PCC, Amerinsa, Asinsa, SCAN 1st *October 16th 2020*

CHEMISTRY 1 – Test 1 – Duration: 1 hour

No document allowed. All types of calculators are authorized.

Answers must be justified.

Results will be given with the appropriate number of digits.

The 4 problems are independent.

***Data*:**	
Rydberg's constant related to hydrogen and hydrogen like system: R_H = 109 677.8 cm^{-1}	Speed of light: $c = 2.998\times10^{8}$ $m.s^{-1}$
Planck's constant: $h = 6.626\times10^{-34}$ J.s	Avogadro's number: $N_A = 6.022\times10^{23}$ mol^{-1}
Electron's mass: $m_e = 9.109\ 10^{-31}$ kg	Elementary charge: $e = 1.602\times10^{-19}$ C

Problem 1: Preliminary question (1 pt)

Starting from the relationship between the wavelength (λ), Planck's constant (h), the speed of light (c) and the energy E write down the following formula: $\mathbf{E(eV)} = \frac{12400}{\lambda(\text{Å})}$ (this expression will be used afterwards).

Problem 2: Identification of a hydrogen-like ion (2 pts)

The absorption wavelength of greater energy of this hydrogen-like ion is 25.33 Å.

Determine the atomic number Z of this hydrogen-like ion and compute its ionization energy in eV to within 0.01 eV.

Problem 3: Study of Beryllium (11 pts)

Let's consider Beryllium atom (Z=4)

1) Give the electronic configuration of Beryllium and give the value of the four quantum numbers associated to each electron.

Now we will focus on the hydrogen-like ion formed by Beryllium (Z=4).

2) Give the electronic configuration of this hydrogen-like ion. Determine and justify the expression of energy levels E_n as a function of n. Calculate in eV the value of the 4 lowest energy levels to within 0.01 eV and draw them on an energy diagram.

3) The absorption spectrum of this ion contains a number of lines of wavelength included between two extreme values λ_1 and λ_2. Give the name and compute the value of λ_1 and λ_2 (in Å to within 0.1 Å).
4) Compute the wavelengths (in Å) of the 3 absorption rays of lower energies.
5) Give the ionization energy of Be^{3+}.
6) Draw on the energy diagram all the emission transitions that can be observed when starting from level 4 and calculate their wavelengths (in Å).
7) Specify if these emission lines are in the visible, ultra-violet or infra-red range.

Problem 4: Hydrogen spectroscopy (6 pts)

We consider a hydrogen atom in its fundamental state.

This atom is irradiated with a monochromatic radiation of wavelength λa = 97.25 ±0.01 nm.

We reproduce the experiment a monochromatic radiation of wavelength λb = 101.39 ±0.01 nm.

In a third experiment, this atom is excited by electron of 14.99 ± 0.01 eV energy.

Note that when hydrogen is irradiated by an electron beam with an energy higher than the ionization energy, this excess energy is transferred to the ejected electron as kinetic energy.

Clearly justifying your answers, explain with a Grotrian's diagram the level reached after each of the 3 experiments and the physical phenomenon observed in each case. In case of ionization, specify the speed of the emitted electron.