

الاسم:
الرقم:

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:

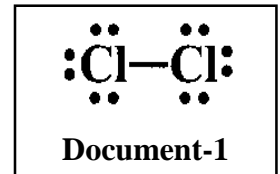
Exercise 1 (7 points)

Chlorine Gas

Chlorine gas (Cl_2) is very toxic at room temperature. Mixing bleaches containing chlorine element such as Javel water with acidic solutions such as vinegar produces chlorine gas. This gas attacks the respiratory system and may lead to death.

Document-1 shows the Lewis electron dot structure of the chlorine gas molecule.

- Pick out from the text the reason why Javel water and vinegar should never be mixed.
- Referring to **Document-1**, answer the following questions:
 - Identify the type of bond in the chlorine gas molecule.
 - Show that chlorine atom has 7 valence electrons.
 - Choose, from the following, the electron configuration of the chlorine atom.
Given: Chlorine element belongs to row 3 (period 3) in the periodic table.
a) K^2L^7 b) $\text{K}^2\text{L}^8\text{M}^7$ c) $\text{K}^2\text{M}^8\text{L}^7$
 - Deduce the atomic number of the chlorine element.
- Chlorine exists in nature as a mixture of different atoms.



Document-2 is a table that shows these chlorine atoms and their percentage abundance in nature.

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

- Justify that ^{35}Cl and ^{37}Cl are isotopes.
- Answer by true or false. Correct the false statements.
 - The atoms ^{35}Cl and ^{37}Cl have the same valence.
 - The atom ^{35}Cl has 35 neutrons.
 - ^{35}Cl is less abundant in nature than ^{37}Cl .

Atom	% abundance
^{35}Cl	x%
^{37}Cl	25%

Document-2

Exercise 2 (6 points)

Lithium-Ion Batteries

Lithium-ion batteries are rechargeable cells that use lithium ion as a key component. These batteries deliver a current of high intensity. They are used in portable electronic devices such as smartphones. They are also used to power electrical systems.

Document-1 is a table that shows the composition of a lithium ion.

- Pick out from the text one use of lithium-ion batteries.
- During the functioning of such batteries, lithium atoms (Li) at the anode lose their valence electrons.
Referring to **Document-1**, answer the following questions:

- Verify that the relative charge of the lithium ion is 1+.

Given:

- Relative charge of an ion = relative charge of nucleus + relative charge of electron cloud.
- Relative charge of a proton = 1+; relative charge of an electron = 1-

Number of Protons	Number of Electrons	Number of Neutrons
3	2	4

Document-1

2.2. Choose, from the following, the half-reaction that takes place at the anode in a lithium-ion battery.

- a) $\text{Li} \rightarrow \text{Li}^{2+} + 2\text{e}^-$ b) $\text{Li} \rightarrow \text{Li}^+ + 1\text{e}^-$ c) $\text{Li} + 1\text{e}^- \rightarrow \text{Li}^+$

3. Researchers have developed a rechargeable lithium-nitrogen battery in which nitrogen gas (N_2) reacts with lithium (Li) to produce an ionic compound lithium nitride (Li_3N), as shown in the equation of the reaction (R):



3.1. Calculate the oxidation number of nitrogen (N) in Li_3N .

Given: The oxidation number of lithium (Li) in $\text{Li}_3\text{N} = +1$

3.2. Show, using oxidation numbers, that the reaction (R) between nitrogen gas and lithium is an oxidation-reduction (redox) reaction.

3.3. Indicate the oxidizing agent (oxidant) in this reaction.

3.4. Explain how nitrogen atom attains stability in lithium nitride (Li_3N).

Given: Nitrogen atom has 5 valence electrons.

Exercise 3 (7 points)

Galvanic Cells

Galvanic cells involve spontaneous electrochemical reactions in which the reactants are separated so that electrons can flow through an external circuit.

Document-1 shows the schema of a cell (G_1) constructed using zinc (Zn) and silver (Ag) metals.

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

1.1. Choose, from the **List (L)**, the solutions used as Solution 1 and Solution 2.

List (L):

- Copper nitrate solution ($\text{Cu}^{2+} + 2\text{NO}_3^-$)
- Zinc nitrate solution ($\text{Zn}^{2+} + 2\text{NO}_3^-$)
- Silver nitrate solution ($\text{Ag}^+ + \text{NO}_3^-$)

1.2. Show that zinc metal is the anode of the cell (G_1).

1.3. Write the oxidation and the reduction half-reactions that take place at the electrodes of the cell (G_1).

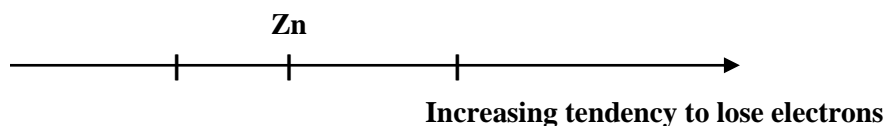
1.4. Deduce the equation of the overall reaction of the cell (G_1).

1.5. What happens to the lamp when the salt bridge is removed?

2. A cell (G_2) is constructed using zinc (Zn) and magnesium (Mg) metals. The written cell representation of (G_2) is: **Mg | Mg²⁺ - salt bridge - Zn²⁺ | Zn**

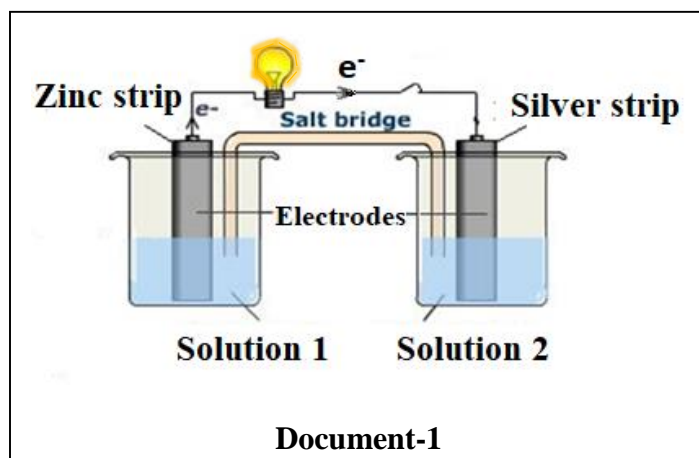
- Explain why the mass of the magnesium strip decreases after a certain time of functioning of this cell.

3. Copy the following axis on the answer sheet and complete it by placing the metals (**Ag**) and (**Mg**) according to their tendencies to lose electrons.



4. In a cell, the greater the difference between the tendencies of metals to lose electrons, the higher is the voltage of this cell.

- Indicate, among the metals Mg, Zn and Ag, those that are used to construct a cell with the highest possible voltage in same conditions.



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	مساابقة في مادة الكيمياء المدة: ساعة واحدة	معيار التصحيح

Part	Exercise 1 (7 points)	Expected Answers	Mark
1	When Javel water is mixed with vinegar, chlorine gas is produced. This gas attacks the respiratory system and may lead to death.		1
2.1	The two Chlorine atoms share one pair of electrons (0.5pt), then the bond is single covalent bond (0.5pt);		1
2.2	According to Lewis dot structure: Chlorine has 3 non-bonding electron pairs then $3 \times 2 = 6$ e- (0.25pt) It has also one bonding pair then it has one single electron (0.25pt) Number of valence electrons = $1 + 6 = 7$ (0.5pt)		1
2.3	The electron configuration is: b) $K^2L^8M^7$		0.75
2.4	Number of electrons = $2 + 8 + 7 = 17$ (0.25) Chlorine is a neutral atom; number of electrons = number of protons = 17 (0.25) $Z =$ number of protons = 17 (0.25)		0.75
3.1	^{35}Cl and ^{37}Cl are isotopes since they are atoms of the same element having different mass numbers.		0.75
3.2	a- True. (0.25pt) b- False (0.25) The atom of ^{35}Cl has 18 neutrons (or 35 nucleons). (0.5pt) c- False (0.25) ^{35}Cl is more abundant in nature than ^{37}Cl . (0.5pt)		1.75

Part	Exercise 2 (6 points)	Expected Answers	Mark
1	They are used in portable electronic devices such as smartphones (or They are also used to power electrical systems).		1
2.1	Relative Charge of ion = relative charge of nucleus + relative charge of electron cloud = number of p^+ \times relative charge of a p^+ + number of e^- \times relative charge of an e^- (0.5) = $3(1+) + 2(1-)$ (0.5pt) = 1+		1
2.2	b) $\text{Li} \rightarrow \text{Li}^+ + e^-$		0.75
3.1	o.n (Li) in $\text{Li}_3\text{N} = +1$ Li_3N (compound) $\Rightarrow 3$ o.n (Li) + o.n (N) = 0 $\Rightarrow 3(+1) + \text{o.n (N)} = 0$ (0.25pt) $\Rightarrow \text{o.n (N)} = -3$ (0.25pt)		0.5
3.2	o.n (Li) in Li = zero (element) (0.25pt) o.n (N) in $\text{N}_2 =$ zero (element) (0.25pt) $6\text{Li} + \text{N}_2 \rightarrow 2\text{Li}_3\text{N}$ Since o.n of lithium element (Li) increases from 0 to +1 (oxidation) (0.25 pt) and the o.n of nitrogen element (N) decreases from 0 to -3 (reduction) (0.25 pt). Since there is a change in oxidation numbers so the reaction is an oxidation-reduction reaction. (0.25 pt)		1.25
3.3	N_2 is the oxidizing agent.		0.5
3.4	Nitrogen atom has 5 valence electrons, to obey octet rule it captures the 3 electrons lost by 3 lithium atoms to become a stable ion N^{3-} .		1

Part	Exercise 3 (7 points)	Expected Answers	Mark
1.1	solution 1 is zinc nitrate solution ($\text{Zn}^{2+} + 2\text{NO}_3^-$) (0.5pt) solution 2 is silver nitrate solution ($\text{Ag}^+ + \text{NO}_3^-$) (0.5pt)		1
1.2	In a galvanic cell, electrons flow from anode to cathode (0.5pt); in the cell (G_1), electrons flow from zinc strip to silver strip. (0.5pt) Then zinc strip is the anode.		1
1.3	Oxidation half-reaction that takes place at the anode is: $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ (0.5pt) Reduction half-reaction that takes place at the cathode is: $\text{Ag}^+ + 1\text{e}^- \rightarrow \text{Ag}$ (0.5pt)		1
1.4	The number of electrons released at the anode (2 electrons) must be equal to the number of electrons captured at the cathode. (0.25pt) then: Multiply the reduction $\frac{1}{2}$ reaction by 2. $\begin{array}{r} \text{Zn} \rightarrow \text{Zn}^{2+} + \cancel{2\text{e}^-} \\ \underline{2\text{Ag}^+ + \cancel{2\text{e}^-} \rightarrow 2\text{Ag}} \end{array}$ (0.5pt) The equation of the overall reaction is: $2\text{Ag}^+ + \text{Zn} \rightarrow 2\text{Ag} + \text{Zn}^{2+}$ (0.5 pt)		1.25
1.5	When the salt bridge is removed, the lamp turns off.		0.5
2.	Magnesium strip is the anode of this cell (0.25pt). It is where oxidation takes place (0.25pt). Its mass decreases due to the oxidation of magnesium atoms into magnesium ions Mg^{2+} that pass into the solution (0.5pt).		1
3.	Copy (0.25pt) Placement of metals (0.5pt) $\begin{array}{c} \text{Ag} \quad \text{Zn} \quad \text{Mg} \\ \text{-----} \longrightarrow \\ \text{Increasing tendency to lose electrons} \end{array}$		0.75
4.	The metals used are: Mg and Ag		0.5