EC Chemistry 1 – Test 1 - Duration 1h

No document allowed. Any non-connected calculators allowed.
Answers must be justified.
The results will be given with the appropriate number of significant figures.

***Data*:**

Rydberg's constant for hydrogen and hydrogen like ions: R_H = 109 677 cm^{-1}
Planck's constant: $h = 6.626\times10^{-34}$ J.s
Light speed: $c = 2.998\times10^{8}$ $m.s^{-1}$
Elementary charge: $e = 1.602\times10^{-19}$ C
Electron mass: $m = 9.10939\times10^{-31}$ kg

Slater's model**:** Atomic radius: $r \propto \frac{n^2}{Z^*}$ with Z*=Z – σ σ: screening constant

Orbital of the electron	*n'*<*n*-1	*n'*=*n*-1	*n'*=*n*	*n'*>*n*
1s	-	-	0.30	0
ns,np	1.00	0.85	0.35	0
nd	1.00	1.00	1.00 for *s* and *p* 0.35 for *d*	0

Contributions of electrons belonging to some specific orbitals in n' on σ the screening constant of an electron that belong to a given orbital on n

Problem 1. Hydrogen and hydrogen-like ion (14 points)

In the hydrogen emission spectrum, 3 rays are observed possessing the following wavelengths:

$\lambda_A = 433.1\ nm$ $\lambda_B = 486.1\ nm$ $\lambda_C = 656.3\ nm$

1. To which domain of the electromagnetic spectrum do these light rays belong? Justify your answer.
2. Compute to within 0.01 eV the energy of the photons associated to the three observed lines.
3. Compute the energies of the first 6 levels of hydrogen (to within 0.01 eV). Justify your calculation.
4. Plot these levels on a Grotrian's diagram. Represent the transitions associated to the λ_A, λ_B *and* λ_C wavelengths on this diagram and justify your answer.

We will now focus on the hydrogen-like ion of Carbon (Z=6).

5. Give the definition of a hydrogen-like ion. Define the ionization energy of a hydrogen-like ion.
6. This particular hydrogen-like ion is bombarded by incident electrons of energy $500.97\ eV$. Show that the electron in the hydrogen-like ion is ejected and calculate its speed.
7. This hydrogen-like ion is now subjected to an electromagnetic radiation with a wavelength of 3 nm. What is observed as a result of this irradiation? Justify your answer.

Problem 2. Atomistic (6 points)

1. Give the principle(s) or rule(s) that explain the filling order of the orbitals of an element.
2. Knowing that germanium (Ge) is located on period 4 and in group 14 of the periodic table, give its electronic configuration. Determine its atomic number.
3. Identify the valence electrons of germanium (shell/subshell and number). Indicate the number of single electrons it possesses.
4. For an electron in the outermost sublayer of germanium, calculate its effective nuclear charge Z*. Justify your calculation.
5. Give a set of values for each quantum number that may characterizes an electron of the outermost sublayer.
6. When it loses an electron, germanium becomes isoelectronic with gallium. Compare the radii of the germanium ion and the gallium atom. Justify your answer.