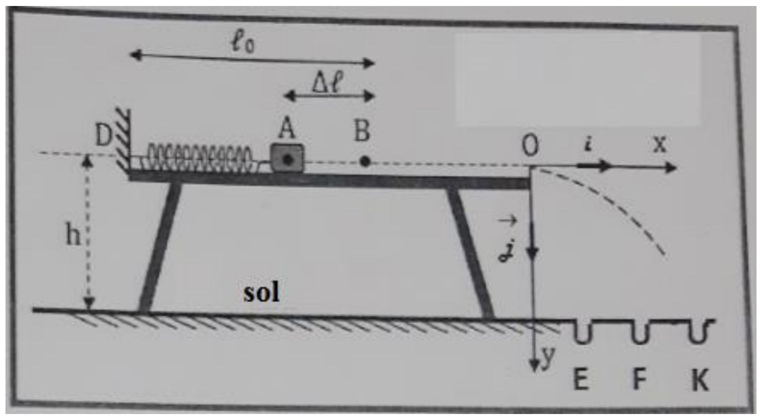
التاريخ - 6 -2023 المدة: 150دقيقة	إمتحان الفصل الاخير مسابقة في مادة الفيزياء	ثانوية انصارالرسمية
الشعبة:....................	الصف: علوم عامة انكليزي	المنسق :محمد فران أستاذ المادة: محمد فران

First exercise **A child's toy**

A spring acts as a launcher, of negligible mass, of length L_0 and of stiffness k=90N/m placed on a horizontal table DO, one of extremity of the spring is fixed to the point D, a particle (S) of mass m=0,4kg is placed at B on the table OD so that (S) is in contact with the free end of the spring (S doesn't attached to the spring)



The purpose of this exercise is to send (S) to one of three overtures E, F and k of respective abscissa :

X_E=0.6m; X_F=1m and X_k=1.4m

To launch S to O we compress the spring by a distance Δl by moving the particle (S) from B to A (see figure) and then released from A without initial velocity. (S) passes through point B with a speed V_B = 3m/s and consequently it leaves the spring and goes towards O. Between B and O the table exerts on (S) a frictional force of supposed constant value parallel to DO.

We neglect air resistance ant take level of the table as a reference level for the GPE.

1- **Motion between A and B. the forces of friction are negligible.**
   - 1-1) Calculate the mechanical energy of the system (S, spring, Earth) at the point B.
   - 1-2) Deduce the value of the compression Δl of the spring.

2- **Motion between B and O.**

   When (S) leaves B, it continues its motion towards O and arrives O with a velocity $\vec{V}_0 = V_0\vec{\imath}$ with V_0=2m/sec.

   - 2-1) Calculate the linear momentum at B P_B and P_O at O.
   - 2-2) The duration of trajectory BO is $\Delta t = 0{,}5\ sec$. Calculate the value of the frictional supposed constant $\vec{f}$ (we can consider $\frac{d\vec{p}}{dt} = \frac{\Delta\vec{p}}{\Delta t}$)
   - 2-3) Deduce the length BO.

3- Motion of (S) between O and the ground

(S) Passes through O at instant t taken as origin of time (t_0=0) with a velocity $\vec{V}_0 = 2\vec{\imath}$

And continues in air without friction in air (without meet any obstacle) until it falls on the ground in one of the overtures.

The altitude of is O h=0,45m above the ground.

3-1) Apply newton's second law show that the linear momentum of (s) during its motion from O and the ground is $\vec{P} = 0{,}8\vec{i} + 4t\vec{j}$.

3-2) Determine the components V_x et V_y of velocity vector $\vec{V}$

3-3) Deduce that $V=\sqrt{4+100t^2}$

3-4) The mechanical energy of the system (S, Earth) is conserved between O and the ground. justify.

3-5) Deduce the speed when S reaches the ground.

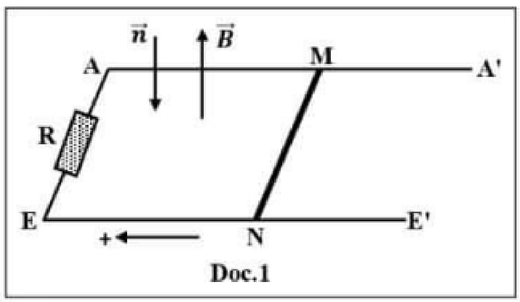
3-6) Determine in which overture (S) fall.

Second exercise phenomenon of induction

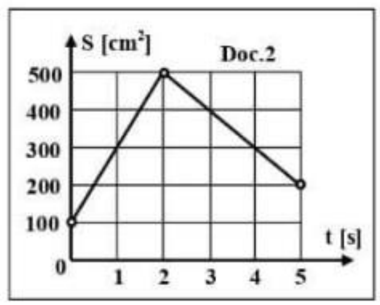
A homogeneous rod of m and of length ℓ=10cm moves without friction with a constant speed $\vec{V}$ along the metallic rails AA' and EE' as shown in the adjacent figure (document 1).

During its motion the rod remains perpendicular to the rails , A resistor of resistance R=10Ω is connected between A and E. the system is placed in a uniform magnetic field $\vec{B}$ of constant value B=0,2 T perpendicular to the plane of the rails we neglect the resistance of the rails and that of the rod.

document 2 represents the variation of the surface AMNE as a function of the time



Doc.1



1- Motion on the horizontal rails

1-1) Determine the expression of the magnetic flux as a function of B and S.

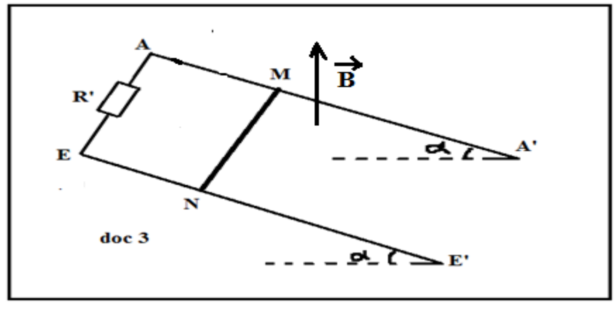
1-2) Explain the existence of the induced current in the loop AMNE, and deduce its expression as a function of B, S and R.

1-3) Calculate the value of i induced for $0 \le t \le 2sec$ and $2 \le t \le 5sec$ deduce its direction in each interval of time .

1-4) Apply Lenz's law in the first interval of time determine the sense of i induced.

2- **Motion on the inclined rails**

The points A and A' are now connected to a wire of resistance de résistance R'=0,2Ω, the resistance of rails and the rod are negligible. The rod enters at $t_0=0$, with the speed V_0, A region of space where there is a uniform magnetic field and vertical of magnitude B=0,6T as shown in document 3. We give $\alpha = 30°$



2-1) Show that the e.m.f induced e that appears in the rod is $|e|$=BLV cosα . V is the speed of the rod at instant t.(we give AM=x)

2-2) Calculate then the value of the induced current as a function of B,L,V and R' that flows in the rod .

2-3) Show that the electromagnetic rod acting on the rod is F=$\frac{B^2L^2V}{R}$cosα

2-4) Apply newton's second law show that the differential equation is :

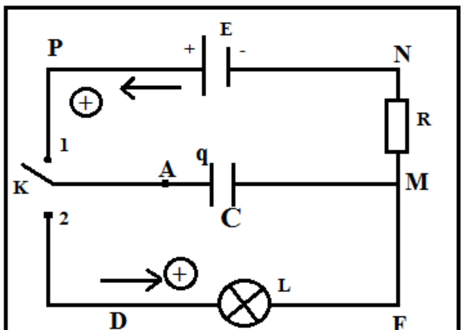
$$\frac{dV}{dt}+\frac{B^2L^2V}{mR\prime}cos^2\alpha = gsin\alpha.$$

2-5) After a certain time the speed of the rod reaches a limiting value and the motion becomes uniform. We give the mass m=20g of the rod .calculate the limiting speed of the rod.

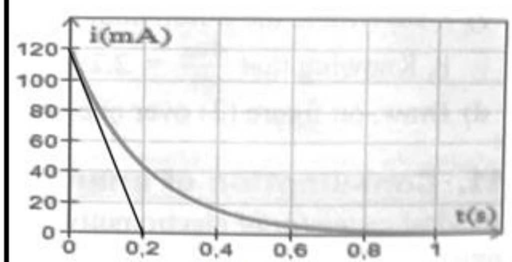
Third exercise **Brightness of the lamp using energy stored in the capacitor**

The circuit of figure 1 contains :

- A capacitor of capacitance C ;
- A generator delivering a DC voltage of value E ;
- A resistor of resistance R=100Ω ;
- Un lamp assimilated to a resistor of resistance r and sensitive to a voltage larger then 3v ;
- Switch K.



Doc 2



Doc 3

Part A

The aim of this part is to determine the value of C.

We connect the switch on 1 at instant t_0= 0

The capacitor is initially neutral.

The figure (doc 3) shows the variation of the intensity i of current as a function of time

1- Name the phase that takes place in the capacitor.

2- Verify that i=c$\frac{du_c}{dt}$.

3- Using the figure 2 show that E=12V

4- show that the differential equation that describes the variation of i is : i+Rc $\frac{di}{dt}$=0.

5- The solution of this equation is

i= a $e^{-\frac{t}{\tau}}$. Determine the expression of a and τ as a function E,R and C.

6- Show that c=2mF(referring to the doc 3) .

7- Calculate the energy stored in the capacitor after one second(end of charging)

Part B

We turn the switch to the point 2 (at $t_0=0$). The capacitor is totally charged (Uc=E). we give C=2mF.

1- Specify the direction of the current in the circuit.

2- Determine the differential equation that describes the variation of U_c.

3- The solution of this equation is $UC=Ee^{-\frac{t}{\tau'}}$ $with\ \tau' = rc$

- Determine the expression of Ln (Uc) as a function of r,C,E and t.

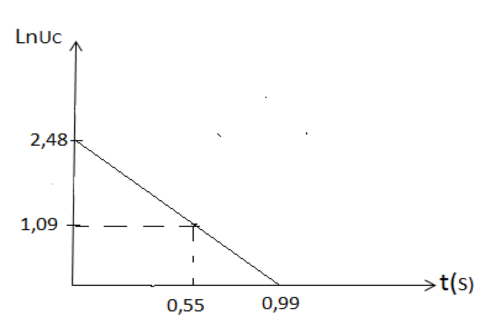
4- The adjacent figure shows the variation of Ln(Uc) as a function of t.

4-1) Show that $r \approx 200\Omega$.

4-2) Deduce the duration of brightness of the lamp

5- Calculate the energy transferred to the lamp

6- Deduce the average power consumed by the lamp.



Fourth exercise : the phenomenon of self -induction

In order to study the effect of the inductance L and the resistance R on the variations du current in the circuit . the setup represented by the adjacent figure (doc 4) contains :

An ideal generator of constant voltage E ;

A coil of inductance L and of a resistance r ;

A resistor of resistance R.

We close k at t=0.

At instant t the circuit carries a current i.

1- Theoretical study

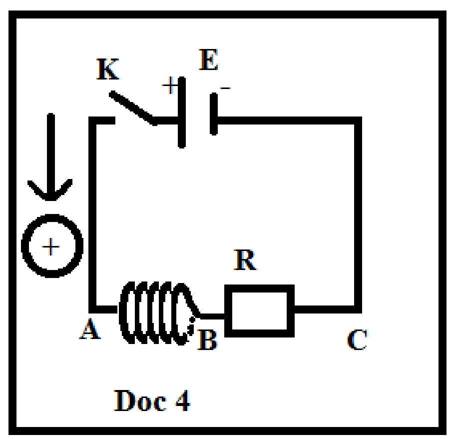
1-1) Derive the differential equation that governs the variation of la variation de i as a function of time.

1-2) The solution of this equation has the form $i= a +b\ e^{-\frac{t}{\tau}}$ with a, b and τ are constant to be determined as a function of E, L, R et r.

1-3) Explain the physical signification of τ.

1-4) Give the expression of minimum duration needed to reach the steady phase.

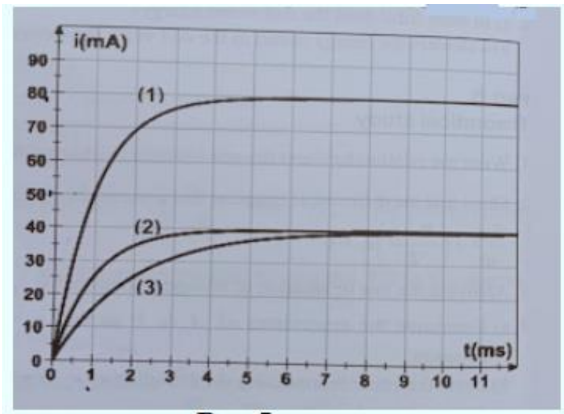
1-5) deduce the expression of the current I_0 in steady state régime.



2- Influence of L and R

We perform three experiments using many couples of resistances and coils listed in the table below :

	1ere expérience	2eme expérience	3eme expérience
L(mH)	100	200	400
R(Ω)	80	180	180



Doc 5

2-1) Specify which physical quantity (τ or I_0) that is not affected by the inductance of the coil.
2-2) Deduce that the curve (1) corresponds to the first experiment .
2-3) Explain why the current I_0 in steady phase is the same in the second and the third experiment.
2-4) Determine the values of (τ) for the curves (2) and (3).
2-5) Justify that the curve (2) corresponds to the second experiment.
2-6) By using the curves (1) and (2) , determine the values of E and of r.