INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

Formation Initiale aux Métiers d'Ingénieurs

Year 1
October 20, 2023

EC Chemistry 1 – Test n°1 - Duration: 1h

No document allowed. All calculators allowed.
Answers must be concisely justified.
The results will be given with the appropriate number of significant digits.

***Data*:**
Rydberg's constant for hydrogen and for any hydrogen-like systems: $R_H = 109677\ cm^{-1}$
Planck's constant: $h = 6.626\times10^{-34}$ J.s
Speed of Light: $c = 2.998\times10^{8}\ m.s^{-1}$
Elementary charge: $e = 1.602\times10^{-19}$ C
Mass of the electron: $m_e = 9.10939\times10^{-31}$ Kg
Slater's model:

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 occupying orbitals of quantum number n' on the screen constant of an electron that occupies an orbital of quantum number n

Exercises 1 and 2 are based on demonstrations that are partly common. If you build a demonstration in the first exercise you solve, you do not need to repeat the demo in its entirety in the one you will solve next.

Exercise 1. Hydrogen (10 points)

1. Using the notion of the short wavelength limit and Ritz-Balmer's equation, give the literal equation linking the energy of a level to its main quantum number.

In the hydrogen emission spectrum, the short-wavelength limit of an unknown series is $\lambda = 2.279\ \mu m$.

2. Identify the departure and arrival levels associated to this transition.
3. For this given series (question 2) calculate the energy of the starting level associated to the emission of a photon with a wavelength of 4.654 μm. From this, deduce then the value for n for the departure level.

We now deal with an absorption experiment.

4. Give the wavelength (in Å) of the photon that allows the electron to reach level 6.
5. Following this absorption, how many lines will be observed in the emission spectrum?

6. Plot on a Grotrian's diagram all the lines associated to the phenomena studied and discussed in questions 2, 3, 4 and 5.

Exercise 2. Hydrogen-like systems (8 points)

1. Give the definition of a hydrogen-like ion (also called hydrogenid).

A hydrogen-like ion has an ionization energy of 666.4eV.

2. What is its atomic number? Represent this hydrogen-like system as X^{n+}

This hydrogen-like ion is now subjected to electromagnetic radiation with a frequency ranging from 1.569×10^{17} to 1.575×10^{17} Hz, and in a second experiment from 1.569×10^{17} to 1.580×10^{17} Hz.

3. Establish the relationship between the value of n (corresponding to the arrival level) and the frequency of excitation.

4. From question 3 indicate the observable transitions for the two frequency bands studied in the two experiments.

Exercise 3. Atomistic (2 points)

An element is located in group 2 of the 5th period of the periodic table.

1. Write down its electron configuration and determine its atomic number. What is the name of the group it belongs to?

2. For this given element, calculate the effective nuclear charge Z* for an electron in the 3d subshell. Justify the calculation.

End of the subject