Ibn KhaldounUniversity – Tiaret
Faculty of Matter Sciences
Department of Physics
1st year LMD S.M

جامعة ابن خلـدون - تيـــارت
كليــة علــوم المـادة
قســم الفيزياء

Academic year: 2025–2026

Module: Structure of Matter (Chemistry 01)

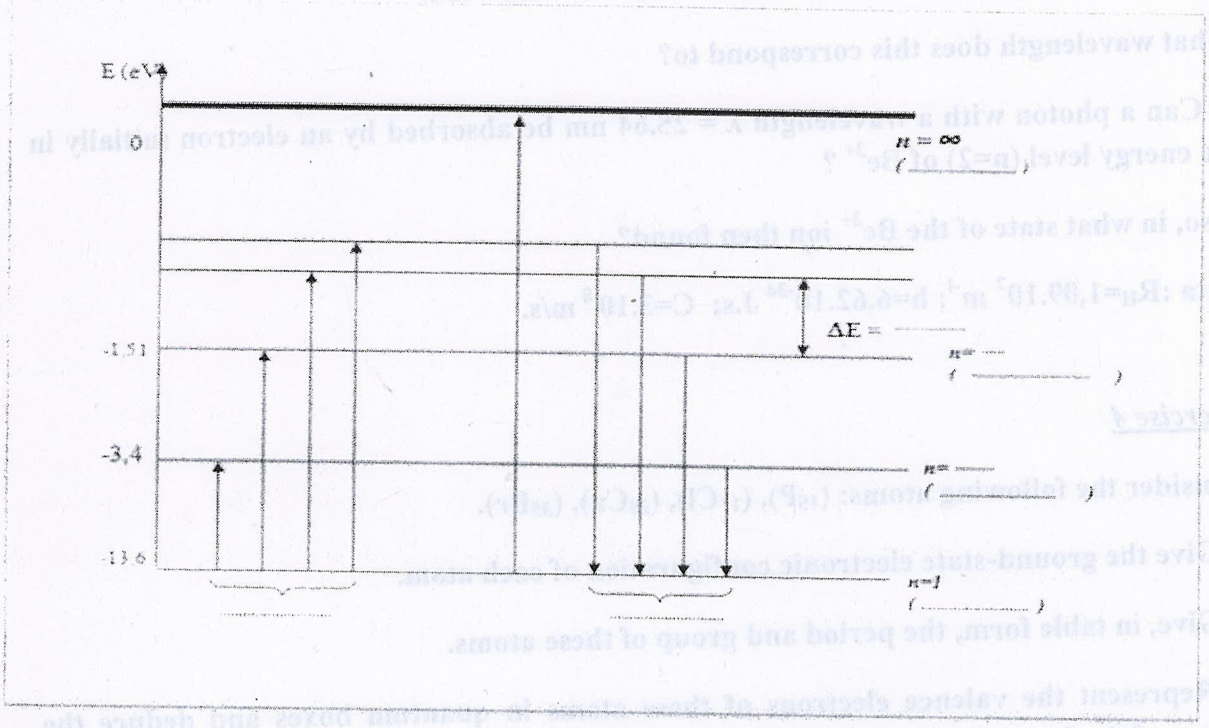
Exam of Chimistry 01

Course Questions

1-The elements that have the same atomic numbers Z and different mass number are …

2- The experiment which consists of bombarding a very thin sheet of metal (gold) with α radiation is …………..……………..

3- Complete this diagram for a hydrogen atom



Exercise 1

An electron beam in a cathode ray tube is accelerated by a potential difference of 60 x 10^{-3} volts. The mass of an electron is given: m(e^-) = 9 x 1 x 10^{-31} kg.

a) What is the kinetic energy acquired by these electrons (in joules and keV)?

b) Calculate their velocity.

Exercise 2

Cesium (134 Cs) emits (β-) radioactive disintegrates products.

1- Write the conservation laws governing this reaction and the balanced chemical equation for the desintegration.

Continuation of the exercise 02

2- The half-life of (^{134}Cs) is T = 2 years. Deduce the radioactive constant of disintegration λ.

3- How long does it take for 99% of cesium-134 to disintegrate?

Exercise 3

I) Give the definition of a hydrogenoid ion.

b) Are the $_{3}Li^{+}$ and $_{4}Be^{3+}$ ions hydrogenoid systems?

c) Define the ionization energy. Calculate it for the Be^{3+} ion.

What wavelength does this correspond to?

d) Can a photon with a wavelength λ = 25.64 nm be absorbed by an electron initially in the energy level (n=2) of Be^{3+} ?

If so, in what state of the Be^{3+} ion then found?

Data :R_H=1,09.10^{7} m^{-1}; h=6,62.10^{-34} J.s; C=3.10^{8} m/s.

Exercise 4

Consider the following atoms: ($_{15}$P), ($_{17}$Cl), ($_{20}$Ca), ($_{35}$Br).

1. Give the ground-state electronic configuration of each atom.

2. Give, in table form, the period and group of these atoms.

3. Represent the valence electrons of these atoms in quantum boxes and deduce the values of the four quantum numbers: n, l, m, s of the last electron.

4. Calculate the first ionization energy of ^{15}P according to Slater's approximation.

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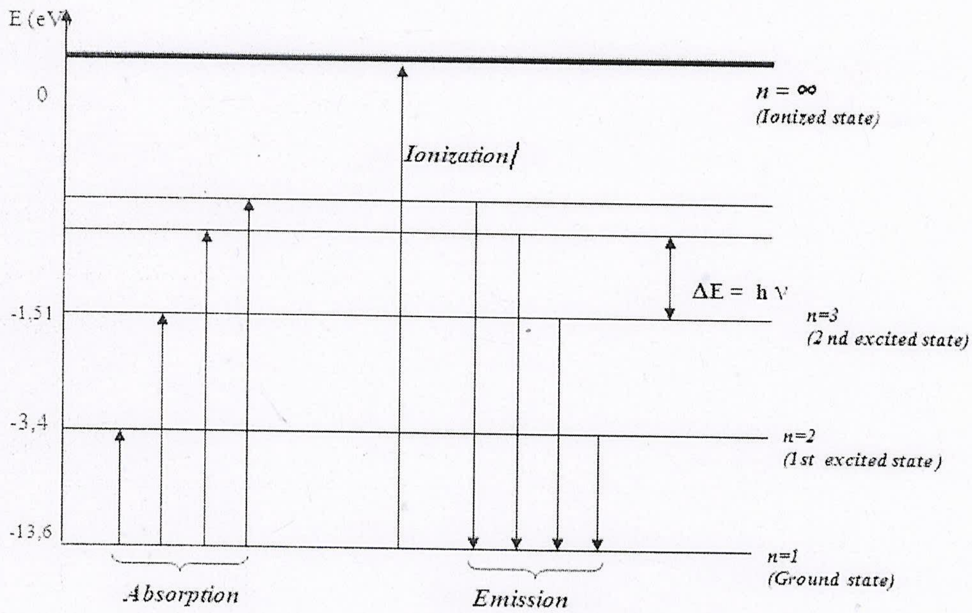
Solution

Course Questions

1-The elements that have the same atomic numbers Z and different mass numbers are isotopes ...... 0.5 pts

2- The experiment which consists of bombarding a very thin sheet of metal (gold) with α radiation is Rutherford's experiment. ....0.5 pts

3- The diagram 2 pts



<u>*Sol Exercice 01*</u> **3/3**

The electrons received kinetic energy from electric energy U (U= e . V) .....0.25 pts

1/kinetic energy of e is: $E_K = \frac{1}{2} mv^2 = e V =$ 1pt

$Ek = 1,6.10^{-16} * 60.10^{+3} = 96\ 10^{-16}$ J .....0.25 pts = 60 KeV ...0.25pt

2/ The velocity of the Electrons ....1.25 pt

$$V = \sqrt{\frac{2\ Ecmax}{m}} = \sqrt{\frac{2.96\ 10^{-16}\ J}{9.1\ 10^{-31} kg}} = 1.45.10^{8}\ m.s^{-1}$$

<u>*Sol d'exercice 2*</u> : **3/3**

The equation of disintegration of the cesium : 0.25 pts

$$^{134}_{55}Cs \longrightarrow {}^{A}_{Z}X + \beta\ ({}^{0}_{-1}e)$$

The Law of Soddy :

Conservation of the mass: 0.25 pts

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Suite Ex 02

$$55 = Z + (-1) \Rightarrow Z = 56$$

Conservation of the Charge 0.25 pts

$$134 = A + 0 \Rightarrow A = 134$$

The total equation of the desintégration

$$^{134}_{55}Cs \rightarrow {}^{134}_{56}X + \beta^-\left({}^{0}_{-1}e\right) \text{ Ou } \quad {}^{134}_{56}X = {}^{134}_{56}Pa$$

$$^{134}_{55}Cs \longrightarrow {}^{134}_{56}Pa + {}^{0}_{-1}e$$

The calcul of λ: 1 pt

$$\lambda = \frac{\ln 2}{T} = \frac{0,69}{2ans} = 0,347 / ans$$

The time is : 1 . 25 pt

$$N_t = N_0 - 99 = 1\%$$

$$N_t = N_0 e^{-\lambda t} \Rightarrow \frac{N_0}{N_t} = e^{\lambda t} \Rightarrow \ln\frac{N_0}{N_t} = \lambda t$$

$$\Rightarrow t = \frac{1}{\lambda}\ln\frac{N_0}{N_t}$$

$$\Rightarrow t_1 = \frac{1}{\lambda}\ln\frac{N_0}{N_t} = \frac{1}{0,347}\ln\frac{100}{1} 13,271ans$$

$$\Rightarrow \boxed{t_1 = 13,271ans}$$

Solu Ex **03: 4/4**

I) The hydrogénoïde ion is a monoatomic ion with only one electron and Z protons. 0.25 pts

b) Li^+ is not hydrogénoide ion , it have 2 electrons. But Li^{2+} is an hydrogénoid ion. 0.25 pts

Be^{3+} is an hydrogénoïde ion with one electron and Z= 4. 0.25 pts

c) Ionization energy is the minimum energy required to remove an electron from a hydrogen-like atom in its ground state. It is positive. ..... 0.5 pt

$E_n = (-13.6 * Z^2/n^2)$ ....0.25 pt

Energy of the hydrogénoïde $\Delta E = E_\infty - E_1$ 0.25 pts

$\Delta E = E_\infty - E_1 = (-13.6\, Z^2/\infty) - (-13.6\, Z^2/1^2) = (-13.6\, 4^2/1^2) =$

$EI = 217.6\ eV = 3.49.10^{-17} J$ .... 0.5 pt

Suite Ex 03

The calcul of the wave length 0.5 pts

$\lambda = h*c/E_1$

$\lambda = 6,626.10^{-34}*3.10^{8}/3,49.10^{-17}$

$= 5,7.10^{-9}$ m = 5,7 nm.

d) The absorption is from n_i=2 to n_f= ?

We used the Balmer Formula with n<m 1 pts

$$\frac{1}{\lambda_{n,m}} = R_H Z^2 \left(\frac{1}{n^2} - \frac{1}{m^2}\right)$$

$$n = \sqrt{\frac{n^2 R_H Z^2 \lambda}{R_H Z^2 \lambda - n^2}} = \sqrt{\frac{2^2 * 1,097.10^7 * 4^2 * 25,64.10^{-9}}{1,097.10^7 * 4^2 * 25,64.10^{-9} - 2^2}} = 6$$

The photonis absorbed by Be^{3+} and passes to excited state n=6 0.25 pt

<u>Solu ex *04*</u> :7/7

0.25 structure, 0.25 case quantique, 0.25 G, 0.25 P, 0.25 n l m s

Element	Electronic Configuration	Quantum boxes	P	G	n	l	m	s
$_{15}$P 1.25 pts	$1s^2 2s^2 2p^6\ 3s^2 3p^3$	[↑↓] [↑|↑|↑]	3	V_A	3	1	+1	+1/2
$_{17}$Cl 1.25 pts	$1s^2 2s^2 2p^6 \underline{3s^2 3p^5}$	[↑↓] [↑↓|↑↓|↑]	3	VII_A	3	1	0	-1/2
$_{20}$Ca 1.25 pts	$1s^2 2s^2 2p^6 3s^2 3p^6 \underline{4s^2}$	[↑↓]	4	II_A	4	0	0	-1/2
$_{35}$Br 1.25 pts	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2 3d^{10}\ 4p^5$ $\underline{4s^2 4p^5}$	[↑↓] [↑↓|↑↓|↑]	4	VII_A	4	1	0	-1/2

4- The ionisation energy of the slater : 2 points.

P : $1s^2 2s^2 2p^6\ 3s^2 3p^3$ et P^+ $1s^2 2s^2 2p^6\ 3s^2 3p^2$

Suite Ex 04

Énergie électronique totale du Phosphore : $E_{totale}(P) = 2E_1 + 8E_3 + 5E_{(3s3p)}$ 0.25 Points

Énergie électronique totale de l'ion Phosphore: $E_{totale}(P^+) = 2E_1 + 8E_3 + 4E'_{(3s3p)}$ 0.25 Points

$\mathbf{EI_1 = E_{totale}(P^+) - E_{totale}(P)}$ 0.25 Points

soit ; $\mathbf{I_1 = 4E'_{(3s3p)} - 5E_{(3s3p)}}$ 0.25 Points

$Z_P = 15 - [(5-1)x0,35] - (8x0,85) - (2x1) = 4.8$ 0.25 Points

$Z'_{P+} = 15 - [(4-1)x0,35] - (8x0,85) - (2x1) = 5.15$ 0.25 Points

$\mathbf{EI_1 = 5E'_{(3s3p)} - 6E_{(3s3p)}} = 5(-13.6\ eV.\ Z^{2'}_{P+}/3^2) - 7(-13.6\ eV.\ Z^2_P/3^2)$

$\mathbf{EI_1} =$ 13.8 **eV** 0.5 Points