Exercise I Surround the true answers: (30 pts)

1- The dehydration reaction of alcohols:
   a- Is a homogeneous catalytic reaction.
   b- Takes place by introducing a metal catalyst.
   c- Takes place by introducing an acid catalyst.

2- The rate of a chemical reaction depends on:
   a- The temperature of the reaction medium.
   b- The concentration of the reactants.
   c- The value of the equilibrium constant.

3- Consider the following reaction:
   \[ \text{N}_2\text{O}_4 \text{ (g)} \rightleftharpoons 2\text{NO}_2 \text{ (g)} \quad \Delta H = 57 \text{ KJ/mol} \]
   a- The addition of \( \text{N}_2\text{O}_4 \text{(g)} \) causes the displacement of the equilibrium to the right.
   b- The reduction in temperature causes the displacement of the equilibrium towards the left.
   c- The increase in pressure causes the displacement of the equilibrium towards the left.

4- Consider the following compounds: A: \( \text{CH}_2\text{CH}_2\text{OH} \)  B: \( \text{CH}_3\text{OCH}_3 \)
   a- A is more volatile than B.
   b- A is more reactive than B.
   c- A and B are isomers of position.

5- Tollens reagent:
   a- Is a silver based oxidant.
   b- Can oxidize propanone in propanoate.
   c- Reduce aldehyde into alcohol.

6- Propanoic acid and methyl acetate:
   a- Are isomers of function.
   b- Have the same chemical properties.
   c- Have the same physical properties.

7- We consider the following compounds: A: \( \text{butan-1-ol} \)  B: \( \text{butan-2-ol} \)
   a- A is more volatile than B.
   b- A and B are isomers of function.
   c- A and B are isomers of position.

8- The transformation of propanol to propanal is:
   a- A dehydration reaction.
   b- Reduction reaction.
   c- Dehydrogenation reaction.
9- Ethylamine:
   a- Is more volatile than methylamine.
   b- Colors phenolphthalein in pink.
   c- Is more basic than ammonia.
10- Diethylamine:
   a- Is a secondary amine.
   b- Is more basic than ethylamine.
   c- Is a skeleton isomer with ethylamine.

Exercise II (5 pts)
We dissolved in water 12 liters of HCl (gas). The final volume of the obtained solution is 5 liters. Calculate the concentration of HCl in this solution.
Given: molar volume of HCl = 24 liters

Exercise III (8 pts)
At a celebration, students want to decorate the courtyard of their school with 300 helium-filled balloons. They have a gas cylinder containing 25 L of gaseous helium at a pressure of 30 atm. To fill a balloon they need 2.5 L of helium under a pressure of 1.04 atm.
Explain by calculation if the contents of the gas cylinder are sufficient to fill the 300 balloons.
It is assumed that the temperature remains constant during the transformations made.
Exercise IV; (15 pts)
We introduce A moles of nitrogen and B moles of hydrogen at a temperature T in a
container of volume V.
The following equilibrium is established: \( \text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g) \)
If \( P_{\text{total}} \) is the total pressure and \( X \) the number of moles of nitrogen consumed at
equilibrium. Find in function of \( A, B, X \) and \( P_{\text{total}} \):
1) The expression of the partial pressure of each gas at equilibrium.
2) The expression of \( K_p \) at the temperature \( T \) for \( A = 1 \) and \( B = 3 \).
**Exercise V (20 pts)**

We introduce in a 250 mL flask, 6.0 g of ethanoic acid, 12.0 g of ethanol, 0.5 mL of concentrated sulfuric acid and two grains of pumice stone. The mixture is heated for about 30 minutes.

1- Clarify the role of the sulfuric acid and the grains of pumice stone.

2- Write the equation of the reaction.

3- After cooling the reaction mixture, acids present are titrated by a solution of sodium hydroxide (1 mol/L) in the presence of phenolphthalein as indicator. The color change of the indicator is observed after the addition of 20.0 mL of the basic solution. A previous titration showed that 0.5 mL of the concentrated sulfuric acid requires 8.5 mL of sodium hydroxide solution.

a. Determine the number of moles of the reactants and the products before and after the reaction.

b. Calculate the $K_c$ of the reaction.

*Given:* $M(\text{C}) = 12$; $M(\text{H}) = 1$; $M(\text{O}) = 16$
Exercise VI: (12 pts)
We determine the pH at 25°C of three aqueous solutions S₁, S₂ and S₃ containing respectively ethanoic acid, hydrochloric acid and sodium hydroxide as:

\[ \text{pH₁} = 3.1; \quad \text{pH₂} = 2.6; \quad \text{pH₃} = 11.3 \]

1) Indicate the acid solutions and the basic solutions?
2) Determine the concentration C of each solution.
3) What is the pH of a solution which \([\text{H}_3\text{O}^+] = 1.3 \times 10^{-4} \text{ mol/L}\)?
4) What is the pH of a solution which \([\text{OH}^-] = 1.3 \times 10^{-4} \text{ mol/L}\)?

Given: \(pK_a(\text{CH₃COOH/CH₃COO}^-) = 4.8\)
Exercise VII: (10 pts)

Complete the equations of the following reactions and identify the nature of each reaction: esterification, hydrolysis or substitution.

1. $\text{CH}_3\text{COOH} + \text{CH}_3\text{CH}_2\text{OH} =$

2. $\text{CH}_3\text{COOCH}_3 + \text{H}_2\text{O} =$

3. $\text{H}_2\text{O} + \text{propyl ethanoate} =$

4. $\text{CH}_3\text{COOH} + \text{PCl}_5 =$

5. $\text{CH}_3\text{-CO-O-COCH}_3 + \text{H}_2\text{O} =$