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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) **Potassium**

Potassium (K) is a chemical element that is oxidized rapidly in contact with air and reacts violently with water. It is often kept immersed in oil.
Some chemical fertilizers contain potassium element in the form of many salts such as potassium chloride KCl.

1. By referring to the text, justify the storage of potassium in oil.
2. The relative charge of the electron cloud of potassium atom is equal to 19 – :
   2.1. Deduce the relative charge of the nucleus of potassium atom.
   2.2. Show that the atomic number of potassium is 19, knowing that the relative charge of one proton is 1+.
3. **Chlorine has seven valence electrons.**
   Answer the following questions:
   3.1. Indicate the valence of chlorine atom (Cl).
   3.2. Specify the column (Group) to which chlorine element belongs in the periodic table.
   3.3. Given:
   - Potassium has one valence electron.
   - The bond formation between potassium and chlorine is represented by the transfer of an electron from the valence energy level of potassium atom to that of chlorine atom.
   - Identify the type of chemical bond in potassium chloride KCl.
4. Two atoms of potassium and one molecule of chlorine gas react to produce two molecules of Potassium chloride KCl
   -Verify, using oxidation numbers, that the reaction between potassium and chlorine gas is an oxidation-reduction (Redox) reaction.
   Given: The oxidation number of K in KCl is equal to +I.

Exercise 2 (7 points) **Petroleum Products**

Some hydrocarbons with linear (non-branched) carbon chains tend to detonate (explode) in the cylinder of car engines and violently push the piston forward.
Other hydrocarbons with branched carbon chains burn slowly in the engine and gently push the piston forward which limits the detonation.
The octane number is a number that expresses the anti-knock characteristics of a fuel. The higher the octane number, the less explosive is the gasoline.
1. In Lebanon, there are two types of gasoline for cars: «95 octane» and «98 octane», having octane numbers of 95 and 98 respectively.
   Referring to the text, specify which of these two types of gasoline is more explosive.
2. Octane can be extracted from crude oil by a physical process.
   2.1 What is the name of this process?
   2.2 Choose, from the propositions given below, the one that corresponds to this process.
   a) A process during which the components of a mixture are separated based on the difference in their boiling points.
   b) A process during which large molecules are broken down into smaller molecules.

c) A process through which addition of identical molecules occurs.

3. The complete combustion of octane (C_8H_{18}) in the presence of oxygen is a source of pollution.
    3.1. Indicate the family to which octane belongs.
    3.2. Write the word equation of the complete combustion reaction of octane.
    3.3. Carbon dioxide obtained is a greenhouse gas, the increase in the level of greenhouse gases in the atmosphere contributes to global warming.
       - Give one consequence of global warming.
4. Given the hydrocarbon 2,2,4-trimethylpentane.
    Answer by True or False. Correct the false statement(s).
    a) The carbon chain of 2,2,4-trimethylpentane is linear.
    b) 2,2,4-trimethylpentane is an isomer of octane.
    c) 2,2,4-trimethylpentane is more explosive than octane.

Exercise 3 (6 points)   Electrochemical Cells

Metals differ by their tendencies to lose electrons. A metal **(M_1)** is more active than another metal **(M_2)** if it has greater tendency to lose electrons. The metal **(M_1)** serves as anode in an electrochemical cell **M_1- M_2**.
Two galvanic cells **(G_1)** and **(G_2)** are constructed as follows:
For the galvanic cell **(G_1):**
- Magnesium strip is immersed in a solution containing magnesium ions.
- Zinc strip is immersed in a solution containing Zinc ions.
- The two metallic strips are connected by connecting wires through a lamp and a switch.
- The two beakers are connected by a salt bridge containing potassium nitrate solution.
- Galvanic cell **(G_1)** measures a voltage equals to one point sixty one volt.
For the galvanic cell **(G_2):**
- Magnesium strip is immersed in a solution containing magnesium ions.
- Copper strip is immersed in a solution containing Copper ions.
- The two metallic strips are connected by connecting wires through a lamp and a switch.
- The two beakers are connected by a salt bridge containing potassium nitrate solution.
- Galvanic cell **(G_2)** measures a voltage equals to two point seventy one volt.
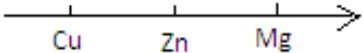Answer the following questions:
1. Knowing that magnesium strip is the anode of the cell **(G_1)**,
    - Indicate the direction of the flow of electrons in this cell.
2. Write the half-reaction that takes place at the anode of the galvanic cell **(G_1)**.
3. The half-reaction that takes place at the cathode of the cell **(G_1)** is: $Zn^{2+} + 2e^- \rightarrow Zn$.
    - Deduce the overall equation of the reaction that takes place in the electrochemical cell **(G_1)**.
4. Show that magnesium strip is the anode of the cell **(G_2)**.
5. Choose, from the proposed representations, the one that corresponds to the electrochemical cell **(G_2)**.
    a) $Cu \mid Cu^{2+}$ - salt bridge - $Mg^{2+} \mid Mg$ b) $Cu^{2+} \mid Cu$ - salt bridge - $Mg \mid Mg^{2+}$
    c) $Mg \mid Mg^{2+}$ - salt bridge - $Cu^{2+} \mid Cu$ d) $Mg^{2+} \mid Mg$ - salt bridge - $Cu \mid Cu^{2+}$
6. In an electrochemical cell, the greater the difference in the tendencies of metals to lose electrons, the higher is the voltage of the cell.
    - Arrange the metals Cu, Mg, and Zn on an axis by increasing order of their tendencies to lose electrons. Justify.

Part of Q	Exercise 1 (7 pts) Potassium Expected Answer	Mark
1.	Potassium is oxidized rapidly in contact with air and reacts violently with water. So it is often kept immersed in oil.	1
2.1	As atom is electrically neutral then the total charge of the atom = 0 **(0.25 pt)** Total charge of the atom = Relative charge of nucleus + Relative charge of electron cloud **(0.5 pt)** Relative charge of nucleus = 0- (19-) =19+ **(0.25 pt)**	1
2.2	charge of nucleus = (number of protons) × (relative charge of a proton) **(0.25 pt)** 19+ = (number of protons) × (1+) **(0.25 pt)** Number of protons $= \frac{19+}{1+} = 19$ **(0.25 pt)** Z = number of protons =19 **(0.25 pt)**	1
3.1	The valence of chlorine atom is 1.	0.5
3.2	Chlorine belongs to column 17 (group VII) **(0.5pt)** since chlorine atom has 7 valence electrons **(0.5pt)**,	1
3.3	There is a transfer of electron between potassium atom and chlorine atom. **(0.5pt)** As there is a transfer of electrons, the bond is ionic. **(0.5pt)**	1
4	$2\ K + Cl_2 \rightarrow 2\ KCl$ 0 0 +I −I **(0.25 × 2)** Let $\varkappa$ be the oxidation number of Cl in KCl $1+ \varkappa = 0$ $\varkappa$ = -1 **(0.5pt)** The oxidation number of chlorine atom decreases from 0 to –I, while the oxidation number of the potassium atom increases from 0 to + I. Since the oxidation numbers vary between reactants and product so the reaction is an oxidation-reduction reaction. **(0.5 pt)**	1.5

Part of Q	Exercise 2 (7 points) Petroleum Products Expected Answer	Mark
1.	Gasoline «95 octane» is more explosive than Gasoline «98 octane» **(0.5 pt)** Since the higher the octane number, the less explosive is the gasoline. **(0.5 pt)**	1
2.1	Fractional distillation	0.5
2.2	**a**. A process during which the components of a mixture are separated based on the difference in their boiling points.	0.5
3.1	Octane belongs to the family of Alkanes.	0.5
3.2	The equation of the complete combustion reaction of octane : Octane + oxygen → carbon dioxide + water vapor.	1
3.3	Melting of polar ice caps. Or change in the distribution of rainfall (precipitations) over various continents.	1

4	- The statement (a) is False **(0.5 pt)** : The carbon chain of 2,2,4-trimethylpentane is branched. **(0.5 pt)** - The statement (b) is correct. **(0.5 pt)** - The statement (c) is False **(0.5 pt)**: Octane is more explosive than 2,2,4-trimethylpentane **(0.5 pt)**	**2.5**

Part of Q	Exercise 3 (6pts) Electrochemical Cells Expected Answer	Mark
1.	In an electrochemical cell, electrons moves from the anode to the cathode then electrons flow from magnesium strip Mg toward the zinc strip Zn.	**0.75**
2.	The half-reaction that takes place at the anode is: $Mg \rightarrow Mg^{2+}+2e^-$	**0.75**
3.	In a redox reaction, electrons are conserved (the number of electrons lost is equal to the number of electrons gained). **(0.5pt)** At the cathode: $Cu^{2+}+2e^- \rightarrow Cu$ + At the anode: $Mg \rightarrow Mg^{2+}+2e^-$ ----------------------- The overall equation of the reaction is: $Mg + Cu^{2+} \rightarrow Mg^{2+}+ Cu$ **(0.5pt)**	**1**
4.	In the schema of the cell **(G₂)**, the anions NO_3^- move toward the solution containing Mg^{2+} ions to maintain its electric neutrality **(0.25 pt)** this indicates that the quantity of positive ions Mg^{2+} increases in the solution **(0.25 pt)** then Mg undergoes oxidation **(0.5 pt)**. Therefore Mg is the anode of this electrochemical cell.	**1**
5.	The written representation of the electrochemical cell **(G₁)** is: c) $Mg \mid Mg^{2+}$- Salt bridge -$Cu^{2+} \mid Cu$	**1**
6.	In the cell **(G₁)**: Mg is the anode then it has more tendency to lose electrons than Zn. **(0.25 pt)** In the cell **(G₂)**: Mg is the anode then it has more tendency to lose electrons than Cu. **(0.25 pt)** The greater the difference in the tendency of metals to lose electrons, the higher is the voltage of the cell. The voltage of the cell **(G₂)** > the voltage of the cell **(G₁)** (2.71V >1.61V) **(0.25 pt)** then : Cu Zn Mg → **Increasing order of the tendency of metals to lose electrons** **(0.75 pt)**	**1.5**