وزارة التربية والتعليم العالي المديريّة العامّة للتربية دائرة الامتحانـات الرسميّة	امتحانات الشهادة المتوسطة	دورة العام ٢٠١٩ الاستثنائية الاثنين ٢٢ تموز ٢٠١٩

مسابقة في مادة الكيمياء المدة: ساعة واحدة	الاسم: الرقم:

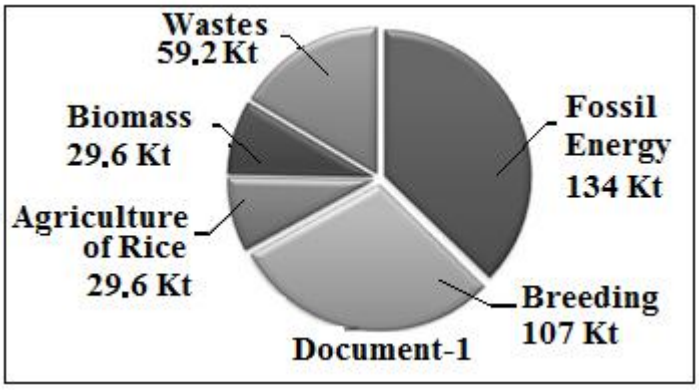
This Exam Is Composed of Three Exercises. It Is Inscribed on Two Pages, Numbered 1 and 2. Answer the Following Three Exercises:

Exercise 1 (7 points) Alert from Methane!

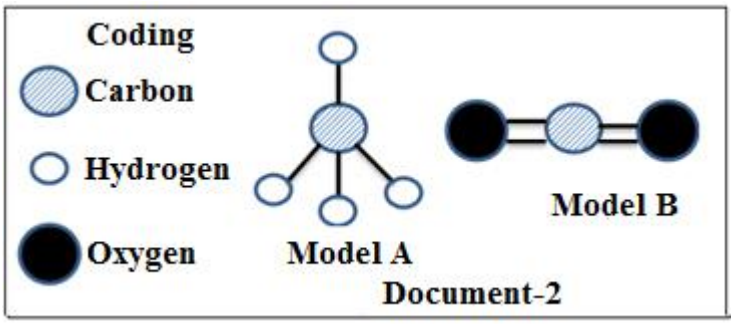
When talking about global warming, people think immediately about the release of carbon dioxide gas (CO_2), but few think about methane. Methane is responsible of one third of global warming since 1750. While the emissions of carbon dioxide start to become stable in certain countries that of methane increase since few years in a worrying rhythm.

Translated from www.les4verites2brane.com/climat-alerte-au-methane

Document-1 represents a circle graph (pie-chart) showing the sectors responsible of the emissions in 2012, of methane gas in kilotons (Kt).



1. Refer to the text and to **Document-1**, answer the following questions:
   - **1.1** Name two gases responsible of global warming.
   - **1.2** Which sector emits the highest quantity of methane gas in 2012?
2. **Document-2** represents the molecular models of carbon dioxide and methane.
   - Refer to **Document-2,** answer the following questions:
   - **2.1** Verify that model A corresponds to methane molecule.
   - **2.2** Identify the type of bond established by the carbon atom in each of the models A and B.



3. Oxygen atom has certain characteristics.
   - Choose, among the propositions given below, the one(s) that correspond(s) to the oxygen atom $^{16}_{8}O$. Justify your choice.
     - **a)** Electrons of oxygen atom occupy three energy levels in the ground state.
     - **b)** The valence of oxygen atom is 2.
     - **c)** Oxygen atom has 16 charged particles.
4. Methane is one of the raw materials used in organic industry. When exposed to light, methane can react with chlorine gas according to a reaction (R) represented by the following equation:

$$CH_4 + 4\,Cl_2 \rightarrow CCl_4 + 4\,HCl$$

Given: The oxidation number of the element carbon in the compound CCl_4 is equal to +IV.

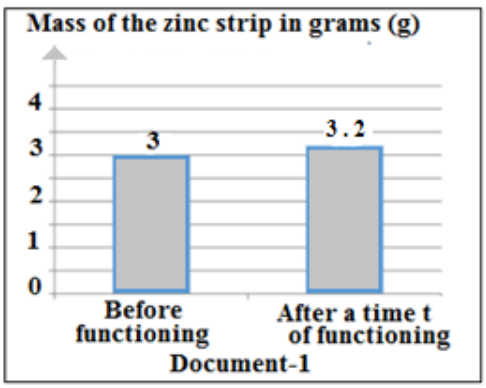
- **4.1** Calculate the oxidation number of carbon element in the compound CH_4.
- **4.2** Deduce that methane is the reductant in reaction (R).

Exercise 2 (6 points) Aluminum – Zinc Cell

Redox reactions involve the transfer of electrons from one chemical species to another.

In the laboratory, a group of students construct an aluminum- zinc electrochemical cell (G), in order to study the variation in mass of the zinc strip during the functioning of this cell.

Document -1 is a bar graph that represents the obtained result.



1. Refer to **Document-1,** answer the following questions:

1.1 Show that the zinc strip is the cathode of the cell (G).

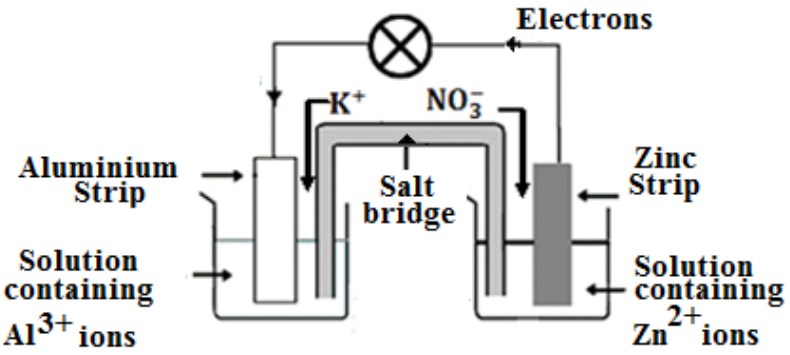
1.2 Identify among the metals zinc and aluminum, the one that has the greater tendency to lose electrons.

2. A grade 9 student, schematizes the cell (G) constructed by his classmates.

- Pick out from the adjacent schema the errors committed by this student. Justify.

3. Write the oxidation and the reduction half- reactions of the cell (G).

4. Deduce the overall equation of the reaction of this cell.



Exercise 3 (7 points) Petroleum

Petroleum is a viscous liquid composed of different hydrocarbons, the majority of which are open chain alkanes and cycloalkanes. This mixture should be treated before it is used.

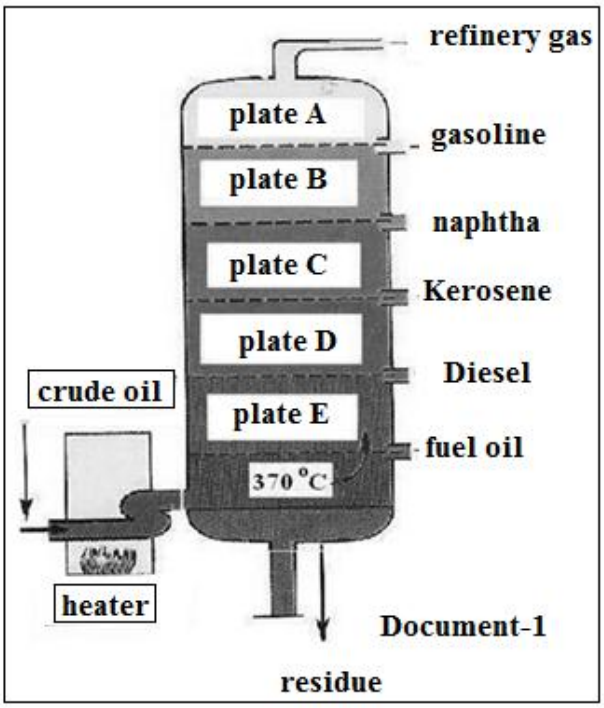
Document-1 shows the schema of a fractionating tower and its different plates.

1. Refer to **Document-1** and to your knowledge, answer the following questions:

1.1 Indicate the lightest petroleum fraction.

1.2 The temperatures in ^{o}C at the plates B and C are respectively $T_1 = 110$ and T_2. Choose the correct answer.

a) $T_2 = T_1$ **b)** $T_2 > T_1$ **c)** $T_2 < T_1$



2. Gasoline contains hydrocarbons having 5 to 10 carbon atoms. Fractional distillation and different treatments lead to the production of hexane and 2,3-dimethylpentane.

2.1 Write the condensed structural formula of each of these two compounds.

2.2 Identify which of these two compounds is a branched chain hydrocarbon.

3. A hydrocarbon C_xH_y, obtained in one of the fractions, burns completely with oxygen gas in air. The balanced equation of the complete combustion reaction of C_xH_y is:

$$C_xH_y + 11\ O_2 \rightarrow x\ CO_2 + 8\ H_2O$$

3.1 Determine the value of y.

3.2 Deduce the molecular formula of this hydrocarbon knowing that it is an alkane.

4. Decane $C_{10}H_{22}$ undergoes cracking to produce heptane and a hydrocarbon of molecular formula C_3H_6.

4.1 Distinguish between cracking and fractional distillation.

4.2 The molecular formula C_3H_6 corresponds to two possible isomers **1** and **2**.

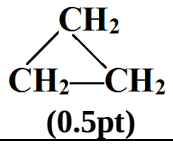
Copy and complete the table given below:

	Condensed structural formula	**Name according to (IUPAC)**	**Saturated or unsaturated hydrocarbon**	**Name of the family**
Isomer 1			Saturated hydrocarbon	
Isomer 2		Propene		

Part of the Q	Exercise 1 (7 points) **Alert from Methane** **Expected answers**	Mark
1.1	The two gases responsible of global warming are: carbon dioxide **(0.25 pt)** and methane **(0.25 pt).**	**0.5**
1.2	Fossil Energy (134 Kt).	**0.5**
2.1	The molecular formula of methane is CH_4 **(0.5 pt)**. According to **Document-2**, In model A, there is one carbon atom and four hydrogen atoms. Model A corresponds to the molecule of methane. **(0.5 pt)**.	**1**
2.2	In model A, the carbon atom shares one pair of electrons with each hydrogen atom. **(0.5 pt)** forming a single covalent bond **(0.25 pt).** In model B, the carbon atom shares two pairs of electrons with each oxygen atom. **(0.5 pt)** forming a double covalent bond **(0.25 pt).**	**1.5**
3	- The prepositions that correspond to the oxygen atom $^{16}_{8}O$ are : b **(0.25 pt)** and c **(0.25 pt).** **b)** The atomic number Z = 8 = number of protons. Since the atom is electrically neutral, the number of protons is equal to the number of electrons= 8 **(0.25 pt)**. The electron configuration of oxygen atom is K^2L^6 **(0.25 pt)**. Oxygen atom needs two electrons to complete its octet then the valence of oxygen is V = 2. **(0.25 pt)** (According to model B, oxygen atom shares two electrons with carbon atom then the valence of oxygen is V = 2). **c)** The nucleus of oxygen atom contains 8 positively charged protons **(0.25 pt).** The electron cloud of this atom contains 8 negatively charged electrons. **(0.25 pt)**. The number of charged particles in oxygen atom = 8+8 = 16 **(0,25 pt).**	**2**
4.1	Let x be the oxidation number of the element carbon in CH_4. o.n (C) + 4 o.n (H) = 0 $x + 4\times(+1) = 0$. $x = -IV$.	**0.5**
4.2	The oxidation number of the element carbon increases from $-IV$ in CH_4 to $+IV$ in CCl_4 **(0.5 pt)** then it undergoes oxidation therefore methane is the reductant. **(0.5 pt).**	**1**

Part of the Q	Exercise 2 (6 points) **Aluminum-Zinc Cell** **Expected answers**	Mark
1.1	According to **Document-1,** the mass of zinc strip increases **(0.25 pt)** then Zn^{2+} ions are reduced into Zn on the zinc strip **(0.5 pt)**. At the cathode reduction takes place then zinc strip is the cathode. **(0.25 pt)**	**1**
1.2	The anode of the cell G is aluminum Al **(0.25 pt)**. Then aluminum undergoes oxidation **(0.25 pt)** therefore it has a greater tendency to loose electrons than zinc **(0.25 pt).**	**0.75**
2	The errors committed by the student are: - The direction of the flow of electrons **(0.25 pt).** - The direction of the migration of the ions in the salt bridge. **(0.25 pt).** ➢ In a cell, electrons move from the anode to the cathode then from aluminum strip to zinc strip **(0.5 pt).**	**2**

	➢ In the cell, cations K^+ move toward the cathode **(0.25 pt)** and anions NO_3^- move toward the anode **(0.25 pt)**. At the anode, aluminum atoms Al are oxidized into Al^{3+} ions this leads to an of positive charges, to keep the electric neutrality of the solution, anions of the salt bridge migrate toward the anodic half-cell. **(0.25 pt)**. At the cathode, Zn^{2+} ions are reduced into Zn atoms this leads to a decrease in positive charges so the cations of the salt bridge migrate toward the cathodic half-cell. **(0.25 pt)**.	
3	Oxidation half- reaction : $Al \longrightarrow Al^{3+} + 3e^-$ **(0.5 pt)** Reduction half reaction : $Zn^{2+} + 2e^- \longrightarrow Zn$ **(0.5 pt)**	**1**
4	The number of electrons lost during oxidation should be equal to the number of electrons gained during reduction **(0.25 pt).** Multiply the reduction half-reaction by 3 and the oxidation half reaction by 2: $(Zn^{2+} + 2e^- \longrightarrow Zn) \times 3$ **(0.25 pt)** $(Al \longrightarrow Al^{3+} + 3e^-) \times 2$ **(0.25 pt)** The overall equation of the reaction is: $2\,Al + 3\,Zn^{2+} \longrightarrow 2\,Al^{3+} + 3\,Zn$ **(0.5 pt)**	**1.25**

Part of the Q	**Exercise 3 (7 points) Petroleum** **Expected answers**	**Mark**
1.1	The lightest petroleum fraction is the refinery gas.	**0.5**
1.2	b) $T_2 > T_1$	**0.5**
2.1	Hexane : $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$ **(0.5 pt)** 2,3-dimethypentane : $CH_3 - CH(CH_3) - CH(CH_3) - CH_2 - CH_3$ **(0.5 pt)**	**1**
2.2	The 2,3-dimethypentane is the hydrocarbon of branched chain **(0.25 pt)** because carbon number 2 (and the carbon number 3) is bonded to more than two carbon atoms. **(0.5 pt).**	**0.75**
3.1	In a chemical reaction, atoms are conserved. **(0.25 pt)** Conservation of hydrogen atoms: $y = 8 \times 2 = 16$ **(0.25 pt).**	**0.5**
3.2	The general molecular formula of an alkane is C_nH_{2n+2} **(0.25 pt)**. $2n+2 = 16$ then $n = 7$ **(0.25 pt)**. The molecular formula of this hydrocarbon is C_7H_{16} **(0.25 pt).**	**0.75**
4.1	Cracking is a chemical transformation that produces new substances. **(0.5 pt).** Whereas fractional distillation is a physical transformation that permit to separate the constituents of crude oil into different fractions. **(0.5 pt)**	**1**
4.2		**2**

	Condensed structural formula	**Name according to (IUPAC)**	**Saturated or unsaturated hydrocarbon**	**Name of the family**
Isomer 1	**(0.5pt)**	Cyclopropane **(0.25pt)**	Saturated hydrocarbon	Cycloalkane **(0.25pt)**
Isomer 2	**CH_2=CH—CH_3 (0.25pt)**	Propene	unsaturated hydrocarbon **(0.25pt)**	Alkene **(0.25pt)**