وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات	امتحانات الشهادة الثانوية العامة الفرع : علوم الحياة	الدورة الإستثنائية للعام 2011
	مسابقة في مادة الفيزياء المدة ساعتان	الاسم: الرقم:

This exam is formed of three exercises in three pages.
The use of a non-programmable calculator is allowed

First Exercise (6 ½ points)

Determination of the inductance of a coil

In order to determine the inductance L of a coil of negligible resistance, we connect this coil in series with a resistor of resistance R = 10 Ω across the terminals of a generator G (Fig. 1). The generator G delivers an alternating sinusoidal voltage $u_{AD} = u_G = U_m \cos\omega t$ (u_G in V, t in s).
The circuit thus carries a current i.

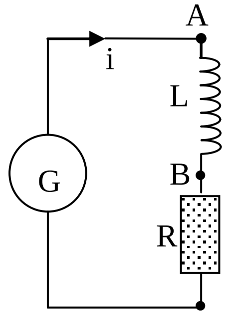


Fig.1

1) Redraw a diagram of figure (1), showing on it the connections of an oscilloscope so as to display the voltage u_G across the terminals of the generator and the voltage $u_R = u_{BD}$ across the terminals of the resistor.

2) Which of these two voltages represents the image of i ?
Justify your answer

3) In figure 2, the waveform (1) represents the variation of u_G as a function of time.
- Horizontal sensitivity: 5 ms/div.
- Vertical sensitivity on both channels: 1 V/div.

a) Specify, with justification, which of the waveforms, (1) or (2), leads the other.

b) Determine:
i. The phase difference between these two waveforms.
ii. The angular frequency ω.
iii. The maximum value U_m of the voltage across G.
iv. The amplitude I_m of i.

c) Write down the expression of i as a function of time t.

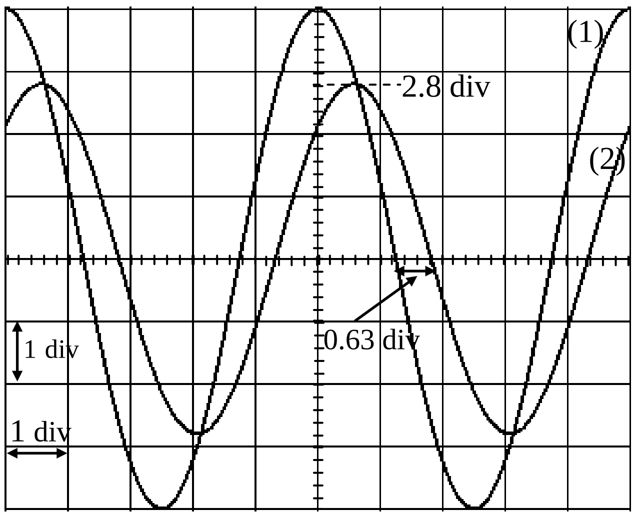


Fig.2

4) Determine the voltage $u_{AB} = u_L$ across the terminals of the coil as a function of L and t.

5) Determine the value of L by applying the law of addition of voltages and by giving t a particular value.

Second Exercise *(7 points)*

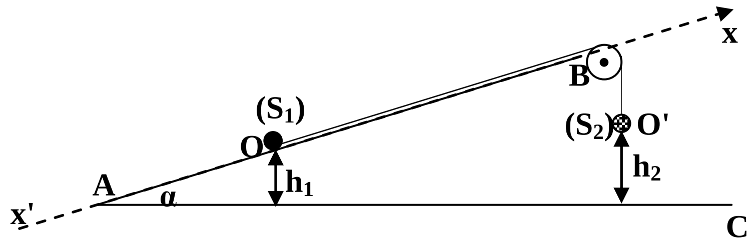
Acceleration of a particle

The object of this exercise is to determine the expression of the magnitude of the acceleration of a particle using two methods. The apparatus used is formed of two particles (S_1) and (S_2) of respective masses m_1 and m_2, fixed at the extremities of an inextensible string passing over the groove of a pulley. (S_1), (S_2), the string and the pulley form a mechanical system (S).

The string and the pulley have negligible mass.

(S_1) may move on the line of greatest slope AB of an inclined plane that makes an angle α with the horizontal AC and (S_2) hangs vertically.

At rest, (S_1) is found at point O at a height h_1 above AC and (S_2) is found at O' at a height h_2 (adjacent figure).



At the instant $t_0 = 0$, we release the system (S) from rest. (S_1) ascends on AB and (S_2) descends vertically.

At an instant t, the position of (S_1) is defined by its abscissa $x = \overline{OS_1}$ on an axis x'Ox confounded with AB, directed from A to B.

Take the horizontal plane containing AC as a gravitational potential energy reference.

Neglect all the forces of friction.

1) Energetic method

a) Write down, at the instant $t_0 = 0$, the expression of the mechanical energy of the system [(S), Earth] in terms of m_1, m_2, h_1, h_2 and g.

b) At the instant t, the abscissa of (S_1) is x and the algebraic value of its velocity is v. Determine, at that instant t, the expression of the mechanical energy of the system [(S), Earth] in terms of m_1, m_2, h_1, h_2, x, v, α and g.

c) Applying the principle of conservation of mechanical energy, show that :

$$v^2 = \frac{2(m_2 - m_1 \sin\alpha)gx}{(m_1 + m_2)}.$$

d) Deduce the expression of the value a of the acceleration of (S_1).

2) Dynamical method

a) Redraw a diagram of the figure and show, on it, the external forces acting on (S_1) and on (S_2). (The tension in the string acting on (S_1) is denoted by $\vec{T}_1$ of magnitude T_1 and that acting on (S_2) is denoted by $\vec{T}_2$ of magnitude T_2).

b) Applying the theorem of the center of mass $\Sigma\vec{F}_{ext} = m\vec{a}$,on each particle, determine the expressions of T_1 and T_2 in terms of m_1 , m_2 , g , α and a .

c) Knowing that $T_1 = T_2$, deduce the expression of a.

Third Exercise *(6 ½ points)*

Provoked Nuclear Reactions

The object of this exercise is to compare the energy liberated per nucleon in a nuclear fission with that liberated in a nuclear fusion.

Given:

Symbol	$^{1}_{0}n$	$^{2}_{1}H$	$^{3}_{1}H$	$^{4}_{2}He$	$^{235}_{92}U$	$^{94}_{Z}Sr$	$^{A}_{54}Xe$
Mass in u	1.00866	2.01355	3.01550	4.0015	234.9942	93.8945	138.8892

1u = 931.5 MeV/c^2

A – Nuclear fission

The fission of uranium 235 is used to produce energy.

1) The fission of one uranium 235 nucleus takes place by bombarding this nucleus by a slow (thermal) neutron of kinetic energy around 0.025 eV .The equation of this reaction is written as :

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{94}_{Z}Sr + ^{A}_{54}Xe + 3^{1}_{0}n$$

- ***a)*** Calculate A and Z specifying the laws used.
- ***b)*** Show that the energy E liberated by the fission of one uranium nucleus is 179.947 MeV.
- ***c)*** ***i)*** The number of nucleons participating in this reaction is 236. Why?
  ii) Calculate then E_1, the energy liberated per nucleon participating in this fission reaction.

2) Each of the obtained neutrons has an average kinetic energy $E_0 = \frac{E}{100}$.

a) In this case, the obtained neutrons do not, in general, provoke fission. Why?
b) What then should be done in order to obtain a fission reaction?

B – Nuclear fusion

Nowadays, many researches are performed in order to produce energy by nuclear fusion. The most accessible is the reaction between a deuterium nucleus $^{2}_{1}H$ and a tritium nucleus $^{3}_{1}H$.

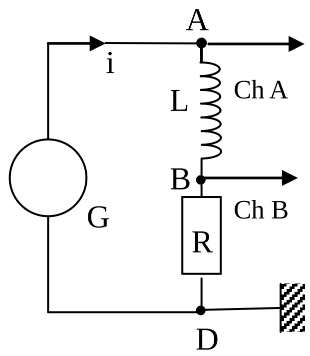
1) The deuterium and the tritium are two isotopes of hydrogen. Write down the symbol of the third isotope of hydrogen.
2) Write down the fusion reaction of a deuterium nucleus with a tritium nucleus knowing that this reaction liberates a neutron and a nucleus $^{A}_{Z}X$. Calculate Z and A and give the name of the nucleus $^{A}_{Z}X$.
3) Show that the energy liberated by this reaction is E' =17.596 MeV.
4) Calculate E'_1 the energy liberated per nucleon participating in this reaction.

C – Conclusion

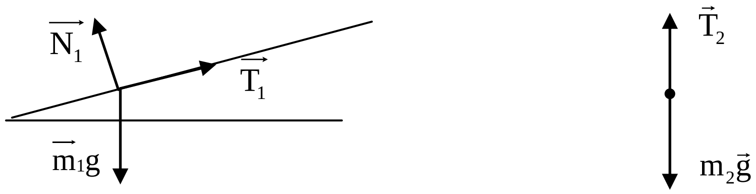
Compare E_1 and E'_1 and conclude.

الدورة الإستثنائية للعام 2011	امتحانات الشهادة الثانوية العامة الفرع : علوم الحياة	وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات
الاسم: الرقم:	مسابقة في مادة الفيزياء المدة ساعتان	مشروع معيار التصحيح

First exercise (6 ½ points)

Part of the Q.	Answer	Mark
1		½
2	$u_R = Ri$, u_R is proportional to i.	½
3-a	u_1 becomes zero before u_2, thus $u_1 = u_G$ leads i ($u_2 = u_R$ represents i).	½
3-b-i	$T \leftrightarrow 5$ div $\leftrightarrow 2\pi$ rad 0.63 div $\leftrightarrow \varphi \Rightarrow \varphi = 2\pi\times\dfrac{0.63}{5} = 0.79$ rd	¾
3-b-ii	T = 5 (div)×5 ms/div = 25 ms $\omega = \dfrac{2\pi}{T} = 251.3$ rad/s	½
3-b-iii	Um = 4 (div)× 1 V/div = 4 V	½
3-b-iv	$U_{Rm} = 2.8\times1 = 2.8$ V $\Rightarrow I_m = \dfrac{U_{Rm}}{R} = \dfrac{2.8}{10} = 0.28$ A	¾
3-c	i lags u_G by 0.79 rad; $i = I_m \cos(\omega t - 0.79)$ $i = 0.28 \cos(80\pi t - 0.79)$	½
4	$u_L = L\dfrac{di}{dt} = -70.37L \sin(80\pi t - 0.79)$	1
5	$u_G = u_R + u_L = Ri + u_L$ $4 \cos(80\pi t) = 2.8 \cos(80\pi t - 0.79) - 70.37L \sin(80\pi t - 0.79)$ For t = 0 ; L = 0.04 H = 40 mH.	1

Second exercise (7 points)

Part of the Q	Answer	Mark
1.a	$M.E = K.E_1 + P.E_{g1} + K.E_2 + P.E_{g2} = 0 + m_1gh_1 + 0 + m_2gh_2$	½
1.b	$M.E = KE_1 + P.E_{g1} + K.E_2 + P.E_{g2}$ $M.E = ½\, m_1v^2 + m_1g\,(h_1 + x\sin\alpha) + ½\, m_2v^2 + m_2g\,(h_2 - x)$	1
1.c	$½\, m_1v^2 + m_1g\,(h_1 + x\sin\alpha) + ½\, m_2v^2 + m_2g\,(h_2 - x) = m_1gh_1 + m_2gh_2$ $\Rightarrow ½\,(m_1 + m_2)\,v^2 = (m_2 - m_1\sin\alpha)\,gx \Rightarrow v^2 = \dfrac{2(m_2 - m_1\sin\alpha)gx}{(m_1 + m_2)}$.	¾
1.d	Derive the expression of v^2 w.r.t time , we get: $2va = \dfrac{2(m_2 - m_1\sin\alpha)g}{(m_1 + m_2)}v \Rightarrow a = \dfrac{(m_2 - m_1\sin\alpha)g}{(m_1 + m_2)}$.	1
A.2.a		1¼
2.b	The relation $\Sigma\vec{F}_{ext} = m_1\vec{a}_1$ applied on S_1 gives: $m_1\vec{g} + \vec{N}_1 + \vec{T}_1 = m_1\vec{a}_1$ ….. (1) Projecting (1) on the axis $\overrightarrow{ox}$ we get : $- m_1g\sin\alpha + T_1 = m_1a_1 \Rightarrow$ $T_1 = m_1g\sin\alpha + m_1a$ (with $a_1 = a_2 = a$). The relation $\Sigma\vec{F}_{ext} = m_2\vec{a}_2$ applied on S_2 gives : $m_2\vec{g} + \vec{T}_2 = m_2\vec{a}_2$ …. (2) Projecting (2) on the vertically downward axis we get: $m_2g - T_2 = m_2a_2 \Rightarrow T_2 = m_2g - m_2a$.	2
2.c	The relation $T_1 = T_2$ gives: $m_1g\sin\alpha + m_1a = m_2g - m_2a$ $\Rightarrow a = \left(\dfrac{m_2 - m_1\sin\alpha}{m_1 + m_2}\right)g$.	½

Third exercise (6 ½ points)

Part of the Q	Answer	Mark
A.1.a	Conservation of nucleons number: 235 + 1 = 94 + A +3 then A = 139 Conservation of charge number: 92 = Z + 54 then Z = 38	**1**
A.1.b	$E = \Delta mc^2$ $= (234.9942+1.00866 - 93.8945 - 138.8892 - 3\times1.00866)\times931.5$ $\Rightarrow$ Energy = 179.947 MeV	**1**
A.1.c.i	We have 235+1 = 236 nucleons	**¼**
A.1.c.ii	$E_1 = \dfrac{179.947}{236} = 0.76$ MeV/nucleon	**¼**
A.2.a	$E_0 = \dfrac{179.947}{100} = 1.79947$ MeV; which is much greater than 0.025 eV	**½**
A.2.b	They should be slowed down,	**¼**
B.1	${}_1^1H$	**¼**
B.2	${}_1^2H + {}_1^3H \rightarrow {}_Z^AX + {}_0^1n$ 2+3 = A + 1 then A = 4 1+1 = Z then Z = 2 The helium nucleus ${}_2^4He$	**1**
B.3	$E' = \Delta mc^2 = (2.01355+3.0155 - 4.0015 - 1.00866)\times 931.5 = 17.596$ MeV	**1**
B.4	We have 2 + 3 = 5 nucleons $\Rightarrow E_1' = \dfrac{17.596}{5} = 3.5912$ MeV/nucleon	**½**
C	E_1' is greater than E_1 ; fusion is more efficient.	**½**