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المديريّــة العامة للتربية	فرع: علوم الحياة	الثلاثاء ١٢ حزيران ٢٠١٨
دائرة الامتحانات الرسمية		مكيفة / إحتياجات خاصة

مسابقة في مادة الكيمياء	الاسم:
المدة: ساعتان	الرقم:

This Exam Includes Three Exercises. It Is Inscribed on ten Pages Numbered from 1 to 10.
The Use of A Non-programmable Calculator Is Allowed.

مسابقة في الكيمياء

(باللّغة الإنكليزية)

المدّة: ساعتان

الاسم:.....

الرقم:.....

Answer the Three Following Exercises:

Exercise 1 (7 points) Properties of an Alcohol

The aim of this exercise is to study the chemical properties of the alcohol (A) and its reaction with methanoic acid.

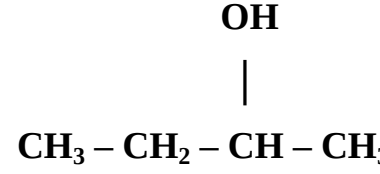
Given: Molar mass in $g.mol^{-1}$: $M_{(H)} = 1$; $M_{(C)} = 12$; $M_{(O)} = 16$.

1. Chemical properties of the Alcohol (A)

Available is a saturated and non-cyclic mono-alcohol denoted (A).
The quantitative analysis of alcohol (A) shows that the percentage by mass of oxygen is **%O = 21.62%**

1.1. Knowing that the general molecular formula of saturated monoalcohol is $C_nH_{2n+2}O$, **calculate** in terms of n, the molar mass of alcohol (A).
- Show that the molecular formula of the alcohol (A) is $C_4H_{10}O$.

1.2. The condensed structural formula of the alcohol (A) is:



1.2.1. Indicate the class of alcohol (A).

1.2.2. **Give** its systematic name.

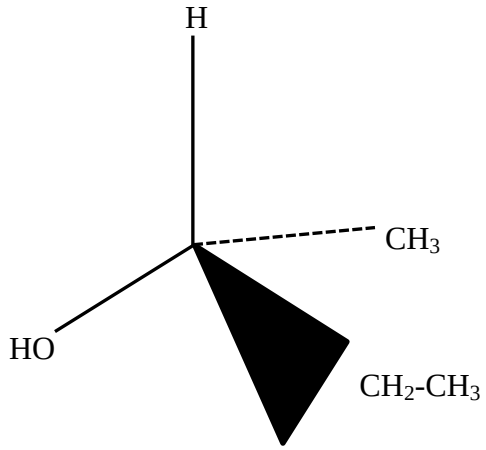
1.2.3. the three alcohol isomers of (A) is:

1- Butanol	**2- Methyl-1-propanol**	**2- Methyl-2- propanol**

Write the condensed structural formulas of these three alcohol isomers.

1.2.4. Justify that the molecule of the alcohol (A) is chiral.

1.2.5. The alcohol (A) possesses two enantiomers. One of them is represented according to Cram by the following structure:



Represent the second enantiomer of alcohol (A).

1.3. The mild oxidation of the alcohol (A) by a solution of acidified potassium permanganate leads to the formation of an organic compound (B).

Choose the correct answer:

1.3.1.

The systematic name of (B) is :	butanal
	butanone
	butanoic acid

1.3.2.

the compound (B) gives with the 2,4-DNPH :	a white crystals
	a yellow- orange precipitate
	a black precipitate

2. Reaction of the Alcohol (A) With Methanoic Acid

A mixture of 0.2 mol of alcohol (A) and 0.2 mol of methanoic acid is heated to reflux, in the presence of few drops of concentrated sulfuric acid as a catalyst.

The esterification reaction is represented by the following equation:

methanoic acid + alcohol (A) ⇌ ester (E) + water

2.1. Copy and **Complete**, by using the condensed structural formula, the equation of the following esterification reaction:

$HCOOH + CH_3 – CH_2 – CH\ OH – CH_3 \rightleftharpoons$ …… + ……..

At an instant **t** the equilibrium is reached.

The number of moles of methanoic acid remained at equilibrium is $\mathbf{n_{(acid)} = 0.08\ mol}$.

2.2. Complete the following table:

	methanoic acid + alcohol (A) ⇌ ester (E) + water			
t = 0 min	0.2 mol	0.2 mol	0	0
t at equilibrium	**0.08 mol**	……..	……..	……..

2.3. Give the expression of the equilibrium constant Kc.

Calculate its value.

2.4. The same experiment is carried out again with only one change: "without the addition of concentrated sulfuric acid" .The equilibrium state is reached at an instant of time t'.

Choose the correct answer. **Justify**.

a. $t > t'$ **b.** $t = t'$ **c.** $t < t'$

Exercise 2 (6 points) **Kinetic of the Oxidation of Javel Water with Ammonia**

In an aqueous solution, ammonia (NH_3) reacts with hypochlorite ions ($C\ell O^-$) in a slow and complete reaction that takes place according to the equation below:

$$2\ NH_{3\ (aq)} + 3\ C\ell O^-_{(aq)} \longrightarrow N_{2\ (g)} + 3\ C\ell^-_{(aq)} + 3\ H_2O_{(l)}$$

The aim of this exercise is to study the kinetic of this reaction.

Javel water is a sodium hypochlorite aqueous solution ($Na^+ + C\ell O^-$)

Document- 1

1. Preparation of a Javel Water Solution (S_1)

A volume $\mathbf{V_1 = 250\ mL}$ of the solution **(S_1)** of molar concentration $\mathbf{C_1 = 0.25\ mol.L^{-1}}$ is prepared by diluting **25 times** a commercial Javel water solution **(S_o)**.

1.1. Show that the volume $\mathbf{V_o}$ withdrawn from solution **(S_o)** to prepare 10 mL of the solution **(S_1)**.

1.2. Choose, from **document- 2**, the essential glassware needed to carry out the preparation of solution **(S_1)**:

- To withdraw: $\mathbf{V_o}$.
- To contain the solution **(S_1):**

Beakers	100 mL	250 mL	500 mL
volumetric flask	100 mL	250 mL	500 mL
graduated cylinder	5 mL	10 mL	25 mL
volumetric pipet	5 mL	10 mL	25 mL

Document- 2

2. Kinetic Study

A volume $\mathbf{V_1=200\ mL}$ of a solution $\mathbf{(S_1)}$ of Javel water solution of molar concentration $\mathbf{C_1 = 0.25 mol.L^{-1}}$ is mixed with an excess of ammonia solution at constant temperature $\mathbf{T = 27\ ^oC.}$

Using an appropriate method, the number of moles of nitrogen gas $\mathbf{N_2}$ formed is determined at different instant t, the results obtained are grouped in the table of **document- 3**:

t (min)	2	4	6	8	10	12	16
$n(N_2)$ (10^{-3} mol)	4.3	8.0	10.3	12.0	13.3	14.3	15.5

Document-3

2.1. Show that the initial number of moles of hypochlorite ions $\mathbf{C\ell O^-}$ is equal 5×10^{-2}mol.

2.2. Calculate the number of moles of $\mathbf{N_2}$ expected to be obtained at the end of the reaction.

Verify whether the instant of time t = 16 min represents the end of the reaction.

2.3. Plot the curve representing the variation in the number of moles of (N_2) as a function of time:

n (N_2) = f (t) within the interval of time [0 – 16 min].

Take the following scales: In abscissas: 1cm for 1 min;

In ordinates: 1cm for 1×10^{-3} mol.

2.4. Deduce, graphically, the variation of the rate of formation of (N_2) as a function of time.

2.5. **Choose** the correct answer:

a. $r_{(ClO^-)t} = 3\, r_{(N2)t}$ **b.** $r_{(ClO^-)t} = \frac{r(N2)t}{3}$ **c.** $r_{(ClO^-)t} = r_{(N2)t}$

Knowing that:

$r_{(N2)t}$:the rate of formation of (N_2) at an instant of time t.

$r_{(C\ell O^-)t}$: the rate of disappearance of $C\ell O^-$ at the same instant t.

2.6. **Define** the half- life time of the reaction $t_{1/2}$.

Determine graphically this time.

2.7. The same kinetic study is carried out but with one change: it takes place in this case at temperature T' higher than 27^{o}C.

Specify, in this study, whether the following statement is true or false:

The number of moles of nitrogen gas (N_2) formed at t = 4 min becomes less than 8.0×10^{-3} mol, given value in **document- 3**.

Exercise 3 (7 points) **Titration of an Ethanoic Acid Solution**

Ethanoic acid is a weak acid of formula CH_3COOH.

The aim of this exercise is to study the behavior of ethanoic acid in water and to determine its molar concentration by pH-metric titration.

Given: - This study is carried out at 25 °C.

- pKa of the pair (CH_3COOH / CH_3COO^-) = 4.8

1. Study of the Behavior of Ethanoic Acid in Water

In the laboratory, available is a flask containing an ethanoic acid solution **(S)** of unkown molar concentration $\mathbf{C_a}$.

1.1. Complete the equation of the reaction of ethanoic acid CH_3COOH with water:

$$\mathbf{CH_3COOH + H_2O \rightleftharpoons \ldots A \ldots + \ldots B \ldots}$$

1.2. Knowing that α is the degree of dissociation of ethanoic acid in water.

- Complete the following table :

	$\mathbf{CH_3COOH + H_2O \rightleftharpoons \ldots A \ldots + \ldots B \ldots}$			
Initial state	$\mathbf{C_a}$	excès	0	0
Equilibrium state	$\mathbf{C_a - C_a \alpha}$	excès	?	?

- **verify** the following relation:

$$\frac{[CH_3COO^-]}{[CH_3COOH]} = \frac{\alpha}{1-\alpha}$$

1.3. Show that the value of α is close to 0.04, knowing that:

- pH of the solution (S) is equal to 3.4

- The pH is calculated by this relation pH = pKa (acide / base) + log $\frac{[base]}{[acide]}$

1.4. Based on the value of α, **justify** that ethanoic acid is a weak acid.

2- Titration of the Ethanoic Acid Solution (S)

Into a beaker, introduce a volume V_a = 20.0 mL of the ethanoic acid solution (S) and a certain volume of distilled water to immerse properly the pH-meter electrode. A sodium hydroxide solution ($Na^+ + HO^-$) of molar concentration $C_b = 2.0\times10^{-2}$ mol.L^{-1} is added progressively. A sample of the experimental results is given in **document-1** :

V_b (mL)	0	5	10	15
pH	3.5	4.8	pH_E	11.2

Document-1

2.1.Choose, From the given material of **document-2**, the most suitable ones needed to carry out the titration.

- Volumetric flasks: 50 and 100 mL
- Beaker : 100 mL
- Graduated cylinders: 10, 20 and 50 mL
- Magnetic stirrer and its bar
- Graduated buret : 25 mL
- pH – meter and its electrode
- Precision balance

Document-2

2.2.Write the equation of the titration reaction between **CH_3COOH** and **HO^-** ions.

2.3. Based on the chemical species present in the beaker at equivalence. **Specify** the point that represents the equivalence point:

A (V_{bE} = 10 mL ; pH_E = 8.3) ;

B (V_{bE} = 10 mL ; pH_E = 7) ;

C (V_{bE} = 10 mL ; pH_E = 5.8).

2.4.Determine the molar concentration of ethanoic acid in the solution (S).

2.5.Plot the shape of the curve representing the change in the pH as a function of the volume of the base added pH = f (V_b) passing by the four remarkable points extracted from the table of **document-1**.

Take the following scales: In abscissa 1 cm = 1 mL;

In ordinates; 1cm = 1 unit of pH.

2.6. – Plot the predominance axis of the chemical species of the pair CH_3COOH / CH_3CO0^-.

- Referring to **document-1** and using the predominance axis **specify** the chemical species which predominates at the end of the titration for V_b = 15 mL.