This Exam Is Composed of Three Exercises. It is inscribed on seven pages, numbered from 1 to 7. Answer the following three exercises.

مسابقة في مادّة الكيمياء

المدّة: ساعة واحدة

(إنكليزي)

الاسم:.....

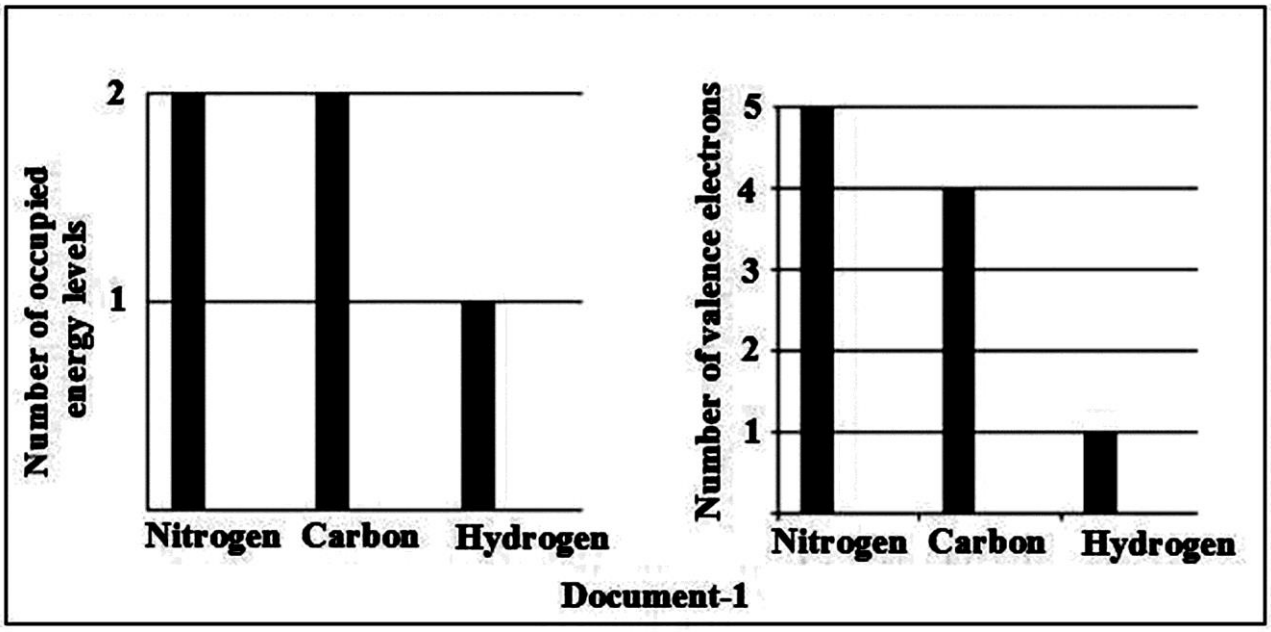
الرّقم:.....

Exercise 1 (7 points) **The Unpleasant Odor of Fish**

The unpleasant odor of fish is partly due to the formation of a volatile compound, the methylamine of molecular formula $\mathbf{CH_5N}$.

To reduce this odor when cooking fish, vinegar which is a solution containing ethanoic acid is added.

Document-1 represents **two** histograms, showing the number of occupied energy levels and the number of valence electrons of the atoms nitrogen **(N)**, carbon **(C)** and hydrogen **(H).**



Document-1

1. By referring to **Document-1**:

1.1 Correct the following propositions:

a. The Lewis electron dot symbol of hydrogen atom is: $\ddot{\mathrm{H}}$

b. Carbon element belongs to the fourth period (row 4) in the periodic table.

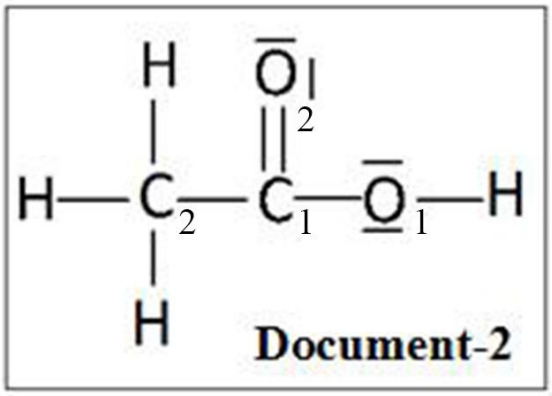
1.2

1.2.1 Write the electron configuration of nitrogen atom **(N).**

1.2.2 Deduce the atomic number of nitrogen element **(N).**

1.3 Write the Lewis structure of the molecule $\mathbf{CH_5N}$.

2. Document-2 represents the Lewis structure of **ethanoic acid** molecule.



Document-2

By referring to **Document -2:**

2.1 Give the molecular formula of **ethanoic acid**.

2.2 Indicate the type of chemical bonding between:

- **C_1** atom and **O_1** atom.
- **C_1** atom and **O_2** atom.

Justify.

2.3 Choose from the propositions given below, the one that corresponds to the valence of oxygen atom:

a) 2 **b)** 4 **c)** 6

3. By referring to the text, **indicate** the solution that should be added to reduce the unpleasant odor when cooking fish.

Exercise 2 (6 points) **Methane**

Methane is quite abundant in the natural environment; its complete combustion with oxygen gas releases a significant amount of heat energy.

The products obtained are carbon dioxide gas and water vapor. The release of carbon dioxide can be a source of pollution.

1. The complete combustion of an alkane **(A)** $\mathbf{C_nH_{2n+2}}$ is represented by the following equation:

$$\mathbf{C_nH_{2n+2} + 2\ O_2 \rightarrow n\ CO_2 + (n+1)\ H_2O}$$

1.1 By applying the law of conservation of matter on the oxygen atoms, **show that** the molecular formula of alkane **(A)** is $\mathbf{CH_4}$.

1.2 Deduce that the alkane **(A)** is methane.

2. Methane $\mathbf{(CH_4)}$ reacts with chlorine gas $\mathbf{Cl_2}$, under appropriate experimental conditions to produce chloromethane $\mathbf{CH_3Cl}$ from methane and hydrogen chloride **HCl**.

2.1 Write, using molecular formulas, the equation of the reaction allowing the preparation of chloromethane from methane.

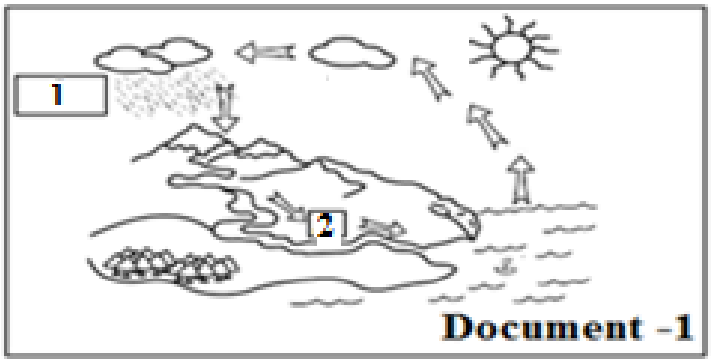
2.2 Indicate whether this reaction is a substitution or addition reaction.

3. The boiling point temperature of methane at atmospheric pressure **P = 1 atm** is $\mathbf{t = -164^oC}$.

- **What is** the physical state of methane at the same pressure and at temperature $\mathbf{20^oC}$?

4. The total amount of water in earth remains unchanged, because even if it circulates, it always follows the same cycle. Human activities such as burning fossil fuels affect the water cycle because some gases such as **CO_2**, **NO_2** and **SO_2** dissolve in water to form acid rain.

Document-1 represents the water cycle.



Document -1

4.1 By referring to **Document-1** , **indicate** in which stage **1** or **2** acid rain is formed.

4.2 Give <u>two consequences</u> of acid rain.

Exercise 3 (7 points) **Classification of Metals**

Spontaneous redox reactions occurring between a metal **X** and a metallic ion $\mathbf{Y^{n+}}$ release chemical energy. In these reactions, the more active metal acts as the reducing agent (reductant).

1. **Document-1** represents the procedure and the results of an experiment realized in a laboratory.

A copper strip **(Cu)** is immersed in a colorless solution of silver nitrate **($Ag^+ + NO_3^-$).** A deposit of silver **(Ag)** covers this strip and the solution turns to blue. **Document- 1**

By referring to **Document-1**, answer the following questions:

1.1 The oxidation half-reaction taking place is**:**

$$\mathbf{Cu \rightarrow Cu^{2+} + 2e^-}$$

- **Choose**, among the half-reactions given below, the one that corresponds to the reduction half-reaction taking place.

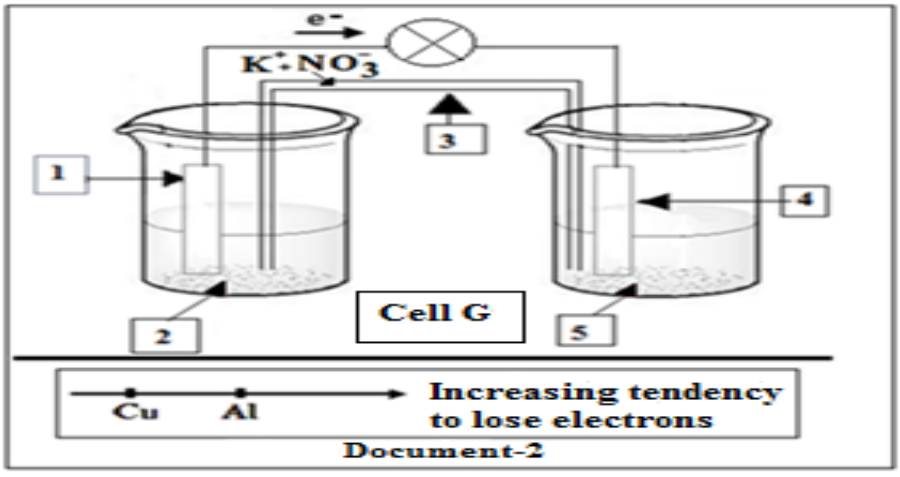
a- $\mathbf{Ag \rightarrow Ag^+ + 1e^-}$

b- $\mathbf{Ag^+ + 1e^- \rightarrow Ag}$

c- $\mathbf{Ag^+ \rightarrow Ag + 1e^-}$

1.2 By referring to the text, **Indicate** among the following metals **Cu** and **Ag**, the one that is more active.

2. **Document-2** represents the cell **(G) Al-Cu** in functioning as well as the axis showing the increasing order of the tendency of the two metals **Al** and **Cu** to lose electrons.



Document-2

By referring to **Document-2**, **answer** the following questions:

2.1 Using the list given below, **Name** the numbered parts **1, 3** and **4** of the electrochemical cell **(G)**.

List:

- Aluminum strip (**Al**)
- Copper strip (**Cu**)
- salt bridge
- aluminum sulfate solution **($2Al^{3+} + 3SO_4^{2-}$)**
- copper **(II)** sulfate solution **($Cu^{2+} + SO_4^{2-}$).**

2.2 Knowing that the equation of the oxidation –reduction reaction of the electrochemical cell **(G)** is

$$2\ Al + 3\ Cu^{2+} \rightarrow 2\ Al^{3+} + 3\ Cu$$

Write the oxidation and the reduction half-reactions that take place at the electrodes of the electrochemical cell **(G).**

2.3 Using oxidation numbers, verify that the reaction

$$2\ Al + 3\ Cu^{2+} \rightarrow 2\ Al^{3+} + 3\ Cu$$

is a **redox reaction**.

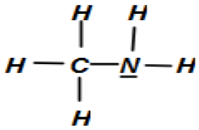
2.4 **Answer** by true or false. **Correct** the underlined words if necessary.

a- The solution **5** contains **<u>copper (II) ions Cu^{2+}.</u>**

b- <u>Potassium ions K^+</u> present in part **3** of the cell **(G)** migrate towards solution **5**.

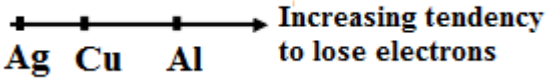
c- During reaction, the quantity of aluminum ions Al^{3+} <u>decreases</u>.

3. **Arrange on an axis** the three metals **Al, Ag** and **Cu** <u>in increasing order</u> of their tendency to lose electrons.

Part	Exercise 1 (7 points) The Unpleasant Odor of Fish Expected Answers	Mark
1.1	**a.** The Lewis dot symbol of the hydrogen atom is: $\dot{H}$ **(0.75pt)** **b.** Carbon element belongs to the second period (row 2) in the periodic table. **(0.75pt)**	1.5
1.2.1	Then the electron configuration of nitrogen is: K^2, L^5	0.75
1.2.2	Nitrogen has : 2+5=7 electrons **(0.25)** As atom is electrically neutral then the number of electrons is equal to number of protons Number of protons = atomic number Z =7 **(0.5pt)**	0.75
1.3		0.5
2.1	The molecular formula of ethanoic acid is: $C_2H_4O_2$	0.5
2.2	The atom C_1 and the atom O_1: single covalent bond **(0.5pt)** because these atoms share one bonding pair of electrons. **(0.25pt)** The atom C_1 and the atom O_2: double covalent bond **(0.5pt)** because these atoms share two bonding pairs of electrons. **(0.25pt)**	1.5
2.3	The valence of oxygen is 2 **(a).**	1
3	Vinegar solution is added when cooking fish to reduce the unpleasant odor.	0.5

Part	Exercise 2 (6 points) Methane Expected Answers	Mark
1.1	By applying the law of conservation of matter on oxygen atom: 4 =2n +n+1 thus 4-1 =3n then n = 1 **(0.5 pt)** The molecular formula of the alkane (A) is CH_4. **(0.25 pt)**	0.75
1.2	The number of carbon atoms in the alkane (A) is 1 then (A) is methane.	0.5
2.1	$CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$	1
2.2	The reaction allowing the preparation of chloromethane from methane is a substitution reaction.	1
3.	A 20˚C, methane is in the gaseous state**.**	1
4.1	In **Document-1**, acid rain is formed at stage 1.	0.75

4.2	Consequences of acid rain on the environnement : - Acid rain attacks trees in forests. **(0.5pt)** - Acid rain destroys the aquatic life in lakes. **(0.5pt)**	**1**

Part	**Exercise 3 (7 points)** **Classification of Metals** **Expected Answers**	**Mark**
1.1	Reduction half- reaction is: (b) $Ag^{+} + 1e^{-} \rightarrow Ag$.	**0.5**
1.2	Copper metal (Cu) is more active than silver metal (Ag).	**0.5**
2.1	**1** : aluminum strip **(0.25 pt)** **3** : salt bridge **(0.25 pt)** **4** : copper strip **(0.25 pt)**	**0.75**
2.2	At cathode, the reduction half-reaction is: $Cu^{2+} + 2e^{-} \rightarrow Cu$ **(0.5 pt)** At anode, the oxidation half-reaction is: $Al \rightarrow Al^{3+} + 3e^{-}$ **(0.5 pt)**	**1**
2.3	The equation of the overall reaction is: $2\,Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$ **0** **+II** **+III** **0** **(0.25$pt \times 4$)** o.n increases: oxidation o.n decreases: reduction o.n of aluminum increases from 0 to +III then Al undergoes oxidation **(0.25pt)** o.n of copper decreases from +II to 0 then Cu^{2+} undergoes reduction **(0.25pt)** As o.n change then the reaction is an oxidation-reduction reaction. **(0.25pt)**	**1.75**
2.4	**a.** True **(0.5 pt)** **b.** True **(0.5 pt)** **c.** False **(0.25 pt)**, the quantity of Al^{3+} ions increases. **(0.5 pt)**	**1.75**
3.		**0.75**