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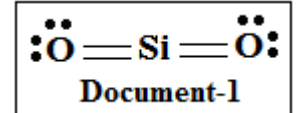
مسابقة في مادة الكيمياء  
المدة: ساعة واحدة

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

### Exercise 1 (6 points) Manufacture of Glass

The principle of manufacturing glass and the raw materials used had almost been the same since thousands of years.

The constituents of glass vary according to the type of glass manufactured. The most common raw materials of glass are mainly silicon dioxide (silica)  $\text{SiO}_2$ , calcium oxide  $\text{CaO}$  and sodium oxide  $\text{Na}_2\text{O}$ .



- Pick out from the text, the names of the raw materials used in the manufacture of glass.
- Document-1** shows the Lewis structure of the silica molecule  $\text{SiO}_2$ .

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

- Specify the column (group) to which silicon (Si) belongs in the periodic table.
- Choose the valence of oxygen atom (O) in silica. Justify.

a) Valence = 6

b) Valence = 4

c) Valence = 2

- Quick lime is the name given to the ionic compound calcium oxide  $\text{CaO}$ .

**Document-2** represents the equation of formation of calcium ion  $\text{Ca}^{2+}$  and the electron configuration of this ion.

- Equation of formation of calcium ion:  $\text{Ca} \rightarrow \text{Ca}^{2+} + 2e^-$
- Electron configuration of calcium ion:  $\text{K}^2 \text{L}^8 \text{M}^8$

**Document -2**

- Answer by true or false. Justify.

- The nucleus of calcium atom (Ca) and its corresponding ion have the same composition.
- The number of electrons in calcium ion  $\text{Ca}^{2+}$  is equal to 20.
- The atomic number of calcium element is  $Z = 20$ .
- Explain how oxygen atom attains stability in each of the compounds calcium oxide  $\text{CaO}$  and silicon dioxide  $\text{SiO}_2$ .

### Exercise 2 (7 points) Electrochemical Cells

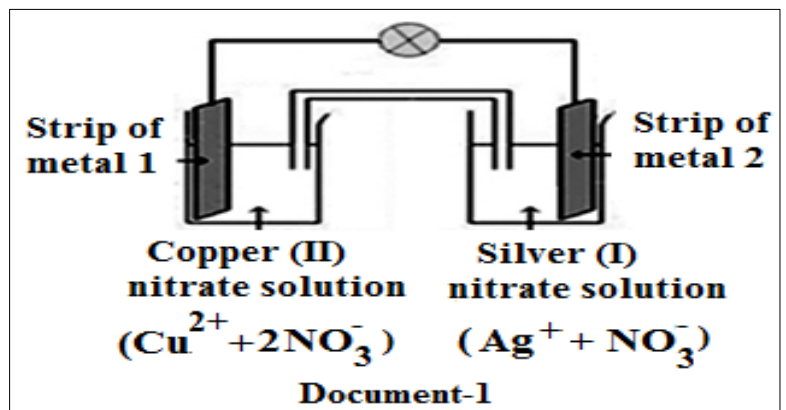
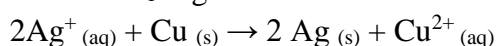
An electrochemical cell converts chemical energy into electric energy. Several metals can be used to construct cells. Metals differ in their tendencies to lose electrons; for example copper (Cu) has more tendency to lose electrons than silver (Ag) and it has less tendency to lose electrons than magnesium (Mg).

The greater the difference between the tendencies of metals to lose electrons, the higher the voltage of the cell.

- An electrochemical cell  $G_1$  is constructed.

**Document-1** shows the schema of the functioning cell  $G_1$ .

- Identify the metal (1).
- The overall equation of the cell reaction  $G_1$  is given below:



**Document-1**

1.2.1. Show, using oxidation numbers, that the above equation corresponds to an oxidation-reduction reaction.

1.2.2. Write the half-reactions that take place at the anode and the cathode of the cell  $G_1$ .

1.3. Justify the following statements:

- The mass of the copper strip decreases after a certain time of the functioning of the cell  $G_1$ .
- When the salt bridge is removed, the lamp of the cell  $G_1$  doesn't glow.

2. Referring to the text, answer the following questions:

2.1. Arrange the metals copper (Cu), silver (Ag) and magnesium (Mg) on an axis according to their increasing tendencies to lose electrons.

2.2. A cell  $G_2$  is constructed by connecting the two half-cells:

- A magnesium strip (Mg) dipped in a solution containing magnesium ions  $Mg^{2+}$ .
  - A silver strip (Ag) dipped in a solution containing silver ions  $Ag^+$ .
- Give the symbolic representation of the cell  $G_2$ .

2.3. Under standard conditions, the voltage of the cell  $G_1$  is  $U_1 = 0.46V$ .

- Choose from the following values, the one that corresponds to the voltage ( $U_2$ ) of the cell  $G_2$  under the same conditions. Justify.

a)  $U_2 = 0.46 V$

b)  $U_2 = 0.16 V$

c)  $U_2 = 3.17 V$

### Exercise 3 (7 points)

### Organic Compounds

Organic molecules play an important role in the functioning and the structure of organisms. These molecules are mainly made up of the element carbon and may contain other elements such as H, O, N...

Hydrocarbons are organic compounds that consist only of the elements carbon and hydrogen.

**Document-1** is a table that shows the condensed structural formulas of some organic compounds.

1	2	3	4
$CH_3-CH_2-CH_2-CH_2-CH_3$	$CH_2 = CH_2$	$CH_3-CH-CH_2-CH_3$   $CH_3$	$CH_3-CH_2OH$
<b>Document-1</b>			

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

1.1. Name according to the IUPAC system the compounds (1) and (3).

1.2. Show that compounds (1) and (3) are isomers.

1.3. Specify whether compound (4) is a hydrocarbon or not.

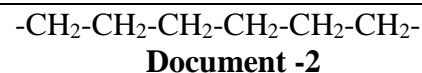
1.4. Choose one unsaturated compound.

2. Write, using condensed structural formulas of organic compounds, the equation of the reaction that allows preparing compound (4) starting from compound (2).

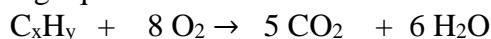
3. Under appropriate conditions, Compound (2) is used to prepare a polymer (P).

**Document-2** represents a part of the polymeric chain of (P).

- Indicate the number of repeating units in the given part of polymer (P).



4. The complete combustion of hydrocarbon (A) of molecular formula  $C_xH_y$  is represented by the following equation:



4.1. Determine the molecular formula of hydrocarbon (A).

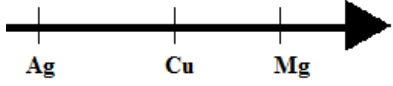
4.2. Carbon dioxide  $CO_2$  released by this combustion reaction is one of the greenhouse gases.

The increase in the amount of greenhouse gases in the atmosphere leads to global warming.

- List two consequences of global warming.

Part of the Q	Exercise 1 (6 pts) Manufacturing of glass Expected answers	Mark
1.	Silicon oxide (0.25 pt), Calcium oxide (0.25 pt) and sodium oxide (0.25 pt).	0.75
2.1.	Silicon makes a double covalent bond with each of the two oxygen atoms (0.25 pt.), then silicon shares two pairs of electrons with each of the two atoms of oxygen. (0.25 pt.) , therefore it has $2 + 2 = 4$ valence electrons (0.25 pt ) then the silicon (Si) belongs to column 14 (group IV). (0.25 pt )	1
2.2.	The expected answer is c. (the valence of oxygen is 2) (0.5 pt ) Each oxygen atom shares 2 pairs of electrons with silicon. (0.5 pt ) (Valence is the number of electrons gained, lost or shared by an atom).	1
3.	a. True. (0.25 pt ) The atom loses two electrons to become an ion. The number of protons and neutrons is conserved. (0.5 pt ) b. False. (0.25 pt ) Based on the electron configuration of calcium ion given in Document-2, the total number of electrons = $2 + 8 + 8 = 18$ . (0.5 pt ) c. True (0.25 pt ). Based on the equation : $\text{Ca} \rightarrow \text{Ca}^{2+} + 2\text{e}^-$ Calcium atom has two electrons more than $\text{Ca}^{2+}$ , the number of electrons of calcium atom is $18 + 2 = 20$ . Number of protons = number of electrons (the atom is electrically neutral). Then the atomic number of calcium element is 20. (0.5 pt )	2.25
4.	In the ionic compound calcium oxide CaO, oxygen atom gains two electrons coming from calcium atom and become saturated and stable according to octet rule. (0.5 pt ) In the molecular compound SiO <sub>2</sub> , each oxygen atom shares two pairs of electrons with silicon atom and becomes saturated and stable according to octet rule. (0.5 pt )	1

Part of the Q	Exercise 2 ( 7 points) Electrochemical Cells Expected answers	Mark
1.1	In an electrochemical cell each metal is dipped in a solution containing its corresponding ions. Metal 1 is copper (0.5 pt ) since it is dipped in a copper (II) nitrate solution containing $\text{Cu}^{2+}$ ions (0.5 pt )	1
1.2.1	$2 \text{Ag}^+_{(\text{aq})} + \text{Cu}_{(\text{s})} \rightarrow 2 \text{Ag}_{(\text{s})} + \text{Cu}^{2+}_{(\text{aq})}$ o.n. :    +I            0            0            +II (0.25 × 4 pt ) The oxidation number of silver element decreases from (+I) to (0) ; it undergoes reduction. (0.25 pt ) The oxidation number of copper element increases from (0) to (+II); it undergoes oxidation. (0.25 pt ) Then the reaction of the cell G <sub>1</sub> is a redox reaction as change in oxidation numbers takes place. (0.25 pt )	1.75

1.2.2	At the anode oxidation half reaction: $\text{Cu}_{(s)} \rightarrow \text{Cu}^{2+}_{(aq)} + 2e^{-}$ (0.5 pt) At the cathode reduction half reaction: $\text{Ag}^{+}_{(aq)} + 1e^{-} \rightarrow \text{Ag}_{(s)}$ (0.5 pt)	1
1.3	a) When the cell $G_1$ is functioning, copper undergoes oxidation, it is oxidized into $\text{Cu}^{2+}$ ions, then the mass of copper decreases. (0.5 pt) b) The salt bridge closes the electric circuit. If the salt bridge is removed, the circuit is no longer closed and there will be no passage of electric current and the lamp will turn off. (0.5 pt)	1
2.1	 <p style="text-align: center;">Increasing tendency to lose electrons</p>	1
2.2	$\text{Mg}/\text{Mg}^{2+}$ – salt bridge – $\text{Ag}^{+}/\text{Ag}$	0.5
2.3	The expected answer is c. (0.25 pt) The greater the difference between the tendencies of metals to lose electrons, the higher the voltage of the cell. As the difference between the tendencies of Ag and Mg metals to lose electrons in cell $G_2$ is greater than that between the tendencies of Ag and Cu metals to lose electrons in cell $G_1$ , then $U_2 > U_1$ . (0.5 pt)	0.75

Part of the Q	Exercise 3 ( 7 points)                      Organic compounds Expected Answers	Mark
1.1.	Compound (1) is pentane (0.5 pt) Compound (3) is 2 – methylbutane (methylbutane) (0.5 pt)	1
1.2.	The molecular formula of compound (1) is $\text{C}_5\text{H}_{12}$ . The molecular formula of compound (3) is $\text{C}_5\text{H}_{12}$ . Since compounds (1) and (3) have the same molecular formula $\text{C}_5\text{H}_{12}$ but different condensed structural formulas then compounds (1) and (3) are isomers.	1
1.3.	Compound (4) is not a hydrocarbon. (0.5 pt) Since it is formed of carbon, hydrogen and oxygen and not only of carbon and hydrogen. (0.5 pt)	1
1.4.	Compound (2) is an unsaturated hydrocarbon.	0.5
2.	$\text{CH}_2=\text{CH}_2 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{-CH}_2\text{OH}$	1
3.	The number of repeating units is 3.	0.5
4.1.	Based on the law of conservation of matter, the number of atoms of each element is conserved (0.25 pt) For carbon: $x = 5$ . (0.25 pt) For hydrogen: $y = 6 \times 2 \Rightarrow y = 12$ . (0.25 pt) Then $\text{C}_x\text{H}_y$ is $\text{C}_5\text{H}_{12}$ . (0.25 pt)	1
4.2.	Two consequences of global warming: - Melting of ice polar caps. (Flooding) (0.5 pt) - Change in the distribution of precipitation. (0.5 pt)	1