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1^{st} year LMD SM

Exercises Series N°3

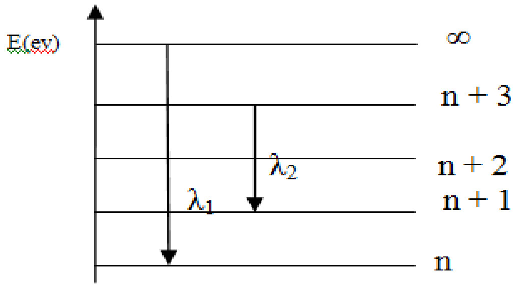
Data : $h = 6{,}62.10^{-34}$ J.s $e = 1{,}6.\ 10^{-19}$C $m = 9{,}1.10^{-31}$ Kg $K = 9.\ 10^{9}$ $R_H = 1{,}097.10^{7}\ m^{-1}$
$C = 3.10^{8}$ m/s $1Å = 10^{-10}$ m $1nm = 10^{-9}$m $1eV = 1{,}6.\ 10^{-19}$j

Exercise 1

1. According to the Bohr model, give the expression for E_n, the total energy of the electron of the hydrogen atom at energy level n.
2. Express E_n as a function of E_1, the energy of the hydrogen atom in the ground state.
3. Calculate E_n at energy levels n= 1, 2, 3, 4, and ∞ for the hydrogen atom.
4. Represent the energy diagram.
5. Calculate the energy absorbed by the hydrogen atom to transition from the ground state to the 1^{st} excited state, 2^{nd} excited state, and the ionized state. If this energy is in the form of light, then calculate the corresponding wavelengths.

Exercise 2

In the emission spectrum of hydrogen, we consider two transitions with respective wavelengths λ_1 and λ_2, represented in the following graph:



1. Determine the value of n, knowing that λ_1 = 3650Å.
2. Calculate the value of the wavelength λ_2.
3. To which series of lines do the two transitions belong?
4. What is the spectral range?

Exercise 3

A) In the emission spectrum of the hydrogen atom, calculate the wavelength λ corresponding to the 5^{th} line of the Lyman series.

B) Calculate the energy required in (eV) to excite the electron of the hydrogen atom from the ground state to the excited level n = 2.

What is the wavelength of the light that this atom must absorb to make this transition?

C) The ionization energy of a hydrogenoid ion is equal to 54.4 eV.

1. Determine its atomic number Z, knowing that the energy of the ground state of the hydrogen atom is equal to $-21{,}76.\ 10^{-19}$ Joules.
2. One of the final lines of the emission spectrum of this hydrogenoid has a wavelength of 2050 Å. Calculate:

a) To which series does this line belong?
b) The wavelength of the first line of this series.

Exercise 4

In the emission spectrum of hydrogen, we consider three lines with wavelengths λ_1, λ_2, and λ_3 such that:

wavelength	λ_1 = 96.67 nm	λ_2 = 484.85 nm	λ_3 = 1091 nm
spectral range			

1. Complete the table.
2. Identify the electronic transitions corresponding to these lines.
3. Represent these transitions in an energy diagram.
4. The hydrogenoid ${}_{Z}X^{b+}$ undergoes the same transition corresponding to λ_2 of hydrogen, knowing that the wavelength of ${}_{Z}X^{b+}$ is $\lambda_Z = 53.87$ nm, determine its atomic number Z and its charge b?
5. Calculate the ionization energy of this hydrogenoid from its ground state.

Exercise 5

During the transition of the electron of a hydrogenoid ion ${}_{Z}X^{b+}$ from the 6^{th} excited state to the 4^{th} excited state, light radiation with a frequency $\upsilon = 2{,}57.10^{14}\ s^{-1}$ is emitted.
1. Determine Z and deduce b.
2. For the same transition, calculate the wavelength λ_H of the hydrogen atom.
3. To which series of lines does it belong?
4. Calculate the wavelength of the first line (λ_{max}) and the final line (λ_{min}) of this series for hydrogen.
5. Calculate the energies in eV corresponding to the three transitions (λ_H, λ_{max}, λ_{min}).