University of Tlemcen
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ST Engineer

Tutorial Series N°3

Exercise 1

1. Determine the wavelength of radiation:
2. **a/** Visible frequency ν_1 = 500TH,
   b/ infrared Frequency ν_2 = 1THz,
   c/γ frequency ν_3 = 500 EHz
3. Calculate, in joules and electronvolts, the energies of the photons corresponding to the above frequencies.
4. Compare the order of magnitude of the energies of γ and visible photons. Conclusion.
5. The yellow line in the spectrum of a sodium vapour lamp has a frequency of $5{,}08.10^{14}s^{-1}$. Calculate: The wavelength of the line and the associated wave number
6. Calculate the wavelengths of the traffic lights, assuming that they emit the frequencies: green ($5{,}75.10^{14}$Hz) ; orange ($5{,}15.10^{14}$Hz) and red ($4{,}27.10^{14}$Hz).
7. What is the wavelength of a radio station transmitting at 98,4MHz?

Data *: $c=3.10^8 m.s^{-1}$; 1EHz = 10^{18}Hz ; 1THz = 10^{12}Hz ; $h=6.025.10^{-34}$J.s ; 1eV = $1{,}602.10^{-19}$J.*

Exercise 2:

A/
Give the electromagnetic spectrum of light in order of increasing wavelength.
<u>B/</u>

1. Calculate the frequency (in MHz) of radiation with a wavelength of 2,865 m.
2. Ultraviolet radiation, which has a fairly high energy level, is the cause of sunburn and discolouration of dyes. How much energy (KJ/mol of photons) do you receive if you are bombarded with one mole of photons with a wavelength of 375 nm?

Data : $C=3.10^8$m/s, $h=6.62.10^{-34}$J.s

exercise 3

The spectrum of hydrogen can be broken down into several series. We will confine ourselves here to the first three series by: Lyman, Balmer and Paschen.

1. What is the general expression for the wavelength of a light line?
2. The lines in each series are framed by two lines of wavelength λ_1 and λ_{lim} respectively. What do these two lines correspond to?
3. Calculate λ_1 and λ_{lim} for these 3 first series.

Data : $\mathbf{R_H}$ = $1{,}096\ 10^7$ m^{-1}

EXERCISE 4

The first line of the Balmer series in the hydrogen spectrum has a wavelength of λ=6562,8 Å.

1) Determine the wavelength limit of this series. Deduce the value of R_H.
2) Determine the wavelengths and frequencies of the 1st and boundary lines of the Lyman series.

EXERCISE 5

A caesium photoelectric cell is successively illuminated by two radiations of frequencies ν_1= $42857.10^{10}s^{-1}$ and ν_2=$55556.10^{10}s^{-1}$. The extraction energy of an electron from this metal is E_0=3.10^{-19}J.
1) Calculate the threshold frequency ν_0.
2) When there is a photoelectric effect?
3) If there is a photoelectric effect, calculate the maximum speed of the electrons stripped from the metal.
4) Calculate the stopping potential in this case.
***Data** : $e=1,6.10^{-19}C$; $m_e=9,1.10^{-31}Kg$; $h=6.025.10^{-34}J.s$; $c=3.10^8m.s^{-1}$.*

exercise 6

A/

1. Give the definition of a hydrogenoid ion.

B/

A hydrogenoid ion is experimentally created from a lithium gas (Z=3) subjected to light radiation. What is the hydrogenoid ion obtained?.

1- Calculate the energy of the first excitation for this ion.
2- Deduce the corresponding wavelength.
3- Calculate the ionisation energy of this atom.
4- Calculate the wavelength corresponding to this transition.
5- To which area of the electromagnetic spectrum do these two wavelengths belong?

Data : $h=6.025\ 10^{-34}$ J.s R_H= $1.097\ 10^7m^{-1}$ C=$3\ 10^8$m/s E_0= - 13.6eV

EXERCISE 7

Consider the hydrogenoid Be^{3+} (Z=4). The shortest wavelength line in its spectrum is at 57,3Å.
1) What transition does it correspond to?,
2) Calculate the corresponding energy.
3) Bohr's theory can be used to calculate the energy of the first ionisation of beryllium?

EXERCISE 8

1. When the electron of the helium atom is at the n=1 level, its first ionisation energy is 54,4eV. What is the energy of the fundamental level?
2. A helium atom is in an excited state. One of its electrons is then at the energy level equal to -13,6 eV. What is the wavelength of the radiation emitted when this electron falls back to the fundamental level?

Exercise 9

A/

1. Calculate the De Broglie wavelength associated with a proton travelling at speed 1.0 x 10^5 m/s. m_p= 1.67 x 10^{-27} kg.

2. A rifle bullet weighs 5g. Calculate the De Broglie wavelength associated, given that it travels through the air at 1930 km.h^{-1}. Conclude.

B/

1- What is the error in the velocity of the electron in the hydrogen atom if we know its position r (order of the Bohr radius) to within 0.5%? Conclusion ? Similarly, what error do you get in the speed of a 30,000 kg lorry travelling at 72 km/h if you know its position to within 1 mm? Conclusion? We give the speed of the electron on the first Bohr orbit v = 2,189.10^6 m/s

Exercises for student

EXERCISE 1

A hydrogen atom in its ground state absorbs a photon of frequency 3,07.10^{15} Hz.

1. What is the wavelength, in nm, of the light absorbed?
2. What is the energy variation in joules, corresponding to?
3. Deduce the energy level at which the electron is located after absorption.

EXERCISE 2

In the emission spectrum of the hydrogen atom, the ratio between the wavelengths of two successive boundary lines is 4/9.

1. To which series do each of the extreme lines correspond? Calculate the emission energy of these two extreme lines in eV.
2. Deduce the values of the wavelengths of the two successive boundary lines.