be due to the large number of neutrons compared to the number of protons it contains.

c- The isotopes of the same element $^{A}_{Z}X$ are found on the same line on the Segré diagram (Z,N).

d-The nuclei $^{10}_{5}B$, $^{14}_{6}C$, $^{12}_{5}B$ are radioactive α .

e- The nucleus $^{10}_{5}B$ is stable.

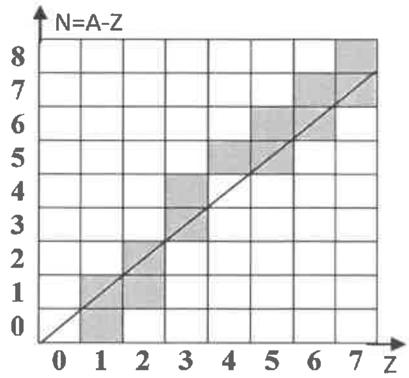

Figure 1

2- Nuclear fission

2-1- Write the equation of the nuclear reaction corresponding to the bombardment of boron nucleus $^{10}_{5}B$ by a neutron to form an α particle and a lithium nucleus $^{A}_{Z}Li$, determine Z and A.**(0,25pt)**

2-2- Compare the stability of the α particle and that of the $^{A}_{Z}Li$.**(0,5pt)**

2-3- Calculate, in MeV unit, the energy $|\Delta E|$ released by the fission of one nucleus of boron 10.**(0,25pt)**

Exercise 4 :Electricity (5 points)

This exercise aims to study:
-The charge of a capacitor and its discharge through an inductor
- The amplitude modulation and demodulation of an electromagnetic wave

1-Charge of a capacitor and its discharge through an inductor

We perform the mounting shown in figure 1. This mounting consists of:

-An ideal generator of current;
-A capacitor of variable capacitance C, without initial charge;
-An inductor (b) of inductance $L=8,6\,mH$ and of resistance $r=12\,\Omega$;
- A microammeter;
- A switch K.

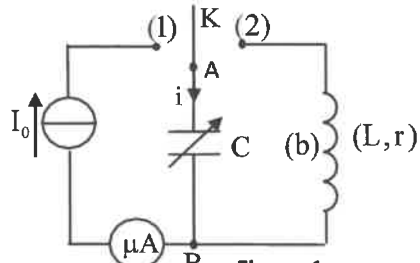

Figure 1

We adjust the capacitance of the capacitor to a value C_0.
We place the switch K in position (1) at an instant of date $t=0$. The microammeter indicates $I_0=10\,\mu A$. A suitable computing system allowed obtaining the graph in figure 2 representing $\sqrt{E_e}=f(t)$ with E_e being the electric energy stored in the capacitor at an instant t.

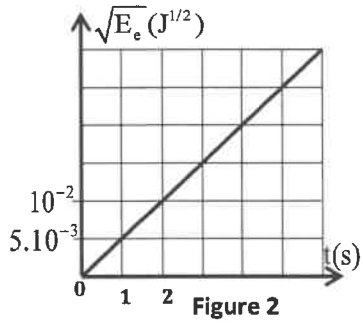

Figure 2

1-1- Give the expression of the energy stored in the capacitor in terms of its charge q and its capacitance C_0.**(0,25pt)**

1-2-Show that $C_0=2\,\mu F$.**(0,75pt)**

1-3- When the voltage between the terminals of the capacitor takes the value $u_{AB}=40\,V$, we switch the switch K to the position (2) at an instant chosen as new origin of dates $(t=0)$. A suitable device allows to visualize the curves giving the variations during the time of the intensity of the current $i(t)$ in the circuit (figure 3).

1-3-1- Calculate the energy dissipated by joule effect in the circuit between the instants $t=0$ and $t=t_1$ (figure 3). **(0,75pt)**

1-3-2- Indicate, by justifying, if the capacitor charges or discharges between the instants t_2 and t_3 (figure 3).**(0,5pt)**

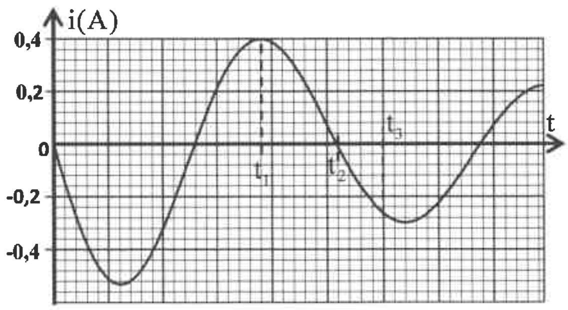

Figure 3

2-Amplitude modulation and demodulation of an electromagnetic wave.

We can transmit information over a great distance, by modulating the amplitude of an electromagnetic wave that propagates from a transmitter to a receiver. The transmitter must ensure the production of the electromagnetic wave and its modulation to carry the informative signal. As for the receiver, it must be designed to demodulate the wave and recover the informative signal, providing the meaning for the user. The amplitude modulation consists in varying the amplitude of the carrier wave during the time according to the temporal evolution of the informative signal to be transmitted.

In order to obtain an amplitude modulated signal, we use an integrated multiplier circuit X (figure 4).
We apply at the input:
- E_1 : The voltage $u_1(t)=s(t)+U_0$ with $s(t)=S_m.\cos(2\pi.f.t)$ representing the informative signal and U_0 is the offset voltage.
- E_2 : a sinusoidal voltage representing the carrier $u_2(t)=U_m.\cos(2\pi.F.t)$.

The output voltage $u_s(t)$ obtained is $u_s(t) = k.u_1(t).u_2(t)$;
k is a constant which depends on the integrated circuit X.
The output voltage $u_s(t)$ thus defined is expressed by :
$u_s(t)=S(t).\cos(2\pi F.t)$ with $S(t)=A\left[1+m\cos(2\pi f.t)\right]$.
In this expression, $S(t)$ is the amplitude of the modulated voltage and m is the modulation index.

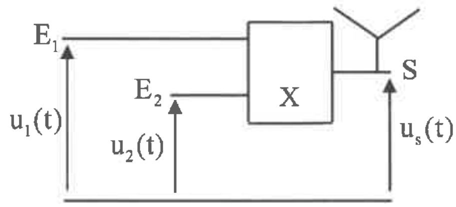

Figure 4

2-1-A suitable device allows to simultaneously visualize two of the voltages $u_1(t)$, $u_2(t)$ and $u_S(t)$. We can thus observe the oscillograms (a) and (b) in figure 5.
Indicate, by justifying, for each of the oscillograms in figure 5, whether it corresponds to the modulating signal, the modulated signal or to the carrier. **(0,5pt)**
2-2- Based on the oscillograms in figure 5, determine :
2-2-1- The frequency of the carrier and that of the informative signal.**(0,5pt)**
2-2-2- The modulation index m. **(0,5pt)**

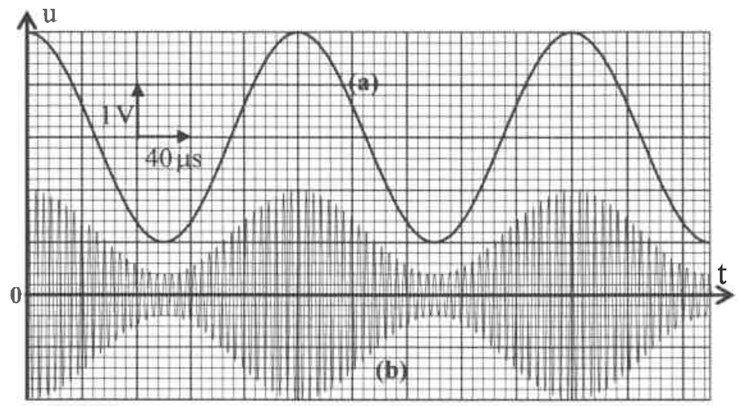

Figure 5

2-3- Demodulation of the wave

Figure 6 schematizes a component of a radio receiver linked to the demodulation circuit. This component is equivalent to the previous inductor (b) of inductance L and resistance r associated with the capacitor of variable capacitance C.
The circuit formed by the inductor (b) and the capacitor is set in forced vibration through the antenna which captures all the waves emitted by all the stations.
To listen to a single transmitter, it suffices to tune the natural frequency of the circuit to the frequency of the transmitter by adjusting the capacitance of the capacitor.
We take: $\pi^2=10$.

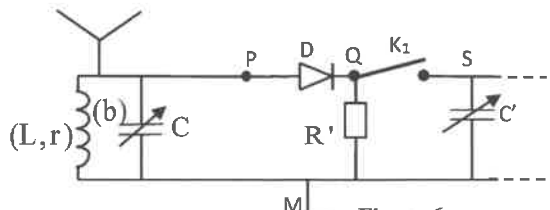

Figure 6

2-3-1- Calculate the value to which we have to adjust the capacitance C of the receiving element so that the natural frequency is $N_0 = 180\,kHz$.**(0,5pt)**
2-3-2- Find out the range of values of the capacitance C' to get a high quality detection envelope knowing that the frequency of transmitted information is $N_i = 5\,kHz$ and $R' = 100\,k\Omega$.**(0,75pt)**

Exercise 5: Mechanics (4,5 points)

Part I and part II are independent

Part I :Motion of a sled

We study the motion of a sled modeled by a solid (S) of center of inertia G and of mass m in two stages of its course:

- **First stage:** Linear motion of (S) on an inclined plan;
- **Second stage:** vertical fall of (S) in water.

Given :- The mass of the sled : $m = 20\,kg$;
-The gravitational field strength: $g = 10\,m.s^{-2}$.

1-First stage: motion of a sled on an inclined plan

We study the motion of the center of inertia G in the frame of reference $(A;\vec{i};\vec{j})$ linked to the Earth assumed Galilean (figure 1).

After the push down stage, the solid (S) reaches a velocity $V_A = 5,0\,m.s^{-1}$ at point A and slides without friction along the linear runway AB at an angle α to the horizontal. The slope is inclined at 20% ($\sin\alpha = 0,20$).

1-1- By Applying Newton's second law determine the value of the acceleration a_{th} of the center of inertia G of (S) .**(0,25pt)**

1-2- The origin of dates ($t = 0$) is chosen at the instant of crossing through point A.
Find out the distance traveled, from point A, when the sled reaches velocity $V_1 = 25\,m.s^{-1}$.**(0,5pt)**

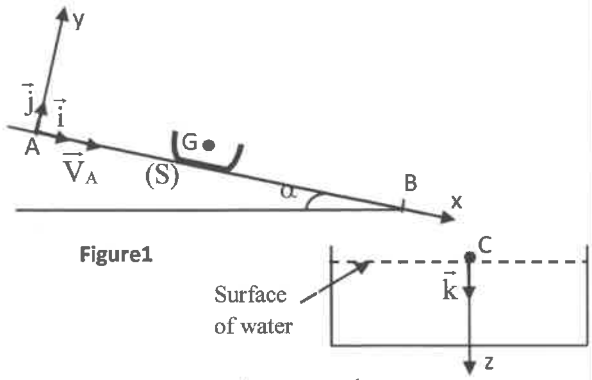

Figure1

1-3- We film the motion of the sled, and then the video is exploited with a suitable software. This allowed tracing the curve representing the variations of the velocity of G in function of time: $V_{exp} = f(t)$ (figure 2).

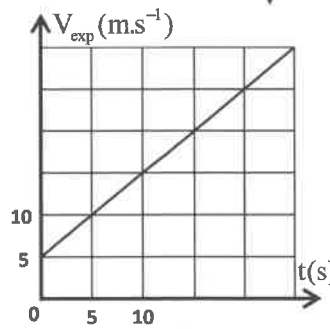

Figure 2

1-3-1-Graphically determine the experimental value a_{exp} of the acceleration of the center of inertia G.**(0,25pt)**

1-3-2- We interpret the difference between a_{th} and a_{exp} by the existence of frictions. Remember that when the contact between the inclined plan and the sled is done with a solid friction; the runway applies on (S) a force $\vec{R}$ having a tangential component $\vec{R}_T$ and a normal component $\vec{R}_N$ .During the motion of (S) , the magnitudes of $\vec{R}_T$ and of $\vec{R}_N$ are related by the relation $R_T = \mu.R_N$, with μ is a constant called the coefficient of friction which depends on the materials in contact and their surface condition.
Find out the expression of μ in terms of a_{th} , a_{exp} ,g and α . Calculate its value. **(0,5pt)**

2- Second stage: Vertical fall of (S) in water

The sled leaves the runway at B and falls into a lake at point C (figure 1).
After stopping for a few moments, the sled begins to sink vertically without initial velocity from point C.
We study the motion of the center of inertia G in the frame of reference $(C,\vec{k})$ linked to the Earth assumed Galilean (figure 1).
We locate the position of G at any instant by the Z coordinate of the vertical axis $(C,\vec{k})$ directed downwards. The origin of dates $(t_0 = 0)$ is taken at point C.

During its fall in water, the sled obeys, in addition to its weight, to a frictional fluid force: $\vec{f} = -k\vec{v}$ where $k = 200\,S.I.$ and $\vec{v}$ is the velocity of G at an instant t.
Note that the upthrust force (Archimedes' force) is negligible.

2-1- Show that the differential equation of the motion of G verified by the velocity v is written as: $\frac{dv_z}{dt}+\frac{1}{\tau}.v_z=\frac{v_\ell}{\tau}$ with $\vec{v}=v_z\vec{k}$. We will give τ and v_ℓ in terms of the parameters of the exercise.**(0,75pt)**

2-2- The solution of the differential equation of the motion of G is written as: $v_z(t)=v_\ell(1-e^{-\frac{t}{\tau}})$.
Find out, at the instant $t=41\tau$, the depth reached by the sled from point C, origin of the coordinate z.**(0,5pt)**

Part II: Motion of a beam of protons in a uniform electrostatic field

This part aims to determine the characteristics of the motion of protons in a uniform electric field.
We assume that the motion of the proton occurs in the vacuum and its weight does not influence the motion.
A plan capacitor consists of two horizontal rectangular parallel metal plates (A) and (B) of length L and separated by a distance d(figure 3).The two plates are supplied by a voltage $U_0=|V_A-V_B|$.Between the two plates there is a uniform electrostatic field $\vec{E}$.

The motion of the proton is studied in an orthonormal frame of reference $R(O,\vec{i},\vec{j},\vec{k})$ linked to the earth assumed Galilean.

A beam of protons enters between the two plates in the point O with the velocity $\vec{V_0}$ at an angle α to $\vec{i}$. We take the instant when the proton passes through O as origin of dates $(t=0)$.
The proton entered in O obeys, during its motion along the distance L, to the electrostatic force $\vec{F}=e\vec{E}$ with e is the charge of the proton.

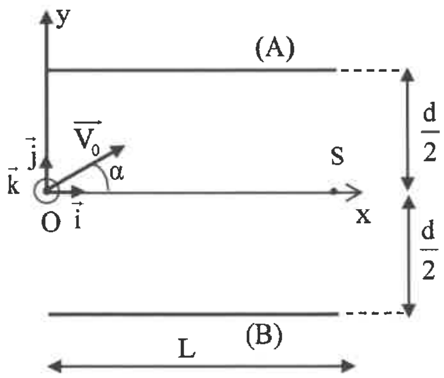

Figure 3

Given:

- $L=20cm$; $d=7cm$; $\alpha=30^0$; $V_0=4,5.10^5\,m.s^{-1}$; $e=1,6.10^{-19}\,C$;
- Mass of the proton : $m_p=1,67.10^{-27}\,kg$.

Remember that: $E=\frac{U_0}{d}$.

The beam of protons leaves the electrostatic field in S of the capacitor.

1- By applying Newton's second law, establish the parametric equations of the motion x(t) and y(t) of the proton in terms of t and the quantities of the exercise. **(0,5pt)**
2-Deduce the equation of the path of the proton. **(0,25pt)**
3- Determine the value of the voltage U_0 in order that the beam comes out effectively in S. **(0,5pt)**
4- Determine at what minimum distance from the upper plate A the beam of protons passes.**(0,5 pt)**

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المسالك الدولية
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- عناصر الإجابة -

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

Exercice1 : Chemistry (7 points)

Question	Element of answers	Scale	Reference of the question in the Reference Framework
Part I 1	Demonstration.	0,5	- Determine the pH for an aqueous solution. - Determine the pH value of aqueous solution based on the molar concentration of ions H_3O^+ or HO^-. -Write the equation of titration reaction (use only one arrow) -Draw the progress table of a reaction and exploit it. -Exploit the curve or the results of the titration.. -Write and use the expression of the acid dissociation constant K_A associated with the reaction of an acid with water. -Know the relationship pK_A= $-\log K_A$ -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. -Know that, the reaction quotient in equilibrium $Q_{r,eq}$, associated to the reaction equation of a chemical system, takes a value independent of concentrations, called equilibrium constant K .
2-1	Equation of the reaction.	0,5	
2-2	$m \simeq 6,69\,mg$.	0,75	
3-1	$\tau \simeq 4,67\%$, Equation of the reaction.	2x0,25	
3-2	Demonstration.	0,5	
4-1	Method ; $pH \simeq 2,68$.	2x0,25	
4-2-1	Equation of the reaction.	0,5	
4-2-2	Method ; $pH \simeq 4,95$.	0,5+0,25	
Part II 1	4 false statements.	0,5	-Determine the direction flow of the charge carriers in a cell using the criterion of spontaneous evolution. -Interpret the functioning of a battery based on: the direction of electric current flow, the electromotive force (emf), the electrode reactions, the polarity of electrodes or the movement of charge carriers. -Write the half-equation that occurred in each electrode (use double arrows) and write the overall equation of the reaction during the battery functioning (use one arrow). -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	The overall equation	0,5	
3	Method ; $Q_r \simeq 44,55$.	0,5+0,25	
4	Method ; $t_1 = 965\,s$.	0,5+0,25	

Exercice 2 : Waves (2 points)

Question	Element of answers	Scale	Reference of the question in the Reference Framework
1	Longitudinal+ justification.	2x0,25	-Define a mechanical wave and its wave speed. -Define a transverse wave and a longitudinal wave. -Exploit the relationship between time delay, distance and wave speed. -Exploit experimental documents and data in order to determine: * distance; * time delay; * wave speed. -Know (Recall) and use the relationship $\lambda = v.T$
2	$\lambda = 8{,}5\,mm$.	0,5	
3	$\Delta t = D\left(\frac{1}{V_a} - \frac{1}{V_h}\right)$.	0,5	
4	The oil is not pure Justification.	0,5	

Exercice 3 : Nuclear transformations (1,5 points)

Question	Element of answers	Scale	Reference of the question in the Reference Framework
1	3.	0,5	-Know the meaning (significance) of the symbol $^A_Z X$ and give the corresponding composition of the nucleus. -Recognise the isotopes of a chemical element. -Recognise the areas of stability and instability of the nuclei on the N-Z diagram. -Exploit the N-Z diagram. -Define and calculate the binding energy per nucleon and exploit it. -Define and calculate the mass defect and the binding energy. -Use different units of mass, energy and the relationships between their units. -Know the relationship of the mass-energy equivalence; and calculate the energy of mass. -Define the fission and fusion. -Know and exploit the two laws of conservation. -Write the equation of a nuclear reaction by applying the two conservation laws. -Calculate the energy released (produced) by a nuclear reaction: $E_{pro} = \lvert\Delta E\rvert$
2-1	Equation of the reaction.	0,25	
2-2	Method ; He is more stable than Li.	2x0,25	
2-3	$\lvert\Delta E\rvert = 3{,}812\,MeV$.	0,25	

Exercice 4 : Electricity (5 points)

Question	Element of answers	Scale	Reference of the question in the Reference Framework
1-1	$E_e = \frac{1}{2}\frac{q^2}{C_0}$	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 and their submultiples $\mu F, nF \text{ and } pF$. -Determine the capacitance of a capacitor graphically or by calculation. -Exploit experimental documents in order to:…. -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. -Know and exploit the voltage expression $u = r.i + L.\frac{di}{dt}$ between the inductor (coil) terminals using the receiver convention. -find out the expression of the electro-magnetic energy stored in an inductor. -Find out the differential equation for the voltage between the capacitor terminals or for its charge $q(t)$ in the negligible damping case and verify its solution. -Know and exploit the expression of the charge $q(t)$ and deduce the current intensity expression $i(t)$ flowing in the circuit and exploit it. -Know and exploit the natural period expression. -Know and exploit the expression of the total energy in the circuit. -Find out the differential equation for the voltage between the capacitor terminals or for its charge $q(t)$ in the damping case.
1-2	Demonstration.	0,75	
1-3-1	$\Delta E_j = \frac{1}{2}Li_1^2 + \frac{1}{2}C_0 r^2 i_1^2 - \frac{1}{2}C_0 U_{AB}^2$ $\Delta E_j \simeq -8,9.10^{-4}$ J .	0,5 0,25	
1-3-2	The capacitor is discharging + justification.	2x0,25	
2-1	(a) : the modulating signal $u_1(t)$; (b) : the modulated $u_s(t)$.	0,25 0,25	-Know that for a transmitting antenna, the electromagnetic wave emitted has the same frequency as that the transmitted electrical signal. -Know the mathematical expression of the sinusoidal voltage. -Know that in the receiving antenna, the electromagnetic wave generates an electric signal that has the same frequency. -Know that the amplitude modulation process is to transform the modulated amplitude voltage to affine function of the modulating voltage. -Recognise the stages of the amplitude modulation. -Exploit the different experimental obtained curves. -Recognise the different stages of amplitude modulation and amplitude demodulation through their corresponding assembly schemes. -Know the role of different used filters. -Know the stages of demodulation. -Know the conditions allowing to get an amplitude modulation and a high quality detection envelope. -Know the selective role of the LC (bung circuit) for the modulated voltage.
2-2-1	$F = 180\,kHz$, $f = 5\,kHz$.	2x0,25	
2-2-2	Method ; $m = \frac{2}{3} \simeq 0,67$	2x0,25	
2-3-1	Method ; $C \simeq 90\,pF$.	2x0,25	
2-3-2	Method ; $0,05\,nF << C' < 2\,nF$.	0,5+0,25	

Exercice 5 : *Mechanics (4,5 points)*

Question	Element of answers	Scale	Reference of the question in the Reference Framework
I- 1-1	$a_{th} = 2\,m.s^{-2}$	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. -Exploit the curve $v_G = f(t)$. -Apply Newton's second law to determine the kinetic quantities $\overrightarrow{v_G}$ and $\overrightarrow{a_G}$ and dynamic quantities and exploit them. -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 find out the differential equation of a solid's centre of inertia motion in frictional vertical fall. -Know and exploit the characteristics of the uniformly accelerated straight line motion and its parametric equations (t is the parameter).
1-2	Method ; $d = 150\,m$.	2x0,25	
1-3-1	$a_{exp} = 1\,m.s^{-2}$.	0,25	
1-3-2	$\mu = \dfrac{a_{th} - a_{exp}}{g.\cos\alpha}$; $\mu \simeq 0,1$.	2x0,25	
2-1	Demonstration ; $\tau = \dfrac{m}{k}$; $v_\ell = \dfrac{m.g}{k}$.	3x0,25	
2-2	Method ; $H \simeq 4\,m$.	2x0,25	
II- 1	$x(t) = V_0.\cos(\alpha).t$ $y(t) = -\dfrac{eU_0}{2d.m_p}t^2 + V_0\sin(\alpha).t$	0,25 0,25	- Know and exploit the relationships $\vec{F} = q\vec{E}$ and $E = \dfrac{U}{d}$ - Apply Newton's second law in the case of charged particleto: * find out the differential equation of motion; * establish the parametric equations of motion and exploit them. * find the equation of the path and exploit it to calculate the electric deflection.
2	$y = -\dfrac{eU_0}{2d.m_p V_0^2 \cos^2\alpha}x^2 + x\tan\alpha$	0,25	
3	$U_0 = \dfrac{d.V_0^2.m_p.\sin 2\alpha}{e.L}$; $U_0 \simeq 640,6\,V$.	0,25 0,25	
4	Method ; $d_{min} \simeq 0,61\,cm$	2x0,25	

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