

الاسم:
الرقم:

مسابقة في مادة الكيمياء
المدة: ساعة واحدة

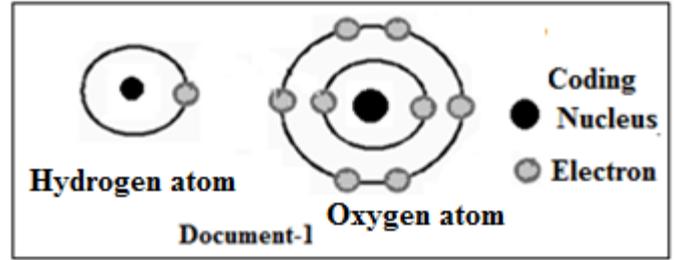
This Exam Is Composed of Three Exercises. It Is Inscribed on Two Pages, Numbered 1 and 2.
Answer the Three Following Exercises:

Exercise 1 (6 points)

Chemical Elements of the Human Body

98.5% of the human body mass is constituted of six elements: oxygen, carbon, hydrogen, nitrogen, calcium and phosphorus. Most of the human body is composed of water; therefore the most present element in the human body mass is oxygen. Carbon (C), the basic element of the organic cells, comes in the second position.

Document-1 shows the schematic representation of hydrogen and oxygen atoms.



- By referring to **Document-1**, answer the following questions.
 - Determine the atomic number of the oxygen atom.
 - Calculate the relative charge of the electronic cloud of the hydrogen atom, knowing that the relative charge of an electron is $1-$.
 - Explain the bond formation in water molecule H_2O .
- Document-2** shows the atomic number and the mass number of four atoms A, B, C and D.

Atom	A	B	C	D
Atomic number	6	20	6	18
Mass number	12	40	14	40

Document-2

- Indicate the isotopes among these four atoms. Justify.
 - One of the preceding isotopes represents the basic element of the organic cells.
 - Pick out from the text the name of this element.
 - Write the symbolic representation of an atom of this element, knowing that its mass number is equal to 12.
- The electron configuration of the nitride ion N^{3-} is: K^2L^8 .
Choose, among the electron configurations given below, the one that corresponds to the nitrogen atom.
 - K^2L^3
 - $K^2L^8M^3$
 - K^2L^5

Exercise 2 (7 points)

Alkanes

Propane is an open carbon chain alkane. It is a derivative of petroleum, used as an energy source in engines of internal combustion.

- By referring to the text, pick out the use of propane.
- The molecular formula of propane is C_3H_8 .
 - Give its condensed-structural formula.
 - The products of the complete combustion reaction of propane are: carbon dioxide CO_2 and water vapor H_2O . Write using molecular formulas, the equation of this reaction.

3. **Document-1** shows four alkanes with their normal boiling points.

By referring to **Document-1**, correct the following expressions:

- Upon going from decane to ethane, the normal boiling point increases.
- At the temperature $t = 0\text{ }^{\circ}\text{C}$, the physical state of propane is liquid.

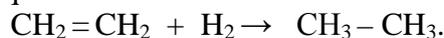
Alkane	Molecular formula	Normal boiling point in $^{\circ}\text{C}$
Ethane	C_2H_6	- 89
Propane	C_3H_8	- 42
Octane	C_8H_{18}	126
Decane	$\text{C}_{10}\text{H}_{22}$	174

Document-1

4. The thermal cracking of decane produces octane and a hydrocarbon (**A**) of molecular formula C_xH_y according to the following equation:



- Show that the molecular formula of hydrocarbon (**A**) is C_2H_4 .
- Name hydrocarbon (**A**) and write its structural formula.
- Indicate the family to which hydrocarbon (**A**) belongs.
- The catalytic hydrogenation of hydrocarbon (**A**) leads to the formation of another hydrocarbon, according to the following equation:

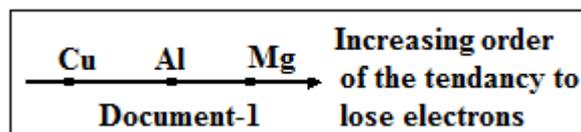


Specify whether this reaction is an addition or a substitution reaction.

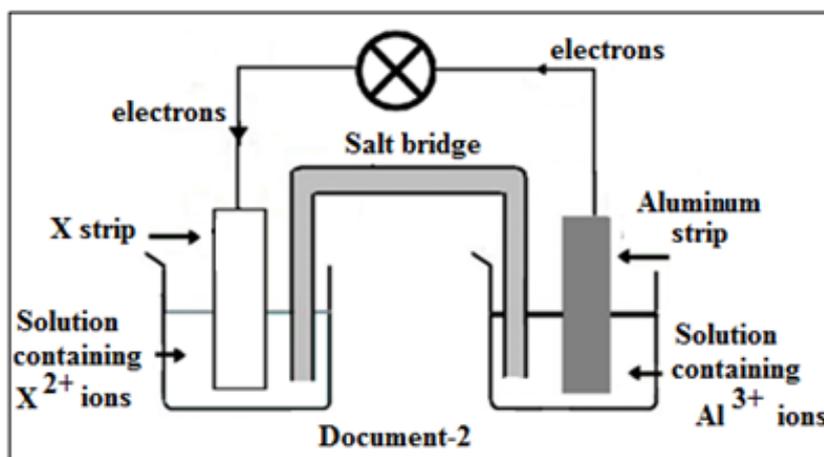
Exercise 3 (7 points)

Electrochemical Cell

Metals tend to lose electrons, but this tendency is not the same for all metals. **Document-1** shows the increasing order of the tendency to lose electrons of some metals.



- Among the metals present in **Document-1**, indicate the one which has the least tendency to lose electrons.
- Document-2** represents the schema of a functioning electrochemical cell Al- X.



- By referring to **Document-2**, show that aluminum strip is the anode.
- By referring to **Document-1**, identify the metal X.
- Choose, among the schematic representations given below, the one that corresponds to this cell:
 - $\text{Al}^{3+} | \text{Al} - \text{salt bridge} - \text{X}^{2+} | \text{X}$
 - $\text{Al} | \text{Al}^{3+} - \text{salt bridge} - \text{X}^{2+} | \text{X}$
 - $\text{X} | \text{X}^{2+} - \text{salt bridge} - \text{Al}^{3+} | \text{Al}$
- The anode half-reaction is : $\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^-$
 - Write the cathode half-reaction.
 - Deduce the equation of the overall reaction of this electrochemical cell.
- Justify why the strip of metal X becomes thicker during the functioning of this cell.
- Give one role of the salt bridge in an electrochemical cell.

Part of Q	Exercise 1 (6 points) Chemical Elements of the Human Body Expected Answer	Mark
1.1	According to Document -1 , the number of electrons in an oxygen atom is: $2 + 6 = 8$. (0.25pt) The atom being neutral, the number of protons = number of electrons = 8. (0.25pt) Z, the atomic number is equal to the number of protons (0.25pt) thus $Z = 8$. (0.25pt)	1
1.2	According to Document -1 , the number of electrons in a hydrogen atom is equal to 1. (0.25pt) The relative charge of the electronic cloud = number of electrons \times relative charge of an electron. (0.25pt) The relative charge of the electronic cloud = $1 \times (1-) = 1-$. (0.25pt)	1
1.3	According to their electron configurations, oxygen needs 2 electrons to become stable and satisfy the octet rule, (0.5pt) while hydrogen needs one electron to become stable and satisfy the duet rule. (0.5pt) The oxygen atom shares one pair of electrons with each hydrogen atom forming a single (simple) covalent bond. (0.5pt)	1.5
2.1	According to Document-2 , the atoms A and C are isotopes (0.5pt) since they have same atomic number but different mass numbers. (0.5pt)	1
2.2.1	According to the text, it is carbon.	0.5
2.2.2	The representation of this atom is: $^{12}_6C$.	0.5
3.	The electron configuration of nitrogen atom is: c- $K^2 L^5$.	0.5

Part of Q	Exercise 2 (7 points) Alkanes Expected Answer	Mark
1.	Propane is used as an energy source in engines of internal combustion.	0.5
2.1	The condensed-structural formula of propane is : $CH_3 - CH_2 - CH_3$	0.5
2.2	The equation of the complete combustion of propane is: $C_3H_8 + 5 O_2 \rightarrow 3 CO_2 + 4 H_2O$.	1
3.	a. Upon going from decane to ethane, the normal boiling point decreases . (0.5pt) b. At the temperature $t = 0^\circ C$, the physical state of propane is gas . (0.5pt)	1
4.1	According to the law of conservation of matter, the number of atoms of each element is conserved: (0.25pt) For carbon: $10 = 8 + x \Rightarrow x = 2$. (0.5pt) For hydrogen: $22 = 18 + y \Rightarrow y = 4$. (0.5 pt) Then C_xH_y is C_2H_4 . (0.25pt)	1.5

4.2	Hydrocarbon (A) is ethene. (0.5pt) The structural formula of Hydrocarbon (A) is:	$ \begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} & \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array} $ (0.5pt)	1
4.3	Family of Alkenes.		0.5
4.4	The catalytic hydrogenation is an addition reaction, (0.5pt) since the double covalent bond (C = C) is broken down and a single covalent bond (C–C) is formed. (0.5pt)		1

Part of Q	Exercise 3 (7 points) Electrochemical Cell Expected Answer	Mark
1.	The metal that has the least tendency to lose electrons is copper Cu.	0.5
2.1	According to Document-2 , electrons move from the Al strip to the X strip. (0.25pt) In a functioning electrochemical cell, electrons move from the anode to the cathode, (0.5pt) thus aluminum strip is the anode. (0.25 pt)	1
2.2	Since Al is the anode of this cell, the cathode is therefore the metal X. X must have less tendency to lose electrons than aluminum. (0.5pt) According to Document-1 , the metal X is the copper Cu. (0.5 pt)	1
2.3	the schematic representation that corresponds to this cell is: b. Al Al ³⁺ - salt bridge - X ²⁺ X	0.5
3.1	The cathode half-reaction is: Cu ²⁺ + 2e ⁻ → Cu	0.5
3.2	The number of electrons lost is equal to the number of electrons gained. (0.25pt) $ (\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}) \times 3 \quad \textbf{(0.25pt)} $ $ (\text{Al} \rightarrow \text{Al}^{3+} + 3\text{e}^{-}) \times 2 \quad \textbf{(0.25pt)} $ <hr/> Overall equation: 3 Cu ²⁺ + 2Al → 2 Al ³⁺ + 3 Cu (0.75 pt)	1.5
4.	The Cu strip becomes thicker during the functioning of this cell, since at cathode, Cu ²⁺ ions are transformed into Cu solid which is deposited on the Cu strip.	1
5.	The role of the salt bridge: - Ensure a closed electric circuit that permits the passage of the electric current. Or: - Maintain the electroneutrality of the solutions in the two half-cells.	1