This is a Class 1 exam

Lebanon Evangelical School for Boys and Girls

Loueizeh - Baabda

Stage Exam 06

19, 20, 21JUN2023

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

Subject :	Chemistry
Class :	10B and 10C
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: Preparation of solutions: (8 points)

Given M(NaOH) = 40g/mol.

A- Sodium hydroxide NaOH is found in the form of white pellets kept in tightly closed plastic boxes. We want to prepare 1000 mL of a sodium hydroxide solution ($Na^+ + OH^-$) with a concentration of 0.1mol/L.

1- Write the dissociation equation of $NaOH_{(s)}$ in water.
2- Calculate the mass of NaOH needed for this preparation.
3- Describe the operating mode of this dissolution.

B- Potassium permanganate solution ($K^+ + MnO_4^-$) is a purple solution used as a disinfectant to treat certain infections in drinking water. In the laboratory, is available a stock solution of ($K^+ + MnO_4^-$) with an initial concentration Ci= 1mol/L, which is too concentrated. This is why we want to dilute it by preparing a final volume V_f=100mL of this solution with a final concentration C_f = 0.01mol/L.

1- Calculate the volume to be taken from the stock solution.
2- Indicate the materials required for this dilution.

Exercise 2: Acid solutions and basic solutions (6 points)

Given: the ion product of water: $K_w = 10^{-14}$ at 25°C.

1) A hydrochloric acid solution ($H^+ + Cl^-$) has a pH = 3 at 25°C.

a- Calculate the molar concentration of H^+ ions in the solution.

b- Determine the molar concentration of OH^- ions.

2) A solution of sodium hydroxide ($Na^+ + OH^-$) has a pH = 10 at 25°C.

a- Calculate the concentration of H^+ ions in the solution.

b- Evaluate the concentration of hydroxide ions OH^- and deduce that of the basic solution: C_b.

3) We have three solutions A, B and C such that:

Solution A: pH=6, solution B: $[H^+] = 10^{-2}$ mol/L and solution C: $[OH^-] = 10^{-10}$ mol/L.

Arrange the three solutions in increasing order of acidity.

Exercise 3: Quantitative study of a chemical reaction (6 points)

Molar masses in g/mol: M(S) = 32; M(Al) = 27.

A mixture of 2g of aluminum and 3g of sulfur is made. After heating, the aluminum sulphide Al_2S_3 is obtained.

a) Write the corresponding equation.

b) Calculate the initial number of moles of each reactant.

c) Is this mixture of reactants stoichiometric? If not, determine the limiting reactant.

d) Calculate the theoretical mass of the obtained product.

e) Determine the mass of the excess reactant remaining at the end of the reaction.

f) Experimentally, we obtain 3g of Al_2S_3.

Calculate the yield of the reaction.

Exercise 1 : Preparation of solutions

A-1- $NaOH_{(s)} \longrightarrow Na^+ + OH^-$ (1)

2- $m_{NaOH} = n \times M(NaOH)$
$= C \times V \times M(NaOH)$
$= 0.1 \times 1000 \times 10^{-3} \times 40$
$= 4\,g$. (1)

3- Operating mode : (2)

- On a balance, weigh out 4g of NaOH taken with a spatula and placed on a watch glass.
- Using a funnel, introduce this mass in a 1000 mL volumetric flask.
- Rinse the watch glass and the funnel with distilled water to avoid any loss of solute.
- Swirl the volumetric flask to dissolve completely the solute.
- Add distilled water up to the Line mark.
- Plug the volumetric flask and invert it several times to homogenize the solution.

B- $\begin{cases} C_i = 1\ mol/L \\ V_i = ? \end{cases} \xrightarrow{\text{Dilution}} \begin{cases} C_f = 0.01\ mol/L \\ V_f = 100\ mL. \end{cases}$

1- During the dilution, number of moles of solute is conserved : $n_i = n_f$ so, $C_i \times V_i = C_f \times V_f$.

$$V_i = \frac{C_f \times V_f}{C_i} = \frac{0.01 \times 100}{1} = 1\ mL. \quad (2)$$

2- Materials needed for this dilution:
Beaker
1 mL volumetric pipet
100 mL volumetric flask
Distilled water. (2)

Exercise 2 : Acid solutions and basic solutions:

1) $(H^+ + Cl^-)$: pH = 3

a- $[H^+] = 10^{-pH} = 10^{-3}$ mol/L. (1)

b- $K_w = [H^+] \times [OH^-] = 10^{-14}$

$[OH^-] = \frac{10^{-14}}{[H^+]} = \frac{10^{-14}}{10^{-3}} = 10^{-11}$ mol/L. (1)

2) $(Na^+ + OH^-)$ pH = 10.

a- $[H^+] = 10^{-pH} = 10^{-10}$ mol/L. (1)

b- $[OH^-] = \frac{10^{-14}}{10^{-10}} = 10^{-4}$ mol/L. (1)

NaOH strong base : $[OH^-] = C_b = 10^{-4}$ mol/L. (1/2)

3) $pH_A = 6$; $[H^+]_B = 10^{-2}$ mol/L : $pH_B = 2$. (1/2)

$[OH^-]_C = 10^{-10}$ mol/L so, $[H^+] = \frac{10^{-14}}{10^{-10}} = 10^{-4}$ mol/L.

$pH_C = -\log[H^+] = -\log(10^{-4}) = 4$. (1/2)

Increasing order of acidity, A - C - B.
(Since $pH_A > pH_C > pH_B$). (1/2)

Exercise 3

a) $2Al + 3S \longrightarrow Al_2S_3$ (0.5)

b) $n_{Al} = \frac{m_{Al}}{M(Al)} = \frac{2}{27} = 0.074$ mol. (0.5)

$n_S = \frac{m_S}{M(S)} = \frac{3}{32} = 0.093$ mol. (0.5)

c) $R_{Al} = \frac{n_{Al}}{coeff} = \frac{0.074}{2} = 0.037$ (0.5)

$R_S = \frac{n_S}{coff} = \frac{0.093}{3} = 0.031$ (0.5)

$R_{Al} \neq R_S$ so, the reactant mixture is non stoichiometric.

$R_S < R_{Al}$, then S : Limiting reactant. (0.5)

d) According to the stoichiometry :

$$\frac{n_{Al\,reacted}}{2} = \frac{n_{S\,reacted}}{3} = \frac{n_{Al_2S_3\,obtained}}{1}$$

$n_{Al_2S_3} = \frac{n_S}{3} = \frac{0.093}{3} = 0.031$ mol. (0.5)

Theoretical mass of Al_2S_3 : $m = n \times M(Al_2S_3)$

$= 0.031 \times [(2 \times 27) + (3 \times 32)]$

$m_{Al_2S_3} = 4.65$ g. (0.5)

e) $n_{Al\,reacted} = \frac{2 \times n_{S\,reacted}}{3} = \frac{2 \times 0.093}{3} = 0.062$ mol. (0.5)

$n_{Al\,remaining}$ = initial n_{Al} — reacted n_{Al}

$= 0.074 - 0.062$

$= 0.012$ mol. (0.25)

Remaining mass of Al $= n \times M(Al)$

$= 0.012 \times 27$

$= 0.324\ g.$

(0.25)

f) yield $= \dfrac{\text{experimental mass of } Al_2S_3}{\text{Theoretical mass of } Al_2S_3}$

yield $= \dfrac{3}{4.65} = 0.6451.$

(1)