

الاسم:
الرقم:

مسابقة في مادة: الكيمياء
المدة: ساعة واحدة

This exam is made of three obligatory exercises in two pages
The use of a non- programmable calculator is allowed

First Exercise (7 Points) Chemical Fertilizers

Chemical Fertilizers, rich in three elements, nitrogen, potassium and phosphorus, are substances added to soil to supply one or more plant nutrients essential to the growth of plants.

1. The representation of the atoms of three elements: nitrogen, potassium and phosphorus are respectively:



1.1. Determine the number of neutrons in the nucleus of each of the above three atoms.

1.2. Deduce among the three atoms the one that has the greatest number of neutrons.

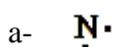
2. Phosphorus is found in fertilizers in the form of phosphate compounds.

2.1. Write the electron configuration of phosphorus atom.

2.2. Specify the placement of phosphorus element in the periodic table.

3. The electron configuration of nitrogen atom is: $K^2 L^5$.

3.1. Choose among the following Lewis electron dot symbols the one that corresponds to nitrogen atom:



3.2. The chemical element nitrogen exists in nature as a di-atomic molecule.

-Explain the bond formation in the molecule of nitrogen (N_2)

4. A bag of a chemical fertilizer contains 1.17g of the nutritive element potassium (K).

-Calculate the number of moles of the element potassium in this bag.

Given: $M(\text{K}) = 39 \text{ g}\cdot\text{mol}^{-1}$

5. Pick out from the text the benefit of adding a chemical fertilizer to soil.

Second Exercise (6 points) Cracking of Octane

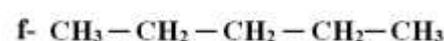
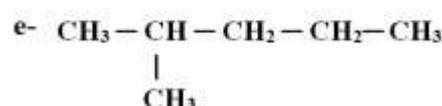
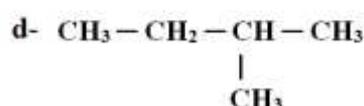
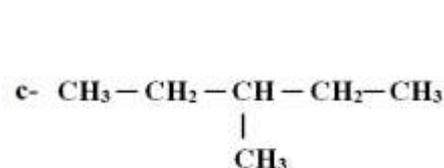
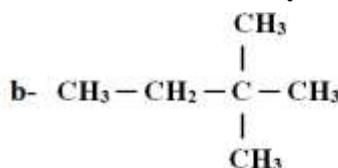
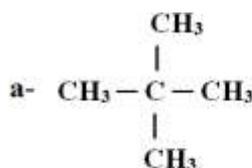
The cracking is an industrial process, carried out under appropriate experimental conditions to break down the molecules of long carbon chain into molecules of shorter carbon chain.

1. The cracking reaction of one molecule of octane (C_8H_{18}) produces one molecule of propene (C_3H_6) and a hydrocarbon molecule (A) of molecular formula (C_xH_y). This reaction is represented by the word equation given below:



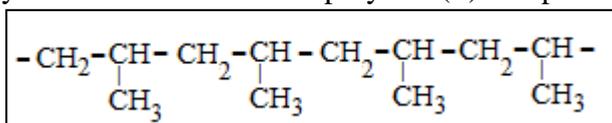
1.1. Show that the molecular formula of hydrocarbon (A) is C_5H_{12} .

1.2. Hydrocarbon (A) admits several isomers. Choose among the condensed structural formulas given below, those that correspond to the isomers of hydrocarbon (A).



1.3. Give the IUPAC name of each of the **branched** isomers of hydrocarbon (A).

2. Propene undergoes addition polymerization reaction producing a polymer (P).
- 2.1. Write the condensed structural formula of propene.
- 2.2. Identify the type of bonds between the carbon atoms in the molecule of propene.
- 2.3. A portion of the polymeric chain of addition polymer (P) is represented below:

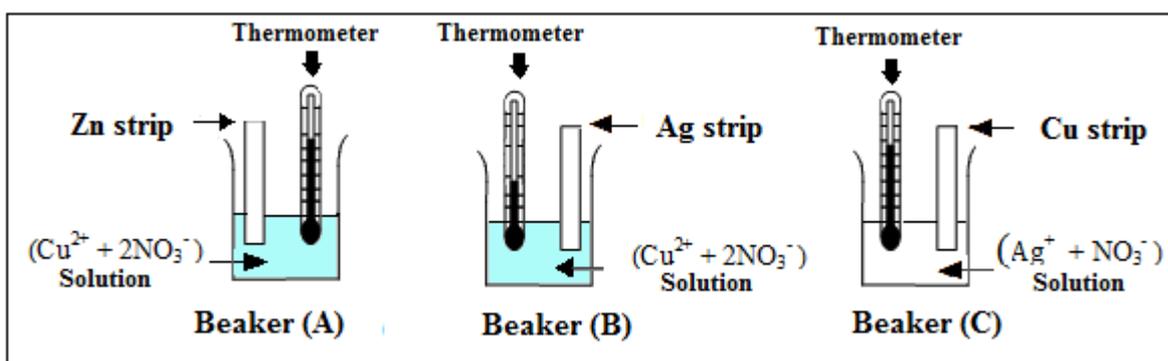


-Indicate the number of repeating units in the portion of the polymeric chain given above.

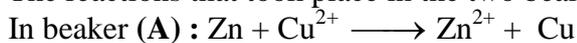
Third Exercise (7points) Reactivity of Metals

A chemical reaction occurs when a metal strip (M) is dipped in an aqueous solution containing ions of another metal (M'), if the metal (M) has greater tendency to lose electrons than that of the metal (M'). In such reaction, energy is liberated in the form of heat.

Experiments are performed as shown in the set-up given below:

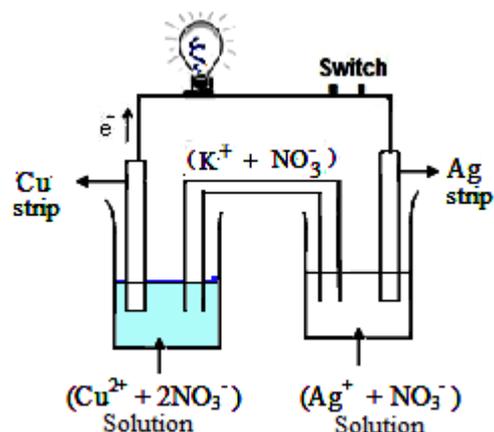


1. The reactions that took place in the two beakers (A) and (C) are represented by the following equations:



Remark: In beaker (B) : $\text{Ag} + \text{Cu}^{2+}$ No reaction occurs.

- 1.1. Show, using oxidation numbers, that the reaction that took place in beaker (A) is an oxidation-reduction reaction.
- 1.2. Indicate the oxidant in the reaction that took place in beaker (C).
- 1.3. Classify the metals Zn, Ag, and Cu in an increasing order of their tendency to lose electrons.
2. A galvanic cell is constructed as shown in the adjacent figure.



- 2.1. Write the oxidation half-reaction and the reduction half-reaction that took place in this galvanic cell.
- 2.2. Deduce the equation of the overall reaction when the galvanic cell is set to function.
- 2.3. Verify that the reaction in this cell is due to indirect contact between the reactants.

First Exercise (7 points)		
Part of the Q	Expected Answer	Mark
1.1	The number of neutrons is given according to the following relation $N = A - Z$ (0.25) For nitrogen atom $N = 14 - 7 = 7$ (0.25); for potassium atom $N = 39 - 19 = 20$ (0.25) and for phosphorus atom $N = 31 - 15 = 16$ (0.25)	1
1.2	K has the greatest number of neutrons: 20 is greater than that of P(16) and that of N (7)	0.75
2.1	The atom is electrically neutral the number of electrons = number of protons (0.25) $Z = 15 =$ number of protons = 15 electrons. Electron configuration of P is: $K^2 L^8 M^5$ (0.5)	0.75
2.2	Phosphorus belongs to period 3 The number of occupied energy level indicates the period (row) (row 3) . (0.5) Phosphorus belongs to group V (column 15) The number of electrons on the valence energy level indicates the number of the group (or the unit digit of the column). (0.5)	1
3.1	The electron Lewis dot symbol of nitrogen is: $\cdot\ddot{N}\cdot$	0.5
3.2	Nitrogen atom has 5 valence electrons; it needs 3 electrons to attain the configuration of the closest inert gas in the periodic table (0.25). Each nitrogen atom shares 3 pairs of electrons (0.25) with the other nitrogen atom to attain stable octet (0.25). The type of bond is triple covalent bond. (0.25)	1
4	Number of mol , $n(\text{mol}) = (m(\text{g})/M_{\text{g}} \cdot \text{mol}^{-1}) = 1.17/39$ (0.5) = 0.03 (0.25) mol (0.25)	1
5	A fertilizer is added to the soil to supply one or more plant nutrients essential to the growth of plants.	1

Second Exercise (6 points)		
Part of the Q	Expected Answer	Mark
1.1	The equation of the cracking reaction is: $C_8H_{18} \rightarrow C_xH_y + C_3H_6$ According to the law of conservation of mass (atoms) ; the number of atoms of an element in the reaction is conserved. For C atom : $8 = x + 3 \Rightarrow x = 5$ For H atom : $18 = y + 6 \Rightarrow y = 12$; The molecular formula of (A) is C_5H_{12}	1
1.2	The isomers of (A) are: a (0.5), d (0.5), and f (0.5).	1.5
1.3	a) 2,2-dimethylpropane (0.5), b) 2-methylbutane (0.5).	1
2.1	The condensed structural formula of propene is. $\overset{3}{\text{C}}\text{H}_3 - \overset{2}{\text{C}}\text{H} = \overset{1}{\text{C}}\text{H}_2$	0.5

2.2	Between the two carbon atoms number 1 and 2: double covalent bond because of sharing of two pairs of electrons. (0.5) Between the carbon atoms number 2 and 3: single covalent bond because of sharing of one pair of electrons. (0.5) .	1
2.3	The number of repeating units is 4	1

Third Exercise (7 points)		
Part of the Q	Expected Answer	Mark
1.1	$0 \quad +\text{II} \quad \quad +\text{II} \quad 0$ $\text{Zn} + \text{Cu}^{2+} \longrightarrow \text{Zn}^{2+} + \text{Cu}$ <p>The oxidation number of Zn changes from 0 to +II and that of Cu changes from +II to 0 Because of the change in the oxidation number, the reaction is an oxidation-reduction reaction.</p>	1
1.2	The oxidant is Cu^{2+} .	0.5
1.3	According to the reaction that takes place in beaker (A): Zn has a tendency to lose electrons more than Cu. (0.5) According to the reaction that takes place in beaker (C): Cu has a tendency to lose electrons more than Ag. (0.5) Thus the increasing order of the tendency to lose electrons is: Ag, Cu, Zn. (0.5)	1.5
2.1	The reduction half-reaction is: $\text{Ag}^+ + 1\text{e}^- \rightarrow \text{Ag}$ (0.75) The oxidation half-reaction is: $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$ (0.75)	1.5
2.2	<p>In a redox reaction, electrons are conserved (number of electrons released equals number of electrons captured) (0.5) Multiply the reduction half-reaction by 2 and the obtained equation add to oxidation half – reaction.(0.5)</p> $ \begin{array}{r} 2 \times (\text{Ag}^+ + 1\text{e}^- \rightarrow \text{Ag}) \\ \text{Cu}^{2+} \rightarrow \text{Cu} + 2\text{e}^- \\ \hline 2\text{Ag}^+ + \text{Cu} \rightarrow 2\text{Ag} + \text{Cu}^{2+} \end{array} $ <p>The equation of the overall reaction is: $\text{Cu} + 2\text{Ag}^+ \rightarrow \text{Cu}^{2+} + 2\text{Ag}$ (0.5)</p>	1.5
2.3	The reaction between the reactants of this reaction is due to indirect contact, because they are placed in separate compartments.	1