This Exam Is Composed of Three Exercises. It Is Inscribed on 2 Pages.
Answer the Three Following Exercises:

First Exercise (6 points)
The Importance of Helium

Scuba divers normally use pressurized mixture of nitrogen gas and oxygen gas for breathing under water. However, when the above mixture is used at depths where pressure is high, the nitrogen gas is dissolved in the blood, which can cause mental disorientation. To avoid this problem, a breathing mixture of helium gas and oxygen gas can be used. The diver still obtains the necessary oxygen gas but the un-reactive helium, that dissolves in the blood, doesn't cause mental disorientation.

Given: - The Lewis dot structure for each of the molecules of nitrogen gas and oxygen gas are shown respectively in **Figure-1.**
- Both nitrogen and oxygen belong to row 2 (period 2) of the periodic table.

$$N \equiv N \qquad :\overset{..}{\underset{}{O}} = \overset{..}{\underset{}{O}}:$$

Figure - 1

Refer to Figure 1 to Answer Questions (1 to 3):

1- Identify the type of bond in oxygen molecule.
2- Indicate the valence of oxygen atom.
3- Determine the atomic number of the element nitrogen.
4- A scuba diver has planned for deep-diving, for this purpose he filled his breathing bottle with a mixture of oxygen (O_2) gas and 0.8g of helium (He) gas.
   4.1- Calculate the number of moles of helium gas filled in the bottle. **Given:** M (He) = 4 g.mol^{-1}
   4.2- Explain why the scuba diver has filled his breathing bottle with a mixture of helium gas and oxygen gas instead of a mixture of nitrogen gas and oxygen gas.

Second Exercise (7 points)
Anode or Cathode!

To know whether a metal is the anode or the cathode in a galvanic cell, its tendency to lose electrons is compared to the tendency to lose electrons of another metal.
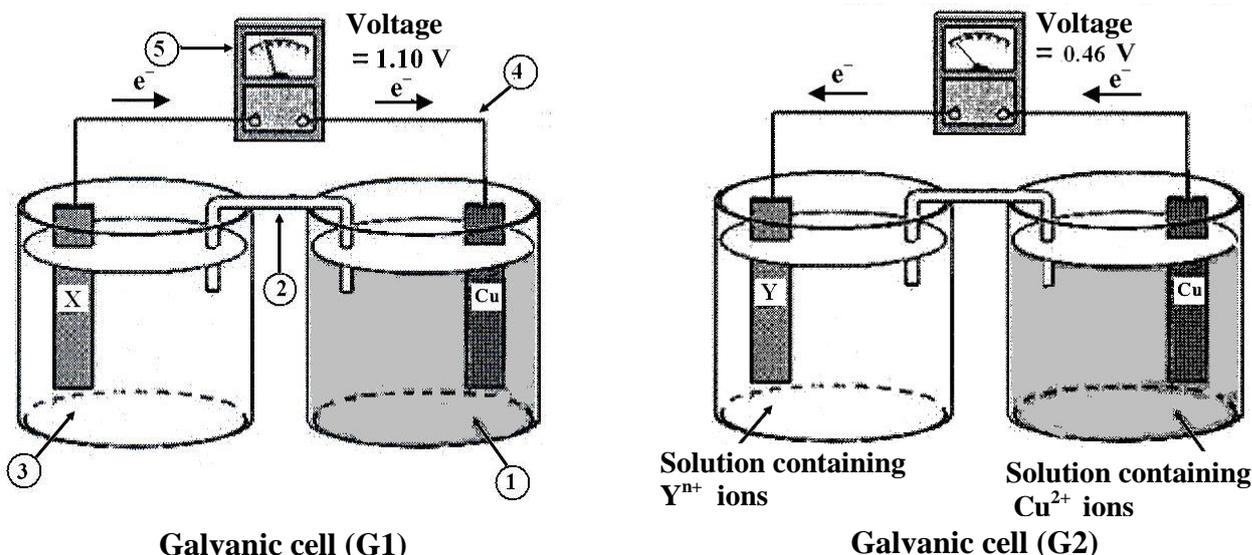**Given:**
  • The tendency to lose electrons of three metals: silver, copper and zinc are arranged in an increasing order on a horizontal axis.

Ag   Cu   Zn

Tendency to lose electrons
in an increasing order.

  • In a galvanic cell, the greater is the difference in the tendency to lose electrons of the metals serving as electrodes, the greater is the voltage of the galvanic cell.

• The schema of each of the two galvanic cells (G1) and (G2) is shown below:

Galvanic cell (G1)   **Galvanic cell (G2)**

Use the given information to answer the following questions:

1- Indicate the anode of the galvanic cell **(G2)**.
2- Identify the metals X and Y in the galvanic cells **(G1)** and **(G2)**.
3- List the names of the materials numbered on the schema of the galvanic cell **(G1)**.
4- Write the half-reaction that takes place at each of the two electrodes in the galvanic cell **(G2)**.
5- Deduce the equation of the overall reaction that takes place in the galvanic cell **(G2)**.
6- Two galvanic cells have the following written cell representations:

      a) $Zn \mid Zn^{2+}$ — salt bridge — $Cu^{2+} \mid Cu$
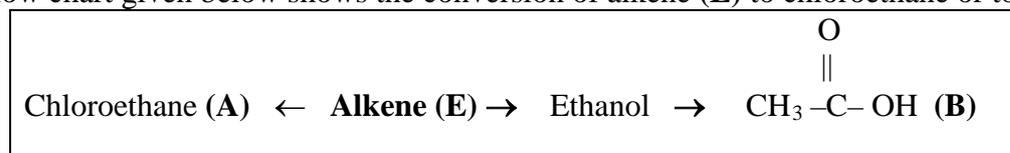   **b)** $Zn \mid Zn^{2+}$ — salt bridge — $Ag^{+} \mid Ag$

Specify among the given written cell representations, the written cell representation of the galvanic cell which has the greater voltage.

Third Exercise (7 points)
Ethanol: An Important Industrial Compound

Ethanol is a raw material used in chemical industry. A molecule of ethanol contains two carbon atoms, six hydrogen atoms and one oxygen atom.

1- The flow chart given below shows the conversion of alkene **(E)** to chloroethane or to ethanol.

$$\text{Chloroethane (A)} \leftarrow \textbf{Alkene (E)} \rightarrow \text{Ethanol} \rightarrow \underset{\displaystyle CH_3-\overset{\textstyle O}{\overset{\textstyle \|}{C}}-OH}{} \textbf{(B)}$$

    1.1- Give the molecular formula of ethanol.
    1.2- Write the condensed structural formula of ethanol.
2- Ethanol can be converted to compound **(B)**.
    2.1- Give the IUPAC name of compound **(B)**.
    2.2- Indicate the type of bond between each of the two oxygen atoms and the carbon atom in the carboxyl group.
3- Industrially, one molecule of ethanol can be obtained by the addition of one molecule of water to one molecule of an alkene **(E)**.
    3.1- Determine the molecular formula of alkene **(E)**.
    3.2- Give the name of the functional group of alkene **(E)**.
4- Write, using structural formulas of the organic compounds, the equation of the reaction which allows to obtain chloroethane from alkene **(E)**.
5- Ethanol reacts with compound **(B)** in the presence of sulfuric acid, to give a compound **(C)** and water. Give the name of the reaction involved.

Part of the Q	Answer	Mark
	First Exercise (6 points)	
1	Based on **Figure-1**, the bond in O_2 molecule is a double covalent bond because it results from the sharing of two pairs of electrons between two oxygen atoms.	1
2	The valence of oxygen atom is 2. *The number of valence electrons for each oxygen atom is 6, its valence is 8-6 = 2 *Based on Lewis dot structure, oxygen atom has two unpaired electrons =>its valence is 2.	1
3	Based on **Figure-1**: N has five valence electrons (Lewis dot structure) **(0.5pt)** N belongs to period 2. The electron configuration of N is: K^2, L^5 **(0.5pt)** The atom is electrically neutral. The number of protons is equal to the number of electrons. **(0.5pt)** Number of protons = Atomic number (Z) $\Rightarrow$ Z = 7 **(0.5pt)**	2
4.1	Number of moles n = m (g) / M $(g.mol^{-1})$ **(0.5pt)** n (He) = 0.8/4 = 0.2mol **(0.5pt)** *No unit **(0.25pt)**	1
4.2	Under high pressure (deep-diving), nitrogen gas is dissolved in the blood, where it can cause mental disorientation. To avoid this disorientation, he filled his breathing bottle with helium-oxygen mixture. The un-reactive helium gas which dissolves in the blood does not cause mental disorientation. *To avoid mental disorientation **(zero)**	1
	Second Exercise (7 points)	
1	- Cu strip is the anode of the galvanic cell **(G2)**.	0.75
2	- In the galvanic cell **(G2)**, metal Y has less tendency to lose electrons than Cu, because Cu is releasing electrons. Based on the given axis "tendency to lose electrons", Y is Ag.**(1pt)** - In the galvanic cell **(G1),** metal X has more tendency to lose electrons than Cu, because X is releasing electrons. Based on the given axis "tendency to lose electrons", X is Zn. **(1pt)**	2

3	The materials numbered on the schema of the galvanic cell **(G1)** are:
	  1 - Solution containing Cu^{2+} ions
	  2 – Salt bridge
	  3 - Solution containing Zn^{2+} ions
	  4 - Connecting wires
	  5 – Voltmeter **(5×0.25 pt)**
		1.25

		* - U tube containing electrolyte. - Multimeter.	
4		- The half-reaction at the anode is: $\quad Cu \rightarrow Cu^{2+} + 2e^-$ **-** The half-reaction at the cathode is: $\quad Ag^+ + e^- \rightarrow Ag$ **(2×0.5 pt)**	**1**
5		$Cu \rightarrow Cu^{2+} + 2e^-$ $\underline{2x \ (Ag^+ + e^- \rightarrow \ Ag \ )} \quad \textbf{(0.5pt)}$ $Cu + 2Ag^+ \rightarrow Cu^{2+} + 2\,Ag$ **(0.5pt)** is the equation of the overall reaction of the galvanic cell (**G2**) .	**1**
6		- The written cell representation which has the greater voltage is: $Zn \mid Zn^{2+}$ — salt bridge — $Ag^+ \mid Ag$ Because the difference in the tendency to lose electrons between Zn and Ag is greater than the difference in the tendency to lose electrons between Zn and Cu.	**1**

		Third Exercise (7 points)	
1.1		The molecular formula of ethanol is C_2H_6O	**1**
1.2		The condensed structural formula is: $\quad CH_3 - CH_2\,OH$	**0.50**
2.1		Compound (**B)** is: Ethanoic acid**.**	**0.75**
2.2		C – OH, is simple covalent bond. C = O, is double covalent bond. **(2×0.50pt)**	**1**
3.1		According to the law of conservation of mass (atoms), the number of atoms of each element is conserved. **(0.5pt)** A molecule of ethanol contains two carbon atoms =>A molecule of alkene (**E**) contains two carbon atoms. The general formula of alkenes is: C_nH_{2n}. For n = 2 $\Rightarrow$ The molecular formula of (**E**) is: C_2H_4 **(1pt)** *$C_nH_{2n}+H_2O \rightarrow C_2H_6O$ for n=2 the formula is C_2H_4 **(1 pt)** *$C_xH_y+H_2O \rightarrow C_2H_6O$ for x= 2 and y+2 = 6 => y=4 the formula of (**E**) is C_2H_4 **(1 pt)** *$C_2H_4+H_2O \rightarrow C_2H_6O$ **(1 pt)**	**1.5**
3.2		The functional group is: Double covalent bond.	**0.50**
4		The equation of the reaction is: $\quad$ H $\quad$ H $\qquad\qquad\qquad$ H $\quad$ H $\quad \mid \quad \mid \qquad\qquad\qquad\quad \mid \quad \mid$ H- C = C - H $\ +$ H- Cl $\ \rightarrow \quad$ H- C – C - H $\qquad\qquad\qquad\qquad\qquad\qquad \mid \quad \mid$ $\qquad\qquad\qquad\qquad\qquad\quad$ H $\quad$ Cl *molecular formula or condensed structural formula **(0.5pt)**	**1.25**
5		Esterification reaction. * Ester formation reaction.	**0.50**

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