

EXERCISE 1

I. If the hydrogen electron is excited to the level $n = 4$:

- Calculate its energy and the radius of its orbit.
- How many different lines can be emitted upon returning to the ground state?
- Rank the corresponding transitions in order of decreasing wavelength of the emitted photon.

II. In the hydrogen atom, the energy of the electron in its ground state is equal to -13.6 eV . What is the energy in eV of:

- The 2nd line produced in the UV region?
- The limit line of the Balmer series?

III. The frequency of one of the lines of the Paschen series in the spectrum of the hydrogen-like ion He^+ is $1.100 \times 10^{15} \text{ Hz}$. Identify the upper level of the transition. What is the order of this line?

IV. The emission spectrum of the hydrogen atom exhibits a line with a wavelength of **4850 Å**. What is the transition corresponding to this line?

V. Calculate the wavelength in Angstroms (Å) and the frequency of the line with the longest wavelength produced in the visible region and the one with the shortest wavelength produced in the UV region.

VI. In the hydrogen emission spectrum, consider the two transitions represented in the following graph:

The wavelength of the limit line is equal to **820.8 nm**.

- Determine the value of n .
- Calculate the value of the unknown wavelength.

EXERCISE 2 :

In a spectral series of a hydrogen-like ion X^{q+} , the wave number corresponding to the first line is $3.3 \times 10^7 \text{ m}^{-1}$ and the one corresponding to the limit line is $4.4 \times 10^7 \text{ m}^{-1}$.

- Calculate n . Which series is this?
- Calculate the atomic number Z and the charge q of the hydrogen-like ion.
- Calculate the wavelength corresponding to the electron transition from the first excited state to the state $n = \infty$.
- Calculate, using two different methods, the ionization energy of the hydrogen-like ion X^{q+} starting from the first excited state

EXERCISE 3

What is, in Å, the wavelength associated with each of the following systems:

- A ball of mass 2 g and speed 300 km/s
- An electron with kinetic energy $E_c = 54 \text{ eV}$
- A dust grain of mass 10^{-12} g propelled at a speed of 0.1 cm/s

What are the conclusions you can draw from these results?

EXERCISE 4

Calculate the uncertainty on the position for:

1. A one-tonne vehicle traveling at 100 ± 0.001 km/h.
2. The electron of the hydrogen atom on the second Bohr orbit, knowing that the speed is measured to within 1%. Compare the result to the occupied orbit.

Remarks and conclusions?

$$h = 6,62 \cdot 10^{-34} \text{ J.s}, c = 3 \cdot 10^8 \text{ m.s}^{-1}, R_H = 1,09678 \cdot 10^7 \text{ m}^{-1},$$

$$m_e = 9,1 \cdot 10^{-31} \text{ kg}, e = 1,6 \cdot 10^{-19} \text{ C}, v_e = 1,094 \cdot 10^6 \text{ m.s}^{-1}, m_n = 1,76 \cdot 10^{-27} \text{ kg}$$