مسابقة في مادة الكيمياء
المدة: ساعة واحدة

الاسم:
الرقم:

This Exam Is Composed of Three Exercises. It Is Inscribed on 2 Pages.
Answer the Following Three Exercises.
The Use of Non-programmable Calculator is Allowed.

First Exercise (7 points)
Important Nutrient Elements to Plants

Plants to grow absorb from the soil water and nutrients. Three important nutrients are nitrogen, phosphorous and potassium. Nitrogen helps the plant to develop leaves, phosphorous is needed for the healthy development of the roots and potassium helps the plant to resist disease and to fight dryness.

A fertilizer for plants

1- Indicate the element which is needed for healthy development of the roots.

2- Write the electron-configuration of: $^{39}_{19}K$, $^{31}_{15}P$, $^{14}_{7}N$ and specify the valence of each element.

3- Deduce the placement, column (group) and row (period), of each of the given elements in the periodic table.

4- Give the Lewis dot representation of the nitrogen molecule (N_2) and indicate the type of the bond in this molecule.

5- Knowing that a fertilizer contains 42g of nitrogen, calculate the number of moles of nitrogen atoms found in the fertilizer.

Given: Molar mass of nitrogen atom = $14 g.mol^{-1}$

Second Exercise (7 points)
Importance of Crude Oil

Crude oil is an important natural resource. After refining crude oil, the products obtained can be employed in the production of many chemicals, where several products can be used, for example, in the manufacture of plastics and other products as a major source of energy.

At the refinery, crude oil is subjected to fractional distillation and the long chain alkanes obtained are further subjected to cracking.

The polymer industry consumes almost about 6 % of the petroleum products produced by refineries.

1- The alkane of molecular formula, C_5H_{12}, admits three possible isomers. The condensed structural formulas of two isomers are given as:

$CH_3\text{-}CH_2\text{-}CH_2\text{-}CH_2\text{-}CH_3$ **(I)** and $CH_3\text{-}CH(CH_3)\text{-}CH_2\text{-}CH_3$ **(II)**

Write the condensed structural formula of the third isomer and give the IUPAC name of each of the three isomers.

2- At the refinery, the cracking of heptane gives an open chain alkane **(A)** containing 4 carbon atoms in its molecule and an alkene **(B)** of molecular formula C_XH_Y according to the equation:

$$C_7H_{16} \longrightarrow \textbf{(A)} + C_XH_Y$$

a) Give the molecular formula of hydrocarbon **(A)**.

b) Determine the molecular formula of **(B)**.

c) Write the condensed structural formula of **(B)** and indicate the type of bonds between the carbon atoms in a molecule of **(B)**.

3- The addition polymerization of **(B)** produces a polymer **(P).**

A portion of the polymer **(P)** is represented as: $-CH_2-CH(CH_3)-CH_2-CH(CH_3)-CH_2-CH(CH_3)-CH_2-CH(CH_3)-$

Give the name of this polymer and the number of repeating units in the given portion of the polymer **(P)**.

4- Give two reasons why crude oil is an important natural resource.

5- Give the name of the physical process applied for refining crude oil at the refinery.

Third Exercise (6 points)
Galvanic Cell

A galvanic cell **(G)** is constructed. The essential components are numbered from 1 to 6 on the figure (F).

The cell representation of the constructed galvanic cell is given as:

$$Zn|\,Zn^{2+} \text{ - salt bridge - } Cu^{2+}|Cu$$

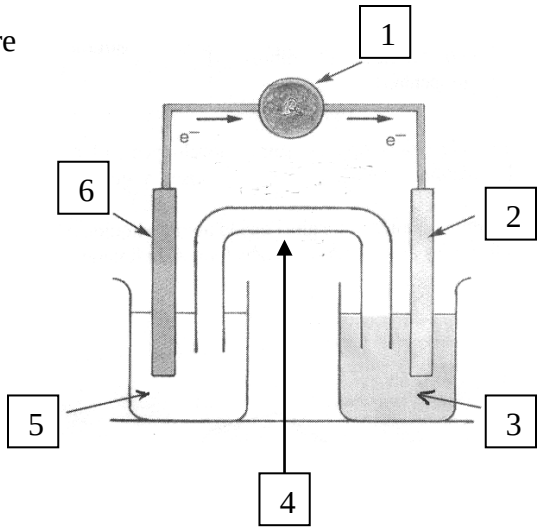


Figure **(F)**

1- Based on the direction of electron flow shown in figure **(F)** and the given cell representation, label all the numbered parts of the galvanic cell **(G)** indicating the anode and the cathode.

2- a) Write the equation of the half-reaction at each electrode.

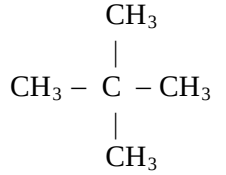
b) Specify the type of each half-reaction.

3- a) Deduce the overall (cell) reaction for the galvanic cell **(G).**

b) Identify the oxidizing agent and the reducing agent.

Basic Education **Chemistry** **2nd Session 2005**

Marking Scheme

Expected Answer	Mark	Comments
First Exercise (7 pts)		
1- The element is phosphorus.	¼	
2- Since the atom is neutral, the number of electrons = the number of protons = Z (atomic number).	½	
The electron configuration is :		
For $^{39}_{19}K$: $K^2 L^8 M^8 N^1$.	¼	- The valence is the number of unpaired electrons.
For $^{31}_{15}P$: $K^2 L^8 M^5$.	¼	- The valence is the number of electrons involved in the formation of bonds.
For $^{14}_{7}N$: $K^2 L^5$.	¼	
The valence is the number of electrons lost, gained or shared by an atom of an element to achieve its octet.	½	
The valence is :		
For K : valence = 1	¼	- Compatible with the electron configuration .
For P : valence = 3	¼	
For N : valence = 3 .	¼	If not (**zero**).
3- The period of an element is the number of the highest energy level occupied in an atom.	½	
The period is :		
For K : period or row 4	¼	- Compatible with the electron configuration .
For P : period or row 3	¼	If not (**zero**).
For N : period or row 2 .	¼	- The number of electrons in the outer shell is acceptable.
The group of an element is the number of the valence electrons in its atom.	½	- Compatible with the electron configuration .
The group is :		If not (**zero**).
For K : group I or column (1)		
For P : group V or column (15)		
For N : group V or column (15)	¼	- : N ≡ N : or | N ≡ N | is acceptable.
4- The Lewis dot representation of nitrogen molecule (N_2) is :	¼	
: N ⋮ ⋮ N :	¼	
The bond in this molecule is triple covalent bond.	½	
5- The number of mole atoms of nitrogen in 42 g of nitrogen is :		
n (mole atoms of nitrogen) = $\frac{m\ (g.)}{M\ (g.mol^{-1})}$	½	- Without units (-¼). - The cross multiplication rule is acceptable(with units).
$n = \frac{42}{14}$ = 3 mol atoms of nitrogen.	¾	
Second Exercise (7 pts)		
1- The condensed structural formula of the third isomer is:  (**III**) Its name is: 2, 2- dimethylpropane.	¼ × 2	- Dimethylpropane is acceptable.

Expected Answer	Mark	Comments
The name of isomer (**I**) is : pentane	¼	n-pentane is acceptable
The name of isomer (**II**) is: 2 – methylbutane.	¼	- méthylbutane is acceptable.
2-a) (A) is an alkane of general formula C_nH_{2n+2} or n = 4 then the formula of (A) is C_4H_{10} .	½	- Justification is not required.
b) According to law of conservation of mass, in a chemical reaction ,the number of atoms of each element is conserved.	½	- Alkene C_nH_{2n} with x = n = 3 $\Rightarrow$ the formula of **B** is C_3H_6 .
$7 = 4 + x \Rightarrow x = 3$		
$16 = 10 + y \Rightarrow y = 6$	½	- $C_7H_{16} \rightarrow C_4H_{10} + C_3H_6$ (1½)
Therefore, the formula of **(B)** is C_3H_6 .	½	
c) The condensed structural formula of (**B**) is $CH_2 = CH - CH_3$.	½	
C = C : double covalent bond.	½	
C – C : simple covalent bond.	½	
3- The name of polymer is: polypropene.	½	
The number of the repeating units is: 4 .	½	
	½	
4- Source of energy and manufacture of plastics.	¼ ×2	- Manufacture of many chemicals or other uses are acceptable..
5- Fractional distillation.	½	
Third Exercise (6 pts)		
1- (1) voltmeter or multimeter or lamp.	¼ × 8	
(2) Strip of copper (cathode)		
(3) Solution containing Cu^{2+} ions		
(4) Salt bridge		
(5) Solution containing Zn^{2+} ions		
(6) Strip of zinc (anode).		
2- a) At the anode : $Zn \rightarrow Zn^{2+} + 2\ e^-$.	½	- Anode and cathode reversed $\Rightarrow$ (**zero**).
At the cathode : $Cu^{2+} + 2\ e^- \rightarrow Cu$.	½	
b) At the anode oxidation reaction takes place because zinc loses 2 electrons.	¾	- Reasoning based on the variation of (oxidation number) is acceptable.
At the cathode reduction reaction takes place because Cu^{2+} ion gains 2 electrons.	¾	- Compatible with part (a)
3- a) $Zn \rightarrow Zn^{2+} + 2\ e^-$		-The number of electrons lost is equal to the number of electrons gained. (¼) + equation **(¼)**.
$Cu^{2+} + 2\ e^- \rightarrow Cu$		
$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$	½	
b) The oxidizing agent is Cu^{2+} because it gains electrons.	½	- Reasoning based on the variation of (oxidation number) is acceptable.
The reducing agent is Zn because it loses electrons.	½	- Reasoning based on oxidation and reduction is acceptable.