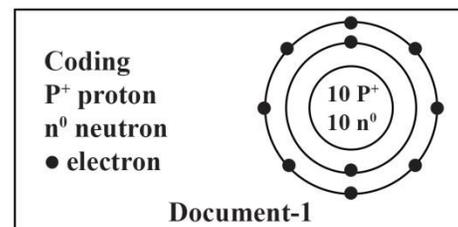| مسابقة في مادة الكيمياء | الاسم: |
| المدة: ساعة واحدة | الرقم: |

This Exam is Composed of Three Exercises. It is inscribed on Two Pages Numbered 1 and 2.
Answer the Three Following Exercises. The Use of a Non- Programmable Calculator is allowed.

Exercise 1 (7 points)   **Aluminum: A Common Metal**

Aluminum is a silvery white metal. It is the most abundant metal on Earth's crust. It has been widely used in industry in recent years replacing iron due to its low density and longer durability, because unlike iron it resists corrosion in humid air.

Document-1 shows the schematic representation of a neon atom (Ne).
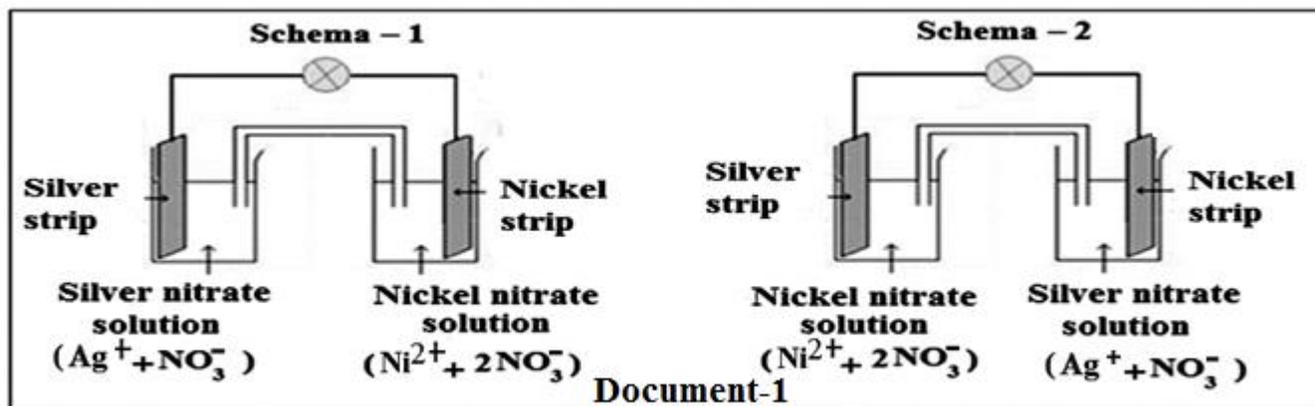
1. Pick out from the text the reasons, why in recent years, aluminum has been used in industry instead of iron.

2. Referring to **Document-1**, answer the following questions.
   2.1 Calculate the mass number (A) of the neon atom.
   2.2 Write the Lewis electron dot symbol of this atom.
   2.3 Indicate the group (column) and period (row) of the neon element in the periodic table.

Coding
P^+ proton
n^0 neutron
• electron

10 P^+
10 n^0

Document-1

3. In certain chemical reactions, each aluminum atom loses 3 electrons to become a stable ion Al^{3+}. Aluminum ion has the same electron configuration as that of the neon atom.
   3.1 Determine the relative charge of the electron cloud of the aluminum ion Al^{3+}, knowing that the relative charge of an electron is 1- .
   3.2 Show that the number of electrons in the electron cloud of the aluminum atom is 13.
   3.3 Deduce the atomic number of the aluminum atom.

4. Aluminum's corrosion resistance is due to the formation of a thin surface layer of aluminum oxide (Al_2O_3) that forms when the metal is exposed to humid air, which prevents effectively further oxidation.
   The equation of the reaction of formation of Al_2O_3 is as follows: $4\,Al + 3\,O_2 \rightarrow 2\,Al_2O_3$
   Verify that the reaction of formation of Al_2O_3 is an oxidation-reduction reaction, knowing that the oxidation number of the aluminum element in the compound Al_2O_3 is +III.

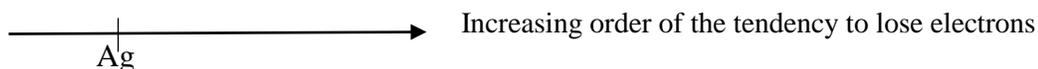**Exercise 2 (6 points)**   **Ni-Ag Electrochemical Cell**

In order to construct a functioning Ni-Ag electrochemical cell, a grade 9 student proposed two labelled schemas represented in **Document-1.**

1. Choose which of these schemas corresponds to this Ni-Ag electrochemical cell. Justify.

2. Among these two metals, nickel is more active than silver.
  2.1 Identify the anode of this cell.
  2.2 Indicate the direction of the flow of electrons.
  2.3 Recopy and represent on the axis given below the placement of the nickel metal.

  ──────────────────────────────▶ Increasing order of the tendency to lose electrons
       Ag

3. During the functioning of this electrochemical cell, half reactions take place at the level of the electrodes.
  3.1 Write the half-reactions that take place at these electrodes.
  3.2 Deduce the overall redox reaction.
  3.3 Specify the reductant (reducing agent) in the overall redox reaction.
4. One of the students suggests the following incorrect representation of this cell: $Ag^+|Ag$-salt bridge- $Ni|Ni^{2+}$ as the symbolic representation of the Ni-Ag electrochemical cell.
  Give the correct symbolic representation of this cell.

Exercise 3 (7 points)   Petroleum

Crude oil is a mixture of many hydrocarbons . In the refinary , petroleum is subjected to fractional distillation and the long carbon chain alkanes obtained are also subjected to cracking.
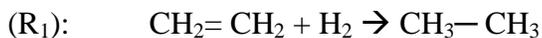**Document-1**, shows the condensed structural formulas and the normal boiling temperature of each of the hydrocarbons (A), (B) and (C) respectively.

Hydrocarbon	(A)	(B)	(C)
Condensed Structural Formula	CH_3-$(CH_2)_4$-CH_3	CH_3-CH-CH_2-CH_2-CH_3 | CH_3	CH_3-CH- CH-CH_3 | | CH_3 CH_3
Normal Boiling Temperature	68.73°C	60.3°C	58°C
Document-1			

1. Referring to **Document-1**, answer the following questions:
  1.1 Show that the three given hydrocarbons are isomers.
  1.2 Deduce how the normal boiling temperature varies as a function of the number of branches in the given isomers.
  1.3 Give the name of each hydrocarbon (A) and (C).
2. In the refinary, the cracking of hexane gives an alkane **(C_xH_y)** and an alkene C_3H_6 according to the following equation :
$$C_6H_{14} \rightarrow C_xH_y + C_3H_6$$
  2.1 Deteremine the molecular formula of the alkane **(C_xH_y)**.
  2.2 Write the structural formula of the alkene C_3H_6 **.**
3. Among the reactions studied in organic chemistry, the following reactions (R) are listed: substitution, addition and polymerization.
  3.1 Match each chemical reaction with its type :

  (R_1): $CH_2= CH_2 + H_2 \rightarrow CH_3— CH_3$ **a.** Polymerization
  (R_2): $CH_4 + Cl_2 \rightarrow CH_3Cl + HCl$ **b.** Substitution
  (R_3) : $n\ CH_2= CH_2 \rightarrow (CH_2— CH_2)_n$ **c.** Addition

  3.2 Give the name of the chemical product obtained in reaction (R_3).

Exercise 1 (7 points)   **Aluminum: A Common Metal**

Part of Question	Expected Answer	Mark
1.	Low density **(0.5 pt)** ; longer durability **(0.5 pt)**	**1**
2.1	The mass number represents the number of nucleons (protons and neutrons) in the nucleus of an atom, then A = number of p^+ (Z) + number of n^0(N) = 10+10 = 20.	**0.75**
2.2	The Lewis electron dot symbol of the Neon atom is: $\overset{\cdot\cdot}{\underset{\cdot\cdot}{:Ne:}}$	**0.5**
2.3	Neon belongs to group VIII (column 18) **(0.25 pt)** and period 2 (row 2) **(0.25 pt)**	**0.5**
3.1	The Aluminum ion Al^{3+} and the Neon atom have the same electron configuration => The Neon atom and the Aluminum ion Al^{3+} have the same number of electrons (10 e^-) **(0.5pt).** The relative charge of the electron cloud of the aluminum ion = number of electrons x relative charge of one electron **(0.25 pt)** = 10 x (1-) = 10- **(0.5 pt)**	**1.25**
3.2	The aluminum ion has 10 electrons. The aluminum atom loses 3 electrons to become an aluminum ion => number of electrons in the electron cloud of the aluminum atom is: 10 + 3 = 13.	**0.75**
3.3	An atom is electrically neutral, the number of electrons = number of protons. **(0.25pt)** The number of protons in the nucleus of aluminum atom =13; **(0.25 pt)** The atomic number = number of protons =Z =13. **(0.5 pt)**	**1**
4.	4 Al + 3 O_2 → 2 Al_2O_3 The oxidation number of Al = 0 (uncombined element) **(0.25 pt)** The oxidation number of O in O_2 = 0 (uncombined element) **(0.25 pt)** The oxidation number of Al in Al_2O_3 = +III The oxidation number of O in Al_2O_3 = -II **(0.25 pt)** The oxidation number of aluminum increases from 0 to +III so it undergoes oxidation. The oxidation number of oxygen decreases from 0 to –II so it undergoes reduction. Since the oxidation number changed between the reactants and the product so this reaction is an oxidation- reduction.**(0. 5pt)**	**1.25**

Exercice 2 (6 points)   **Ni-Ag Electrochemical Cell**

Part of Question	Expected Answer	Mark
1	Schema (**I**) is correct **(0.5pt),** in order to form a half cell each metal should be immersed in a solution containing its proper ions **(0.5 pt).**	**1**
2.1	Since nickel is more active than silver thus nickel undergoes oxidation. **(0.5 pt),** then the nickel strip acts as the anode. **(0. 5 pt)**	**1**
2.2	The electrons flow from the nickel strip (anode) to the silver strip (cathode).	**0. 5**

2.3	Ag ———|—————|———→ Ni (0.25pt x2) Increasing order of the tendency to lose electrons	0.5
3.1	At the anode: $Ni \rightarrow 2e^- + Ni^{2+}$ **(0.5 pt)** At the cathode: $(Ag^+ + 1e^- \rightarrow Ag$ **(0.5 pt)**	1
3.2	The number of electrons lost should be equal to the number of electrons gained. **(0.25 pt)** $Ni \rightarrow 2e^- + Ni^{2+}$. $(Ag^+ + 1e^- \rightarrow Ag$) x2 **(0.25 pt)**. Overall equation : $Ni + 2Ag^+ \rightarrow Ni^{2+} + 2Ag$. **(0.5 pt)**.	1
3.3	The reductant is the species that undergoes oxidation (loses electrons) **(0.25 pt)**, then Ni is the reductant. **(0.25 pt)**	0.5
4	The correct symbolic representation of this cell is : $Ni|Ni^{2+}$-salt bridge- $Ag^+|Ag$	0.5

Exercise 3 (7 points)   Petroleum

Part of Question	Expected Answer	Mark
1.1	These compounds have the same molecular formula C_6H_{14} but different condensed structural formulas then they are isomers.	1
1.2	(A) does not contain branches, (B) contains one branch and (C) contains two branches **(0.25pt)**. $t_{boiling}(A) = 68.73^oC > t_{boiling}(B) = 60.3^oC > t_{boiling}(C) = 58^oC$ **(0.25pt)**. for the isomers of alkanes, the normal boiling temperature decreases as the number of branches increases **(0.5pt)**	1
1.3	(A) : Hexane **(0.5pt)** (C) : 2,3-dimethylbutane **(0.5pt)**	1
2.1	According to the law of conservation of matter, the number of atoms of each element is conserved. **(0.25pt)** For carbon : $6 = x + 3$ then $x = 3$ **(0.5pt)** For hydrogen : $14 = y + 6$ then $y = 8$ **(0.5pt)** Therefore the molecular formula of alkane C_xH_y is : C_3H_8 **(0.25pt)**	1.5
2.2	The structural formula of the alkene C_3H_6 : 	0.5
3.1	$R_1 \rightarrow c$ (addition) $R_2 \rightarrow b$ (substitution) $R_3 \rightarrow a$ (polymerization) 3x(0.5)	1.5
3.2	polyethene	0.5