

الاسم: مسابقة في الكيمياء
الرقم: المدة ساعة واحدة

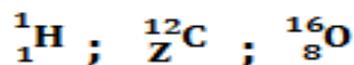
This Exam Includes Three Exercises. It Is Inscribed on Two Pages.

Answer the Following Three Exercises. Use of Non – Programmable Calculator Is Allowed.

First Exercise (7 points) The Element Phosphorus

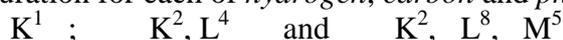
Phosphorus does not occur as free element in nature but it is found in many different minerals, such as calcium phosphate. Phosphorus has 18 isotopes; the mass numbers of the isotopes vary from 26 to 43. The most stable isotope of phosphorus is represented as: (${}_{Z}^{31}\text{P}$). Phosphorus mineral is found in milk, grains, protein-rich foods ... Symptoms of phosphorus deficiency include loss of appetite, anxiety, weakness... and in children, decreased growth, poor bone and tooth development may occur.

Given: The representation of each of hydrogen, carbon and oxygen atom is respectively given on the right.



The relative charge of a proton = +1.

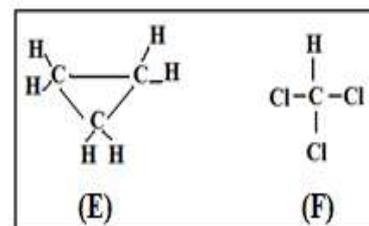
1-The electron configuration for each of *hydrogen*, *carbon* and *phosphorus* atom respectively is:



- 1.1- Determine the atomic number (Z) of carbon.
- 1.2- Calculate the relative charge of the nucleus of oxygen atom.
- 2- Compare the relative charge of the nucleus of carbon atom to that of oxygen atom.
- 3- Four isotopes of phosphorus contain respectively 13, 16, 20 and 25 neutral particles in their nuclei.
 - Show that the number of neutral particles in the nucleus of the most stable isotope of phosphorus is 16.
- 4- Phosphorus combines with hydrogen to form the molecular compound phosphine (PH_3).
 - Explain the bond formation in the molecule of the compound phosphine.
- 5- A child is suffering from loss of appetite, decreased growth and poor bone development.
 - Specify whether the parents of the child should be advised to feed the child milk and protein rich foods.

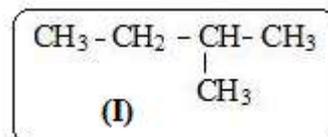
Second Exercise (7 points) Organic Anaesthetic

Cyclopropane is a colorless gas that was once in wide use as an anaesthetic. Anaesthetic is a chemical substance that has sleep-inducing effect, used on patients during surgery to reduce pain. The structural formulas of the molecules of two organic compounds (E) and (F) are shown on the right respectively.



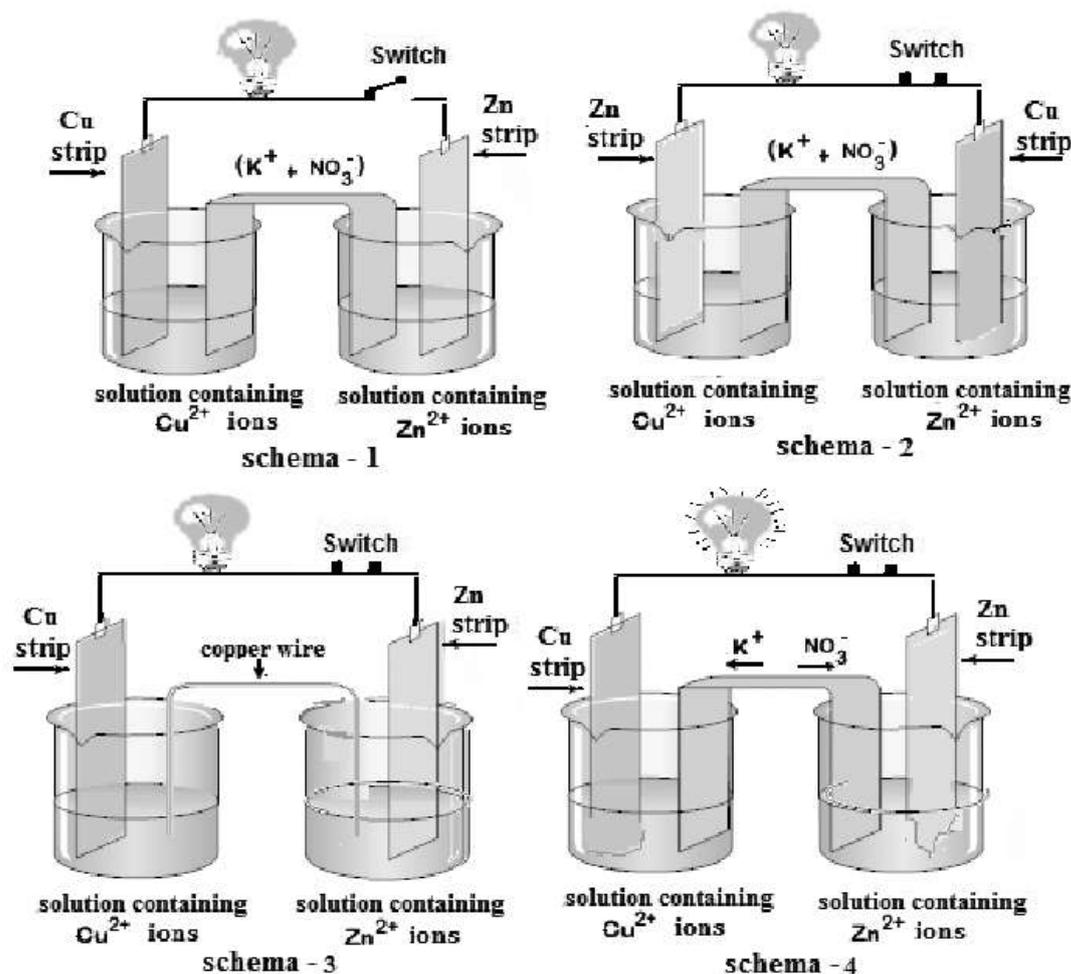
- 1- Give the IUPAC name of each of the compounds (E) and (F).
- 2- Identify among the two compounds (E) and (F) the one which is a hydrocarbon.
- 3- Compound (A) of molecular formula (C_xH_y) produces compound (F) according to the reaction represented by the equation given below:
$$\text{C}_x\text{H}_y + 3\text{Cl}_2 \rightarrow \text{CHCl}_3 + 3\text{HCl}$$
 - 3.1- Determine the molecular formula of compound (A).
 - 3.2- Indicate to what class of hydrocarbons compound (A) belongs.
- 4- Write, using structural formulas for the organic compounds, the equation of the reaction of the preparation of tetrachloromethane starting from compound (F).
- 5- Pick out from the text, for what purpose an anaesthetic is used during surgery.

- 6- Choose the correct name of hydrocarbon (R) having the structural formula (I). Justify your choice.
- a) 2-methylbutane b) 3-methylbutane
 c) 3-methylpentane d) 2-ethylpentane



Third Exercise (6 points)
Zinc-Copper (Zn - Cu) Galvanic Cell

The oxidation-reduction reaction in a galvanic cell is a spontaneous reaction that produces electrical energy. The electrical energy is produced when the oxidation and reduction half-reactions take place in separate containers, joined by an apparatus that allows electrons to flow. Zinc metal has tendency to lose electrons more than copper metal. Four attempts have been done to construct Zn - Cu galvanic cell. Each of the schemas shown below represents an attempt for constructing this cell.



- 1- Justify why the lamp does not light in each of the three attempts for constructing the Zn - Cu galvanic cell as shown in schemas 1, 2 and 3.
- 2- In attempt four, as shown in schema-4, the lamp lights indicating that the galvanic cell is operating.
 - 2.1- Indicate the direction of the electron flow in the Zn - Cu galvanic cell.
 - 2.2- Write the half-reaction that takes place at the anode and the half-reaction that takes place at the cathode.
 - 2.3- Deduce the equation of the overall reaction.
- 3- Explain why the nitrate ions NO_3^- of the jellified electrolyte, in the salt bridge, move towards the anode half-cell as shown in schema-4.
- 4- Give the written cell representation of the operating Zn - Cu galvanic cell.
- 5- Pick out from the text the information which tells how electrical energy is produced in a galvanic cell.

دورة العام 2013 الاستثنائية الخميس 29 آب 2013	امتحانات الشهادة المتوسطة	وزارة التربية والتعليم العالي المديرية العامة للتربية دائرة الامتحانات
الاسم: الرقم:	مسابقة في الكيمياء المدة ساعة واحدة	مشروع معيار التصحيح

	<i>Expected Answers</i>	<i>Marks</i>
	First Exercise (7 Points)	
1.1	In an atom the number of electrons is equal to the number of protons (0.25). Total number of electrons for C atom = 2+4 = 6 (0.25) => number of protons = 6. (0.25) Atomic number (Z) = number of protons => Z = 6 (0.25)	1
1.2	Relative charge of the nucleus = Number of protons x relative charge of a proton. For oxygen atom: $Q_{\text{nucleus}} = 8 \times (+1)$ (0.75) = +8 (0.25)	1
2	Relative charge of the nucleus of an atom is directly proportional to the atomic number of the atom. Atomic number of C (Z=6) is less than atomic number of oxygen (Z=8). (0.5) => Relative charge of the nucleus of carbon atom is less than the relative charge of the nucleus of oxygen atom. (0.5)	1
3	Total number of electrons for P atom = 2+8 +5 = 15. (0.25) In an atom number of electrons is equal to number of protons (0.25) => number of protons = 15. (0.25) The neutral particles in the nucleus of an atom are the neutrons. Mass number = number of protons + number of neutrons. $A = Z + n$. (0.25) Number of neutrons in the nucleus of most stable isotope of phosphorous ($^{31}_{15}\text{P}$) $n = A - Z$. Number of neutrons = 31-15 (0.25) = 16. (0.25)	1.5
4	The electron configuration of phosphorus atom is: $K^2 L^8 M^5$ Phosphorus atom needs three electrons to satisfy octet rule. (0.25) The electron configuration of hydrogen atom is: K^1 Hydrogen atom needs one electron to satisfy duet rule. (0.25) A phosphorus atom shares a pair of electrons with each of the three hydrogen atoms; the phosphorus atom and the three hydrogen atoms attain stable state of configuration. (0.5), thus phosphorous atom forms single covalent bond with each hydrogen atom. . (0.5)	1.5
5	The parents of the child should be advised to feed the child milk and protein rich foods; because milk and protein-rich foods contain phosphorus mineral which is needed to overcome the symptoms of phosphorus deficiency.	1
	<i>Expected Answers</i>	
	Second Exercise (7 Points)	
1	(E) : cyclopropane (0.5) ; (F) trichloromethane (0.5)	1
2	Compound (E) is hydrocarbon; it consists only of the elements carbon and hydrogen.	1
3.1	According to the law of conservation of mass (atoms), the number of atoms of each element in the reaction is conserved. (0.25) For C atom $X = 1$ (0.5) ; For H atom $Y = 3 + 1$ => $Y = 4$ (0.5) The molecular formula of compound (A) is CH_4 . (0.25)	1.5
3.2	Compound (A) belongs to alkanes.	0.5

4	The equation of the reaction is: $\begin{array}{c} \text{Cl} \\ \\ \text{Cl}-\text{C}-\text{H} \\ \\ \text{Cl} \end{array} + \text{Cl}_2 \longrightarrow \begin{array}{c} \text{Cl} \\ \\ \text{Cl}-\text{C}-\text{Cl} \\ \\ \text{Cl} \end{array} + \text{HCl}$	1
5	An anaesthetic is used during surgery to reduce pain.	0.5
6	a) 2-methylbutane. (0.5) Longest chain of carbon atoms is 4. The alkyl group connected to the main chain is methyl. The branch encountered along the main chain receives the lowest possible number. (1)	1.5

	<i>Expected Answers</i>	<i>Marks</i>
	Third Exercise (6 Points)	
1	Attempt (schema) - 1: The switch is open, the circuit is not complete. (0.5) Attempt (schema) - 2: Zn strip is dipped in solution containing Cu^{2+} ions, electrons are exchanged between the metal zinc which is in direct contact with Cu^{2+} cations in aqueous solution, energy is released in the form of heat. Cu strip is dipped in solution containing Zn^{2+} ions. No reaction takes place copper metal has less tendency to lose electrons than Zn metal. (0.5) Attempt (schema) - 3: Copper wire does not allow the migration of ions through it and does not complete the circuit. (0.5)	1.5
2.1	Electrons flow from zinc strip (anode) to the copper strip (cathode) in the external part of the circuit.	0.5
2.2	The half-reaction that takes place at the anode is: $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ (0.5) The half-reaction that takes place at the cathode is: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ (0.5)	1
2.3	The half-reaction at the anode is: $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ The half-reaction at the cathode is: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ In a redox reaction electrons are conserved. (0.25) Because number of electrons released at the anode (2 electrons) are equal to the number of electrons captured at the cathode (2 electrons), add the anode half reaction to cathode half-reaction to obtain the overall reaction. (0.25) The half-reaction at the anode is: $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$ The half-reaction at the cathode is: $\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$ The overall reaction is: $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$ (0.5)	1
3	At the anode, zinc atoms (Zn) are oxidized into zinc ions (Zn^{2+}), the amount of Zn^{2+} ions in solution increases (increase of positive charge in solution), (0.5) to keep charge balance (electro-neutrality) of the solution, the nitrate ions (NO_3^-) of the salt bridge migrate to the anode half-cell. (0.5)	1
4	The written cell representation is: $\text{Zn} \text{Zn}^{2+} \text{ -salt bridge - } \text{Cu}^{2+} \text{Cu}$	0.5
5	The electrical energy is produced when the oxidation and reduction half-reactions take place in separate containers, joined by an apparatus that allows electrons to flow.	0.5