This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 02

26MAR2025

Do NOT write in this box. Your MARK will be placed here.

Subject :	Physics
Class :	12M
Teacher :	Mr. Ali Moukalled
Duration :	1 hour
You are to answer the questions to this exam on : Squared paper	
Your name :	*Time taken to complete exam*
Your Class :	
Exam Room :	
How many sheets, including cover sheet :	

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

EXERCISE 1 (10 points)

Electromagnetic Induction

A- Variation of a magnetic flux

Consider a stiff conducting square frame ABNM. The surface area of the frame is $\mathbf{S = 0.01m^2}$, its resistance is negligible and it is connected to a resistor of resistance $\mathbf{R = 4\,\Omega}$. The square frame lies in a vertical plane perpendicular to a horizontal magnetic field $\vec{B}$ whose value varies with time according to the law: $\mathbf{B = -20t + 0.3}$ where B is expressed in Tesla, and t in seconds. The field $\vec{B}$ is directed inwards and the positive orientation of the frame is indicated in figure (1).

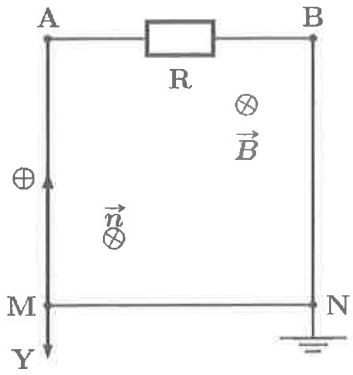


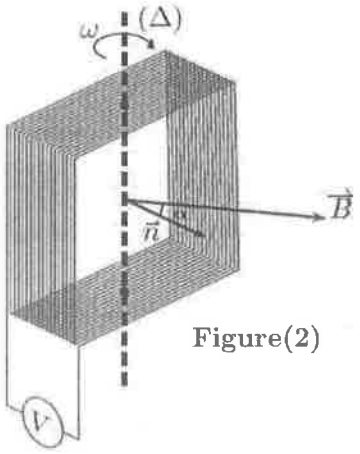
Figure (1)

1. Determine the expression of the magnetic flux ϕ of the magnetic field $\vec{B}$ through the surface of the frame as a function of time.
2. Deduce the value of the induced electromotive force induced in the circuit.
3. Determine the direction of the current induced in the circuit by using Lenz's law, then calculate the value of the induced current.
4. In which sense does the spot on the screen of the oscilloscope move during the variation of $\vec{B}$.

B- Variation of the angle $\alpha = (\vec{B}, \vec{n})$

A conducting frame having a surface area $\mathbf{S = 0.02\,m^2}$, a resistance $\mathbf{R = 10\,\Omega}$, and consisting of $\mathbf{N = 100}$ turns. The frame is placed in a vertical position perpendicular to a horizontal uniform magnetic field $\mathbf{B = 0.3\,T}$. The frame is made to rotate uniformly around a vertical axis (Δ) according to the time equation $\boldsymbol{\alpha = 100\pi t}$ where α is expressed in radians, t in second, and α is the angle between the normal $\vec{n}$ to the plane of the frame and the magnetic field $\vec{B}$. Figure (2).

1. Determine the expression of the magnetic flux ϕ of the magnetic field **B** which traverses the surfaces of the frame.
2. Deduce the algebraic value of the induced electromotive force.
3. Determine the amplitude and the frequency of the induced current.
4. Plot the graph representing the variation of the induced current **i** as a function of time.



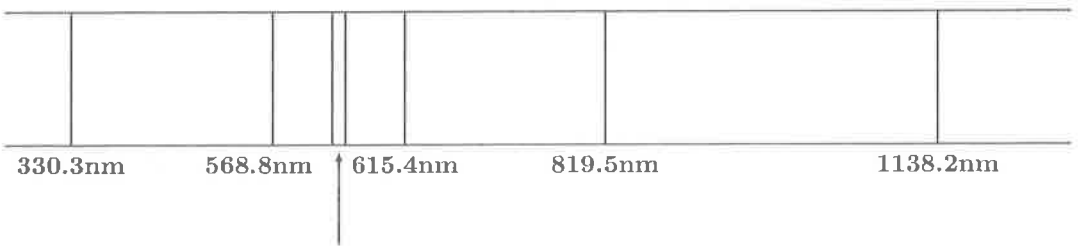
Figure(2)

EXERCISE 2 (10 points)

Sodium Vapor Lamp

Sodium vapor lamps are used to illuminate roads. These lamps contain sodium vapor under very low pressure. This vapor is excited by a beam of electrons that cross the tube containing the vapor. The electrons yield energy to the sodium atoms which give back the received energy during their downward transition towards the ground state in the form of electromagnetic radiations.
Given : $h = 6.62 \times 10^{-34}$J.s ; $c = 3 \times 10^{8}$ms^{-1} ; $e = 1.6 \times 10^{-19}$C ; $1nm = 10^{-9}$m.

1. What do each of the quantities **h, c** and **e** represent ?
2. The analysis of the emission spectrum of a sodium vapor lamp shows the presence of lines of well determined wavelengths **λ**. The figure below represents some of the lines of this spectrum.



Doublet 589 and 589.6nm

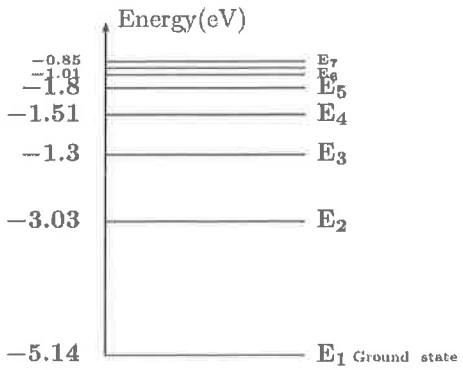
(a) The yellow doublet of wavelengths, in vacuum, $\lambda_1 = 589nm$ and $\lambda_2 = 589.6nm$ is more intense than the other lines.
   i. To what range, visible, infrared or ultraviolet, does each of the other lines of the spectrum belong ?
   ii. The sodium vapor lamps are characterized by the emission of yellow light. Why ?

(b) Is the visible light emitted by the sodium lamp monochromatic or polychromatic ? Justify your answer.

3. (a) Referring to the diagram of the energy levels of the sodium atom in the adjacent figure:

i. Specify an indicator that justifies the discontinuity of the emission spectrum of the sodium vapor lamp.

ii. Verify that the emission of the line of wavelength λ_1 corresponds to the downward transition from the energy level E_2 to the ground state.



(b) In fact, the energy level E_2 is double, that means, it is constituted of two energy levels that are very close to each other. Draw a diagram that shows the preceding downward transition as well as the downward transition corresponding to the emission of the radiation of wavelength λ_2.

4. The sodium atom, being in the ground state,is hit successively by the electrons **(a)** and **(b)** of respective kinetic energies **1.01eV** and **3.03eV**.

   (a) Determine the electron that can interact with the sodium atom.

   (b) Specify the state of the sodium atom after each impact.

   (c) Deduce, after impact, the kinetic energy of the electron that interacts with the sodium atom.

SE02/20242025/Physics/12M/SOLUTION

A. variation of a magnetic flux

$S = 0.01\,m^2$

$R = 4\,\Omega$

$B = -2t + 0.3$

1) $\Phi = NBS\cos(\vec{B}, \vec{n})$

$= 1(-2t + 0.3)(0.01)\cos 0$

$\Phi = -0.2t + 3\times10^{-3}$ (1)

2) Due to Faraday's law

$$e = -\frac{d\Phi}{dt} = -\frac{d}{dt}(-0.2t + 3\times10^{-3})$$

$e = +0.2V$ (1)

3) ~~e<0~~ $e > 0$ $i > 0$ (1) (1)

B is decreasing, so according to Lenz's law

B_{in} is directed inward

so $i > 0$ due to Right hand rule.

4) Upward. (1)

B. variation of the angle $\alpha = (\vec{B}, \vec{n})$

$S = 0.02\ m^2$ $R = 10\ \Omega$ $N = 100$ turns $B = 0.3\ T$

$\alpha = 100\pi t$

1) $\phi = NBS\cos\alpha$

$= 100 \times 0.3 \times 0.02 \cos(100\pi t)$

$= 0.6\cos(100\pi t)$ (1)

2) $e = -\frac{d\phi}{dt} = -\frac{d}{dt}(+0.6\cos(100\pi t))$

$= +0.6(100\pi)\sin(100\pi t)$

$= 60\pi \sin(100\pi t)$ (1)

3) $e = Ri$

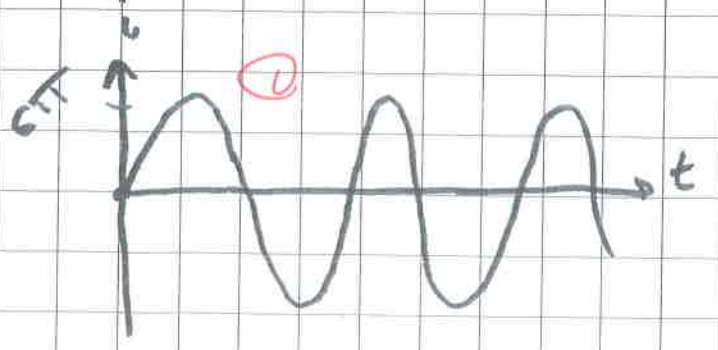
$i = \frac{e}{R} = \frac{60\pi \sin(100\pi t)}{10}$ (1)

$i = 6\pi \sin(100\pi t)$

(1) I_{max} Freq.

4)

t	0					
i	6π					



(1)

Ex2

1) h: Planck's constant
c: speed of light in vacuum
e: elementary charge

2)
a) i) 330.3 nm U.V
568.8nm, 589nm and 615.4nm visible
819.5nm and 1138.2nm IR.

ii) Because this yellow light is much more intense than the others.

b) It is polychromatic because it is made up of several radiations (different frequencies)

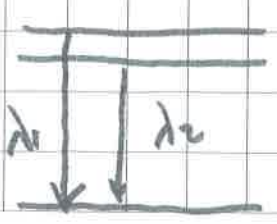
3) a) i) The discontinuity of the emission spectrum is justified by the discontinuous energy levels of the sodium atom.

ii) $E = \frac{hc}{\lambda} = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{589 \times 10^{-9}} = 3.37 \times 10^{-19}\ J$

$= 2.11\ eV$

$E_1 + E = -5.14 + 2.11 = -3.03\ eV$

b)



4) a) $1.01 + (-5.14) = -4.13$ eV, this energy level does not exist $\Rightarrow$ the electron (a) does not interact with the atom.

①

$3.03 + (-5.14) = -2.11$ eV, $-3.03 < -2.11 < -1.93$ eV
$\Rightarrow$ the electron (b) interacts with the atom

b) In case of the electron (a), the atom remains in the ground state.

In case of the electron (b) the atom attains level E_2.

①

c) For the electron (b), K.E $= 3.03 - (3.03 + 5.14)$
$= 0.92$ eV

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