This is a Class 1 exam

Lebanon Evangelical School
for Boys and Girls
Loueizeh - Baabda

Stage Exam 01

06NOV2023

Do NOT write in this box. Your MARK will be placed here.

Subject :	Chemistry	
Class :	11S	
Teacher :	Mrs. Mirella Freige	
Duration :	1 hour	
Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

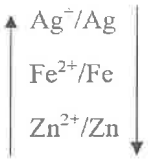
Exercise 1: Qualitative study of a redox reaction (5 points)

1- Consider the following chemical species, Cu, Cu^{2+}, Al and Al^{3+}.
   a) Form the different possible redox couples and write, for each couple, the corresponding half equation.
   b) Write the balanced overall equation knowing that Cu^{2+} oxidizing agent is stronger than Al^{3+}.

2- Which of the following statements is incorrect?
a) The reducing agent undergoes an oxidation.
b) The oxidizing agent is called oxidant.
c) The oxidant gains electrons.
d) The reductant gains electrons.

3- Given the unbalanced equation: $Hg + Au^{3+} \rightarrow Hg^{2+} + Au$
   a) Indicate the redox couples involved.
   b) Balance the above equation.
   c) Identify the strongest oxidizing agent and the strongest reducing agent.

4- Consider the electrochemical classification of the following redox couples:



a) Predict and explain the possible redox reactions.
b) Gold ions Au^{3+} can oxidize silver Ag and produce a gold deposit Au.
   Place the Au^{3+} / Au couple in the above classification.

Exercise 2: **Redox reaction (10 points)**

A hydrochloric acid solution ($H^+ + C\ell^-$) reacts with magnesium metal according to a redox reaction as shown by the equation below:

$$2H^+_{(aq)} + Mg_{(s)} \longrightarrow Mg^{2+}_{(aq)} + H_{2(g)} \qquad (E)$$

In order to study the quantitative aspect of this reaction, a grade11 student introduces a mass m= 0.12 g of magnesium in an Erlenmeyer flask.

At instant t = 0, a volume V = 100.0 mL of a hydrochloric acid solution (S) of molar concentration C = 2×10^{-1} mol/L is poured into the Erlenmeyer flask.

Given:

Molar mass of magnesium Mg is M = 24 g/mol.

1- Preparation of Hydrochloric Acid Solution (S)

The solution (S) is prepared by diluting 50 times a hydrochloric acid solution (S_0).

Choose, from **Document-1,** the most precise set for the preparation of solution (S). Justify by showing the appropriate calculation.

Set 1	Set 2	Set 3
Beaker of 100 mL Graduated cylinder of 10 mL Volumetric flask of 500 mL	Beaker of 100 mL Volumetric pipet of 10 mL Volumetric flask of 500 mL	Beaker of 100 mL Volumetric pipet of 10 mL Volumetric flask of 250 mL

Document-1

2- Quantitative aspect of the chemical reaction

2.1. Calculate the initial number of moles of each reactant.
2.2. Identify the limiting reactant.
2.3. Calculate the maximum number of moles of hydrogen gas.
2.4. Specify whether the instant t = 16 minutes represents the end time of this reaction knowing that at t = 16 mins, 29×10^{-4} mol of hydrogen gas are released.

3- Electrochemical study

3.1. Write the oxidation and the reduction half equations corresponding to the redox equation (E).

3.2. Indicate the redox couples involved.

3.3. Identify the strongest oxidizing agent and the strongest reducing agent.

Exercise 3: Concentration of a stock solution (5 points)

On the label of a bottle containing (S_0) a stock solution of hydrobromic acid solution ($H^+ + Br^-$), the following indications are written:

47%

M(HBr) = 81 g/mol

d= 1.47 g/mL.

a) Show that the molar concentration of (S_0) is equal to 8.53 mol/L.
b) In order to prepare 500 mL of (S_1) a diluted hydrobromic acid solution of concentration $C_1 = 0.1$ mol/L, a volume V_0 should be taken from (S_0) .
   Calculate V_0 .
c) Describe the procedure of this preparation.

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Exercise 1:

1.a) The redox couples are: Cu^{2+}/Cu (0.25) and Al^{3+}/Al (0.25)

The corresponding half equations: $Cu^{2+} + 2e^- \rightleftharpoons Cu$ (0.25)

$Al^{3+} + 3e^- \rightleftharpoons Al$ (0.25)

b) Cu^{2+}: oxidizing agent is stronger than Al^{3+}.

$3\,Cu^{2+} + 2Al \longrightarrow 3Cu_{(s)} + 2Al^{3+}$ (0.75)

2 - d. (0.5)

3 - a) Redox Couples: Au^{3+}/Au (0.25) and Hg^{2+}/Hg (0.25).

b) $3\,Hg + 2\,Au^{3+} \longrightarrow 3\,Hg^{2+} + 2\,Au$. (0.5)

c) The redox reaction takes place between the strongest oxidant and the strongest reductant therefore, Au^{3+} is stronger than Hg^{2+} (0.25)

and Hg is stronger than Au. (0.25)

4 - a) The possible redox reactions occur between: Ag^+ and Fe; Ag^+ and Zn; Fe^{2+} and Zn. (0.75)

b) Au^{3+} can react with Ag so, Au^{3+} is stronger than Ag^+: (0.25)

$\uparrow Au^{3+}/Au$

$Ag^+/Ag \downarrow$ (0.25)

Exercise 2:

1 - Preparation of Hydrochloric Acid solution (S):

$(S_0) \xrightarrow{F=50} (S)$

During dilution, the number of moles of solute is conserved: (0.5)

$C_0 \times V_0 = C \times V$

$F = \frac{V}{V_0}$, so $50 = \frac{V_{Vol.Flask}}{V_{Vol.Pipet}}$ (0.5) Set (2) is the most precise set (1)

$\left(50 = \frac{500\,mL}{10\,mL}\right)$

2- Quantitative aspect of the chemical reaction:

2.1. Initial number of moles of each reactant:

$n_{0\,Mg} = \frac{m}{M} = \frac{0.12}{24} = 5\times10^{-3}$ mol. (0.5)

$n_{0\,H^+} = C\times V = 2\times10^{-1} \times \underbrace{100\times10^{-3}}_{(L)} = 2\times10^{-2}$ mol. (0.5)

2.2. $R_{Mg} = \frac{n_0}{coeff} = 5\times10^{-3}$ (0.5)

$R_{H^+} = \frac{n_0}{coeff} = \frac{2\times10^{-2}}{2} = 10^{-2}$ (0.5)

$R_{Mg} < R_{H^+}$, then Mg is the limiting reactant. (0.5)

2.3. According to the stoichiometry: (0.5)

$n_{Mg\,reacting} = n_{H_2\,produced\,(at\,\infty)} = 5\times10^{-3}$ mol (maximum n_{H_2} obtained at the end of the reaction) (0.5)

2.4. $n_{H_2}(t=16\,mins) = 29\times10^{-4}$ mol $< n_{H_2}$ (end time of this reaction) (0.5)

So $t = 16$ mins doesn't represent the end time of the reaction. (0.5)

3- Electrochemical Study:

3.1. $Mg \longrightarrow 2e^- + Mg^{2+}$: Oxidation half reaction. (0.5)

$2H^+ + 2e^- \longrightarrow H_2$: Reduction half reaction. (0.5)

3.2. Redox couples: Mg^{2+}/Mg (0.5) and H^+/H_2 (0.5).

3.3. The strongest oxidant is: H^+. (0.75)

The strongest reductant is: Mg. (0.75)

Exercise 3 Stock Solution: (5 points)

(S_0) : $(H^+ + Br^-)$ 47%
$d = 1.47\ g/mL$
$M(HBr) = 81\ g/mol$.

a) $m_{solute} = 47\ g$.
$n_{mol} = \frac{m}{M} = \frac{47}{81} = 0.5802\ mol$. (0.5)

$d_{solution} = \frac{m_{solution}}{V_{solution}}$, so $V_{solution} = \frac{m_{solution}}{d}$
$= \frac{100}{1.47} = 68.027\ mL$ (0.5)

$C_0 = \frac{n_{solute}}{V_{solution}} = \frac{0.5802}{68.027 \times 10^{-3}} = 8.529\ mol/L$
$\simeq 8.53\ mol/L$. (0.5)

b) $(S_0)\begin{cases} C_0 = 8.53\ mol/L \\ V_0 = ? \end{cases} \xrightarrow{\text{Dilution}} (S_1)\begin{cases} C_1 = 0.1\ mol/L \\ V_1 = 500\ mL \end{cases}$

During dilution, the number of moles of solute is conserved:
$C_0 \times V_0 = C_1 \times V_1$ (0.5)
$V_0 = \frac{C_1 \times V_1}{C_0} = \frac{0.1 \times 500}{8.53} = 5.86\ mL$. (0.5)

c) In a beaker, pour a certain volume of (S_0). (0.5)
- With a graduated pipet, take 5.86 mL from (S_0). (0.5)
- Pour this volume in a 500mL volumetric flask. (0.5)
- Add water up to the line mark. (0.5)
- Plug the volumetric flask and overturn to homogenize the solution. (0.5)