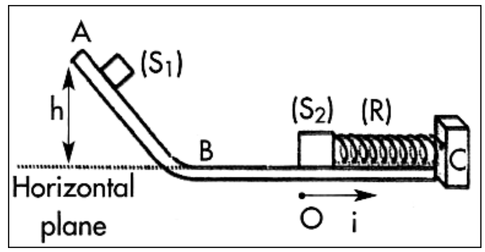
دورة سنة 2003 العادية	امتحانات شهادة الثانوية العامة فرع علوم الحياة	وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات
الاسم : الرقم :	مسابقة في الفيزياء المدة : ساعتان	

This exam is formed of three obligatory exercises in three pages numbered from 1 to 3.
The use of non-programmable calculators is allowed.

<u>First Exercise</u> (6 ½ points) Determination of the force constant of a spring

In order to determine the force constant k of a spring (R) of un-jointed turns, we consider:

- a frictionless track ABC found in a vertical plane,
- a spring (R) having one end fixed to a support C and its other end connected to a solid (S_2) of mass m_2 of negligible dimensions.
- a solid (S_1) of mass $m_1 = 0.1$ kg and of negligible dimensions held at A at height h = 0.8 m above the horizontal plane containing BC.



The horizontal plane containing BC is taken as the gravitational potential energy reference. Take g = 10 m/s^2.

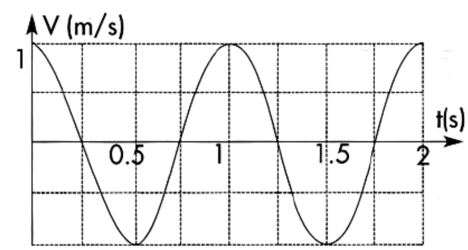
1- (S_1), released from rest at A, reaches (S_2) with a velocity $\vec{V}_1$. Show that the magnitude of $\vec{V}_1$ is $V_1 = 4$ m/s.

2- (S_1), collides with (S_2) and sticks to it, thus forming a particle (S). Determine, in terms of m_2, the expression of V_o the magnitude of the velocity $\vec{V}_o$ of (S) just after the impact.

3- The system [(S), (R)] forms a horizontal elastic pendulum, (S) oscillating around its equilibrium position at O.

a- Determine the differential equation that describes the motion of the oscillator. Deduce the expression of its proper period T_o.

b- Figure (2) represents the variation of the algebraic value of the velocity of (S) as a function of time.
The origin of time corresponds to the instant when the velocity of (S) is $\vec{V}_o$.



i- Give the value V_o of $\vec{V}_o$.
ii- Deduce the value of m_2.
iii- Give the value of T_o.
iv- Calculate k.

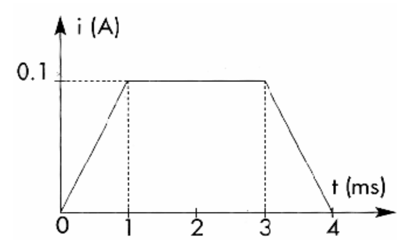
Second Exercise (7 points) Role and characteristics of a coil

Consider a coil (B) that bears the following indications: L = 65 mH and r = 20 Ω.

A- Role of a coil

In order to show the role of a coil, we connect the coil across a generator G_1.

The variation of the current i carried by the coil as a function of time is represented in figure (1).



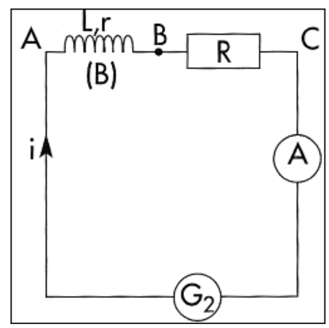
1- a- Give, in terms of L and i, the literal expression of the induced electromotive force e produced across the coil.

b- Determine the value of e in each of the following time intervals: [0; 1ms], [1 ms; 3 ms], [3 ms; 4 ms].

2- In what time interval would the coil act as a generator? Justify your answer.

B- Characteristics of the coil

In order to verify the values of L and r, we perform the two following experiments:



I- **First experiment:** The coil (B), a resistor of resistance R = 20 Ω and an ammeter of negligible resistance are connected in series across a generator (G_2) of electromotive force E = 4 V and of negligible internal resistance (figure 2). After a certain time, the ammeter reads I = 0.1 A. Deduce the value of r.

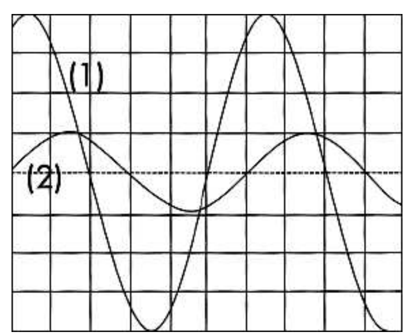
II- **Second experiment:** The ammeter is removed and G_2 is replaced by a generator G_3 delivering an alternating sinusoidal voltage.

1- Redraw figure (2) and show on it the connections of an oscilloscope that allows to display, on the channel (1), the voltage v_g across the generator and, on channel (2), the voltage v_R across the resistor.

2- The voltages displayed on the oscilloscope are represented on figure (3).

Given: vertical sensitivity on both channels: 2 V/division.

horizontal sensitivity: 1 ms/division.



a- The waveform (1) represents v_g. Why?

b- The voltage across the generator has the form: $v_g = V_m \cos\omega t$. Determine U_m and ω.

c- Determine the phase difference φ between v_g and v_R.

d- Determine the expression of the instantaneous current i carried by the circuit.

e- Using the law of addition of voltages at an instant t, and using a particular value of t, deduce the value of the inductance L.

III- Compare the values found for r and L, with those indicated on the coil.

<u>Third exercise</u> (6 ½ points) The two aspects of light

To show evidence of the two aspects of light, we perform the two following experiments:

A- First experiment

We cover a metallic plate by a thin layer of cesium whose threshold wavelength is λ_o = 670 nm. Then we illuminate it with a monochromatic radiation of wavelength in vacuum λ = 480 nm. A convenient apparatus is placed near the plate in order to detect the electrons emitted by the illuminated plate.

1- This emission of electrons by the plate shows evidence of an effect. What is that effect?

2- What does the term "threshold wavelength" represent?

3- Calculate, in J and eV, the extraction energy (work function) of the cesium layer.

4- What is the form of energy carried by an electron emitted by the plate? Give the maximum value of this energy.

Given: Planck's constant: h = 6.6 x 10^{-34} J.s;
speed of light in vacuum: c = 3 x 10^{8} m/s;
1 eV= 1.6 x 10^{-19} J.

B- Second experiment

The two thin slits of Young's apparatus, separated by a distance a, are illuminated with a laser light whose wavelength in vacuum is λ = 480 nm. The distance between the screen of observation and the plane of the slits is D=2m.

1- Draw a diagram of the apparatus and show on it the region of the interference.

2- The conditions to obtain the phenomenon of interference on the screen are satisfied. Why?

3- Due to what is the phenomenon of interference?

4- **a-** Describe the aspect of the region of interference observed on the screen.

b- We count 11 bright fringes. The distance between the centers of the farthest fringes is l = 9.5 mm. What do we call the distance between the centers of two consecutive bright fringes? Calculate its value and deduce the value of a.

C- The two experiments show evidence of two aspects of light. Specify the aspect shown by each experiment.

اسس التصحيح لدورة 2003 العادية		
Question I (07 points)		
1.	Friction being negligible, the mechanical energy of the system [(S_1), Earth] is conserved: $KE_A + GPE_A = KE_O + GPE_O$. Thus, $v_1 = \sqrt{2gh} = \sqrt{2 \times 10 \times 0.8} = 4m/s$	**1**
2.	The linear momentum of the system [$(S_1), (S_2)$] is conserved: $\overrightarrow{v_0} = \frac{m_1}{m_1 + m_2}\overrightarrow{v_1}$	**0.5**
	$\overrightarrow{v_0} = \frac{0.4\vec{i}}{0.1 + m_2}$ where m_2 in kg & v_0 in m/s	**0.5**
3.a)	$ME = \frac{1}{2}(m_1 + m_2)v^2 + \frac{1}{2}kx^2$	**0.5**
	This mechanical energy is conserved because the forces of friction are negligible:	**0.5**
	$\frac{d(ME)}{dt} = 0$; we get: $x'' + \frac{k}{m_1 + m_2}x = 0$	**0.5**
3.b)	The differential equation that governs the motion of the solid (S) is of the form	**0.5**
	$x'' + \omega_0^2 x = 0; \omega_0 = \sqrt{\frac{k}{m_1+m_2}}$	**0.5**
	$T_0 = \frac{2\pi}{\omega_0} = 2\pi\sqrt{\frac{m_1+m_2}{k}}$	**0.5**
4.a)	$v_0 = 1m/s$	**0.5**
4.b)	$v_0 = \frac{0.4}{0.1 + m_2} = 1$, then $m_2 = 0.4kg - 0.1kg = 0.3kg$.	**0.5**
4.c)	$T_0 = 1s$.	**0.25**
4.d)	$T_0 = 2\pi\sqrt{\frac{m_1 + m_2}{k}}$; Then $k = \frac{4\pi^2(m_1 + m_2)}{T_0^2} = 16N/m$	**0.75**

اسس التصحيح لدورة 2003 العادية		
Question II (07 points)		
A-1.a)	$e = -L\dfrac{di}{dt}$	**0.25**
A-1.b)	For $t \in [0; 1ms]$, the current varies linearly; then: $\dfrac{di}{dt} = \dfrac{\Delta i}{\Delta t} = \dfrac{(0.1-0)A}{(1-0)\times 10^{-3}s} = +100A/s$; So, $e = -65\times 10^{-3}\times 100 = -6.5V$ For $t \in [1ms; 3ms]$, $e = 0V$; For $t \in [3ms; 4ms]$, So, $e = -65\times 10^{-3}\times(-100) = +6.5V$	**0.75** **0.25** **0.5**
A-2.	If $t \in [3ms; 4ms]$, the coil acts as a generator since $e = 6.5V > 0$	**0.5**
B-I-1.	$E = rI + RI; 4 = r\times 0.1 + 20\times 0.1$ thus $r = \left(\dfrac{4-2}{0.1}\right) = 20\Omega$	**0.5**
B-II-1.	Diagram	**0.5**
B-II-2.a)	Due to the inductive effect of the coil present in the circuit, the voltage across the generator u_G should lead the current whose image is u_R.	**0.5**
B-II-2.b)	$U_m = S_{v_1}\times y_{1(\max)} = 8V$. The period: $T = S_h \times x = 6ms$; $\omega = \dfrac{2\pi}{T} = \dfrac{1000\,\pi}{3}(\text{rad}/s)$;	**0.5** **0.25** **0.5**
B-II-2.c)	$\lvert\varphi\rvert = 2\pi\times\dfrac{d}{D} = \dfrac{\pi}{3}(\text{rad})$ Then $u_R = 2\cos\left(\dfrac{1000\,\pi t}{3} - \dfrac{\pi}{3}\right)$ Ohm's law: $i = 0.1\cos\left(\dfrac{1000\,\pi t}{3} - \dfrac{\pi}{3}\right)$ (t in s and i in A)	**0.25** **0.25** **0.5**
B-II-2.d)	Law of addition of voltages: $u_G = u_{AB} + u_{BC}$; Let $\dfrac{1000\,\pi t}{3} = 0$, We get $L = \dfrac{6\times 6}{100\pi\sqrt{3}} \approx 0.066H = 66mH$	**1**

اسس التصحيح لدورة 2003 العادية		
Question III (06 points)		
A-1.	The photoelectric effect shows an evidence of corpuscular aspect of light.	**0.25**
A-2.	Definition	**0.5**
A-3.	$W_0 = \frac{hc}{\lambda_0} = 2.96 \times 10^{-19} J = 1.85\ eV$	**0.5**
A-4.	The electron emitted carries kinetic energy. $\lambda < \lambda_0 = 670 nm$, electrons are ejected from the surface of the metal; According to Einstein's relation: $E_{ph} = W_0 + KE_{\max}$. $KE_{\max} = 1.2 \times 10^{-19} J$	**0.25** **0.5**
B-1.	Diagram	**0.5**
B-2.	Same primary source, then coherent sources	**0.5**
B-3.	The interference phenomenon is due to the superposition of two synchronous and coherent beams	**0.5**
B-4.a)	On the screen, in the interference zone, we observe: ✎ a central bright fringe. ✎ alternate, equidistant straight bright and dark fringes	**0.5**
B.4.b)	The distance between the centers of two consecutives bright fringes is called interfringe distance. $i = 0.95 mm$. We have $a = \frac{\lambda D}{i} = 1 mm$	**0.5** **0.25** **0.75**
C	The first experiment (photoelectric emission) shows evidence of the corpuscular aspect of light while the second experiment (interference) shows the wave aspect of light	**0.5**