Univercity center Mila **academic year 2025/2026**

Institute of sciences and technologie **module: Structure of matter**

First year Ing/ ST.

Series N° 2

Exercise 01:

The electron package of the cathode tube is deviated under the influence of an electric field E. The deviation of this package (after measuring the amount of deviation Y_S) resulting from the electric field $E = 3{,}6 \cdot 10^4 V/m$ is abolished by the opposite of the magnetic field $B = 9.10^{-4}$ Tesla, which affects in the same electric field vacuum.

1 . Find the expression for the e/m_e ratio of electrons in terms of E, B, L, Ys.
2. determine the speed and kinetic energy of the electrons.
3. What is the value of the voltage accelerator U that can be applied between the cathode and the anode so that the electrons acquire this Kinetic energy?

$e = 1{,}6.10^{-19}$ C, $me = 9{,}1.10^{-31}$ Kg

Exercise 02 :

Using the device used in ***Millikan's*** experiment, we observe the free fall of a spherical oil droplet in the air at a constant speed equal to $v_1 = 3.\ 10^{-4}$ m/s.
1. with negligent the Archimedes thruster. Calculate the radius of this droplet, its size and mass.
In the presence of the electric field E_1, the droplet rises toward the positive pole of the capacitor (upward) at a new speed $V_2 = 15{,}097.\ 10^{-4}$ m/s
2. What is the q_1 charge value that the droplet acquires if you know that the electric field value is $E_1 = 3.106$ v/m.
3. The electric charge of the droplet changes to q_2. the droplet stabilizes between the two capacitor plates, when the value of the electric field $E_2 = 331554.6$ V/m . Calculate the value of the new electric charge q_2.

$g = 9{,}81$ m.s^{-2}, $\rho_h = 900$Kg/m^3, $\eta = 17{,}3.10^{-6}$ Kg.m^{-1}.s^{-1}

Exercise 03:

Inside the mass spectrometer of ***Bainbridge*** observed that element X has 3 isotopes The ions collide with the photographic board at a distance of: 41,50 cm; 45,65 cm and 37 cm from the collision point of the ions $^{12}C^+$ where the inside of the speed filter is applied electric field $E = 5.104$ V.m^{-1}.

1. Calculate the value of the appropriate magnetic field that allows ions with a speed of 2.10^5 m.s^{-1} pass to the filter without deviation.
2. Calculate the magnetic field inside the analyser knowing that the distance between the exit point from the speed filter and the point of collision of $^{12}C^+$ ions is 49.80 cm.
3. Select the X element and its isotopes knowing they are lighter than carbon

$N_A = 6{,}023.10^{23}$; $e = 1.6 .10^{-19}$C

Exercise 04:

Native copper consists of two stable isotopes with their atomic masses respectively: 62,929 and 64,927; the atomic number of copper Z= 29
Find the components of each isotope.
Calculate the abundance of the isotopes if it is known that the molar mass of the two natural isotopes is 63,540.

Exercise 05:

A pure organic compound with the general formula $C_xH_yO_z$ was introduced into the ionization chamber of a Bainbridge spectrometer, producing ions $(C_xH_yO_z)^+$. If these ions are subjected in the velocity filter to the two fields E=4,104v/m and B= 2Tesla with B_0= 0,3Tesla in the analyzer while the radius of the path R= 4.012cm, calculate the molar mass of this compound.

If the weight percentages of the components of this compound are w(H)=10,34% ; W(O)=27,6%; determine the molecular weight formula of this compound (Find each of x, y, z).

We enter the ionization chamber for the same spectrometer as the previous sample of NO_2 which it gave the two ions O_2^+ and N_2^+.

-Calculate the masses and diameters of the resulting beams (m_{O2}^+, m_{N2}^+, D_{O2}^+ , D_{N2}^+) then arrange all the studied ions on the photographic plate.

^{12}C; ^{1}H; ^{16}O; ^{14}N; $N_A = 6{,}023.10^{23}$

Exercise 06:

The nucleus of a nitrogen atom consists of 7 neutrons and 7 protons. Calculate the theoretical mass of this nucleus in units a.m.u.

-Compare it with its actual value of 14.007515 a.m.u. Calculate the binding energy of this nucleus in joules and Mev.

Calculate the atomic mass of natural nitrogen, knowing that:

-Mass N^{14} is 14.007515 a.m.u and its abundance 99.635%

-Mass N^{15} is 15.004863 a.m.u and its abundance 0.365%

$m_p = 1{,}007277$ u.m.a. $\quad m_n = 1{,}008665$ u.m.a.

$m_e = 9{,}109534\ 10^{-31}$ kg

$N = 6{,}023\ 1023$ $\quad R_H = 1{,}097\ 10^7\ m^{-1}$

$h = 6.62\ 10^{-34}$ J.s $\quad c = 3 \times 10^8\ ms^{-1}$