

الاسم:
الرقم:

مسابقة في مادَّة الكيمياء
المُدَّة: 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 (7 points)

Solar Energy

The sun is an inexhaustible (unlimited) and 100% free source of energy. The use of this energy reduces the harmful effects on the environment. When the solar panels, composed mainly of silicon Si, capture the light, the electrons of silicon move producing a direct electric current.

1. Pick out from the text, two advantages of using solar energy.

2. **Document-1** shows the schematic representation of a silicon atom.

- Referring to **Document-1**, answer the following questions:

2.1. Give the number of valence electrons of a silicon atom.

2.2. What is the placement, column (group) and row (period), of silicon element in the periodic table? Justify.

3. To allow the circulation of electrons, most solar panels contain two elements other than silicon: Boron and phosphorus.

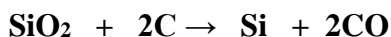
- Boron atom (B) has 5 electrons.

- Phosphorus atom (P) has 5 electrons on its outermost shell M.

3.1. Write the electron configuration of each of these two atoms.

3.2. Identify the atom (B or P) that may gain 3 electrons to saturate its outer energy level.

4. Silicon is obtained by an oxidation-reduction reaction between silica (SiO_2) and carbon (C). The equation of this reaction is:



4.1. Calculate the oxidation number of the element silicon in the compound SiO_2 .

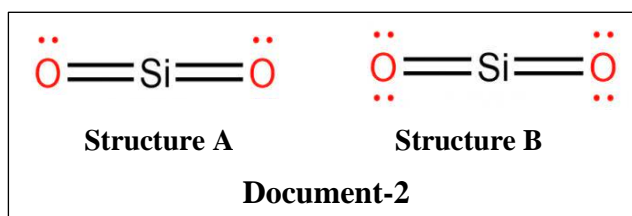
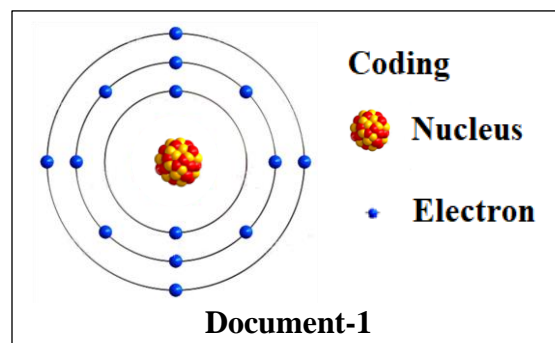
4.2. Specify whether the element silicon is oxidized or reduced in this reaction.

5. **Document-2** shows two proposed structures for the silica molecule.

- Referring to **Document-2**, answer the following questions:

5.1. Choose the correct structure that corresponds to the Lewis structure of silica molecule. Justify.

5.2. Indicate the type of the bond between the silicon atom and the oxygen atom in the silica molecule.



Exercise 2 (7 points)

Calcium Chloride

Calcium chloride (CaCl_2) is a white solid soluble in water. It is the main constituent of several medicinal drugs used to treat calcium deficiency (low levels) in the human body. In agriculture, it is used to provide supplemental calcium to plants to delay their aging.

1. Pick out from the text, the use of calcium chloride in medication.

2. **Document-1** is a table that shows information about two elements: Calcium and chlorine.

Electron configuration of a calcium ion	Relative charge of the nucleus of a chlorine atom	Number of neutrons in a chlorine atom
$\text{Ca}^{2+}: \text{K}^2\text{L}^8\text{M}^8$	17+	18

Document-1

- Referring to **Document-1**, answer the following questions:

- 2.1. Give the number of electrons in the calcium ion Ca^{2+} .
- 2.2. Deduce the number of electrons in the calcium atom Ca.
- 2.3. Show that the atomic number of chlorine element is equal to 17

Given: The relative charge of a proton = 1+

2.4. Answer by true or false. Correct the false statement(s):

- a) The atomic representation of the chlorine atom is : ${}_{17}^{18}\text{Cl}$.
- b) The relative charge of the electron cloud of chlorine atom is equal to 18–
- c) Calcium atom and calcium ion have the same number of protons.

3. Calcium chloride (CaCl_2) is an ionic compound obtained from the reaction between calcium and chlorine gas.

- Explain the bond formation in calcium chloride.

Exercise 3 (6 points)

Electrochemical Cell: Aluminum-Silver

An electrochemical cell is a generator that transforms part of the chemical energy produced by a spontaneous oxidation-reduction reaction into electrical energy.

1. **Document-1** shows the written representation of a cell (**G**) constructed using the metals aluminum (Al) and silver (Ag).



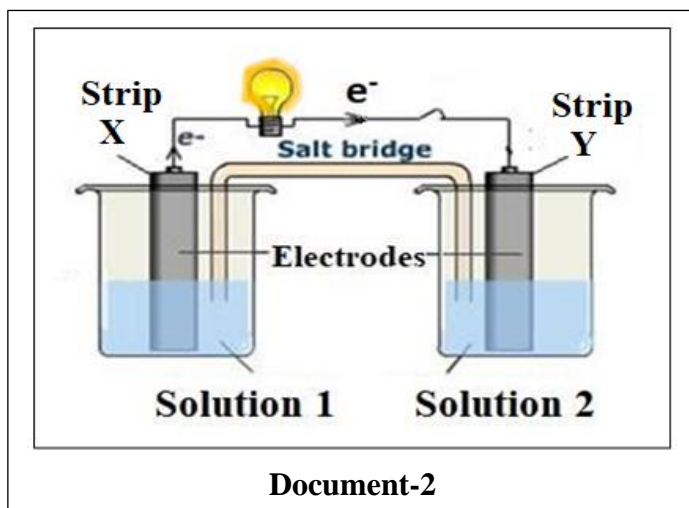
Document-1

- Referring to **Document-1**, answer the following questions:

- 1.1. Indicate the anode of the cell (**G**).
- 1.2. Write the oxidation and the reduction half-reactions that took place in the cell (**G**).
- 1.3. Deduce the equation of the overall reaction of the cell (**G**).
- 1.4. Specify the more active metal (having the greater tendency to lose electrons) in this cell.

2. **Document-2** shows the schema of the same cell (**G**).

- 2.1. Identify the metal of the strip **X**.
- 2.2. Choose, among the following solutions, the one that corresponds to **Solution 2**.
 - a) Solution containing aluminum ions (Al^{3+})
 - b) Solution containing copper II ions (Cu^{2+})
 - c) Solution containing zinc ions (Zn^{2+})
 - d) Solution containing silver ions (Ag^+)
- 2.3. Explain why the anions of the salt bridge migrate towards **Solution 1**.



دورة العام ٢٠٢٢ الاستثنائية	الشهادة المتوسطة	وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات
	مسابقة في مادة الكيمياء المدة: ساعة واحدة	معيير التصحيح

Question	Exercise 1 (7 points)	Expected Answer	Note
1	- It is an inexhaustible (unlimited) (0.25 pt). - It is 100% free source of energy (0.25 pt).		0.5
2.1	The number of valence electrons in silicon atom = 4		0.5
2.2	Silicon is in group IV (column 14) and period 3 (row 3) (0.5 pt) The number of occupied energy levels indicate the period (row). (0.25 pt). The number of electrons on the outer energy levels (valence electrons) indicate the number of group (or the digit unit of the column). (0.25 pt).		1
3.1	The electron configurations are: Boron B : K^2L^3 (0.5) Phosphorus P : $K^2L^8M^5$ (0.5)		1
3.2	The atom P (0.5 pt) since it has 5 electrons on its outer shell, it can gain three electrons to complete its octet (0.5pt)		1
4.1	o.n (O) in SiO_2 = -II SiO_2 (compound) \Rightarrow n.o (Si) + 2 n.o (O) = 0 \Rightarrow n.o (Si) + 2 (-2) = 0 (0.25pt) \Rightarrow n.o (Si) = +IV (0.25pt)		0.5
4.2	Si is an element, o.n (Si) = zero. (0.25 pt) The oxidation number of silicon decreases from (+IV) to (0) (0.5 pt); then it undergoes reduction. Silicon element is reduced in this reaction (0.25 pt)		1
5.1	Structure B (0.25 pt) In the silica molecule, each of the atoms Si and O must acquire a stable octet. In the structure B: - the oxygen atom has 2 non-bonding electron pair and 2 bonding pairs then it has 8 electrons on its outer shell. Therefore, it obeys to the octet rule. - the silicon atom has 4 bonding pairs then it has 8 electrons on its outer shell. Therefore, it obeys to the octet rule. (0.75 pt) (In the structure A, the oxygen atom has 6 electrons on its outer shell.)		1
5.2	Double covalent bond		0.5

Question	Exercise 2 (7 points)	Expected Answer	Note
1	It used to treat calcium deficiency (low levels) in the human body.		1
2.1	Number of electrons in Ca^{2+} = 2+8+8 = 18		0.75
2.2	The atom Ca has lost 2 electrons to become a Ca^{2+} ion. (0.5pt) Number of electrons in Ca = 18+2 = 20 (0.5pt)		1
2.3	Relative charge of nucleus = number of protons \times relative charge of a p+ (0.25pt) Number of protons = $\frac{17+}{1+}$ = 17 (0.5pt)		0.75
2.4	a) False. The atomic representation of the given chlorine atom is: $^{35}_{17}Cl$ (0.75pt) b) False. The relative charge of electron cloud of chlorine atom = 17- (0.75pt)		2

	c) True. (0.5pt)	
3	<ul style="list-style-type: none"> - Calcium atom has 2 valence e-, to obey octet rule it must lose these 2e- from its outer energy level to form a stable ion Ca²⁺. (0.5pt) - Each chlorine atom has 7 valence e-, to obey octet rule it must gain 1e- from calcium atom to form a stable ion Cl⁻. (0.5pt) - The oppositely charged ions formed (Ca²⁺ and Cl⁻) attract each other by an electrostatic force known as ionic bond. (0.5pt) 	1.5

Question	Exercise 3 (6 points)	Expected Answer	Note
1.1	The anode is the aluminum strip.		0.5
1.2	Oxidation half-reaction is: Al → Al ³⁺ + 3e ⁻ (0.5 pt) Reduction half-reaction is: Ag ⁺ + 1e ⁻ → Ag (0.5 pt)		1
1.3	The number of electrons released during oxidation must be equal to the number of electrons gained during reduction. (0.25pt) then: Multiply the reduction ½ reaction by 3. $\begin{array}{r} \text{Al} \rightarrow \text{Al}^{3+} + 3\cancel{e^-} \\ \underline{3\text{Ag}^+ + 3\cancel{e^-} \rightarrow 3\text{Ag}} \end{array}$	(0.5 pt)	1.25
	The equation of the overall reaction is: 3Ag ⁺ + Al → 3Ag + Al ³⁺ (0.5 pt)		
1.4	Aluminum is the more active metal (0.5pt) since it undergoes oxidation (0.25pt) .		0.75
2.1	In a galvanic cell, electrons flow from anode to cathode; in the cell (G), electrons flow from the strip X to the strip Y. (0.5pt) Then the strip X is the anode which is the aluminum strip. (0.5pt)		0.75
2.2	Answer d) Solution containing silver ions (Ag ⁺) (0.5 pt)		0.5
2.3	Aluminum strip is the anode of this cell. Aluminum atoms are oxidized into aluminum ions Al ³⁺ (0.25pt) , this will increase the quantity of Al ³⁺ ions in solution (0.5 pt) . to maintain the electric neutrality of this solution; the anions (-) of the salt bridge move toward Solution1. (0.5pt)		1.25