**THE UNITED REPUBLIC OF TANZANIA**
**NATIONAL EXAMINATIONS COUNCIL OF TANZANIA**
**DIPLOMA IN SECONDARY EDUCATTION EXAMINATION**

**732/2A** **CHEMISTRY 2A**

**Time: 3 Hours** **ANSWERS** **Year: 2022**

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**Instructions.**

1. This paper consists of sections A and B with a total of **Fourteen (14)** questions.
2. Answer **all** questions from section A and **four (4)** questions from section B.
3. Section A carries **forty (40)** marks and section B Carries **sixty (60)** marks.
4. Cellular phones are **note** allowed in the examination room.
5. Write your **examination Number** on every page of your answer booklet(s).

**1. Titration Experiment:**

**Instructions:**
Measure 10 ml of solution A ($Na_2CO_3$) and dilute it up to 150 $cm^3$ with distilled water. Titrate this A (from the burette) against 20.00 or 25.00 $cm^3$ of solution B (HCl) using methyl orange indicator (MO).

**Given:**
Average titre volume = 20.00 $cm^3$

**(a) (i) What is the volume of the pipette used?**
**Answer:** 20.00 $cm^3$

**(ii) Present your results in an appropriate tabular form:**

| Titration | Final Burette Reading ($cm^3$) | Initial Burette Reading ($cm^3$) | Volume Used ($cm^3$) |
|---|---|---|---|
| Rough | 20.20 | 0.00 | 20.20 |
| 1st | 40.20 | 20.20 | 20.00 |
| 2nd | 60.20 | 40.20 | 20.00 |
| 3rd | 80.20 | 60.20 | 20.00 |

**(b) What is the colour of the indicator before and at the equivalence point?**

**Before endpoint (in $Na_2CO_3$ solution):** Yellow

**At endpoint (in acidic medium):** Pink

**(c) Calculate the concentration of HCl in solution B in mol/$dm^3$.**

**Given:**

$C_1V_1 = C_2V_2$

$C_1$ = concentration of $Na_2CO_3$ after dilution

$V_1 = 20.00\ cm^3$

$V_2 = 20.00\ cm^3$

$C_2$ = concentration of HCl

Mole ratio $Na_2CO_3$ : HCl = 1 : 2

**First find moles of $Na_2CO_3$:**
From (d), we'll need concentration first.

**(d) Calculate the concentration (in mol/dm³) of $Na_2CO_3$ after dilution of solution A.**

**Given:**
10 ml contains 0.888 g of impure sodium carbonate
Molar mass of $Na_2CO_3$ = 106 g/mol

**Moles in 10 ml:**
0.888 g / 106 g/mol = 0.00838 mol

**In 150 cm³:**
C = 0.00838 mol / 0.150 dm³ = 0.0559 mol/dm³

**(c) Now calculate concentration of HCl:**

Using
$C_1V_1 = (C_2V_2)/2$

$0.0559 \times 20.00 = (C_2 \times 20.00) / 2$

Simplify:
$1.118 = 0.5C_2 \times 20$
$C_2 = 1.118 \times 2 / 20$
$C_2 = 0.1118$ mol/dm³

**Final answer:** 0.1118 mol/dm³

**(e) Calculate the concentration (in mol/dm³) of $Na_2CO_3$ before dilution of solution A.**

Before dilution:
10 ml was diluted to 150 ml

Concentration before dilution = 0.0559 × (150 / 10)
= 0.8385 mol/dm³

**(f) If the diluted 10 ml of solution A contains 0.888 g of impure sodium carbonate, what is the percentage composition of sodium carbonate in the solution?**

**Mass of pure $Na_2CO_3$:**
0.00838 mol × 106 g/mol = 0.888 g

Since the entire 0.888 g is taken as impure, and based on titration it acted as 0.888 g pure (as per calculation), so:

**Percentage purity = (0.888 / 0.888) × 100 = 100%**

**But normally there should be a difference. Since it's given as impure but no impure mass is provided separately, based on this calculation, it behaves as 100% pure.**

**(g) Why is the impure sodium carbonate dissolved in water first and then made up to 250 cm³ solution, rather than being dissolved directly in 250 cm³ of distilled water?**

**Answer:**
To ensure complete dissolution of the impure sodium carbonate before adjusting the final volume. If added directly to 250 cm³, some might remain undissolved, making the final concentration inaccurate.

**2. Reaction Rates Experiment:**

**Given:**

0.02 M $KMnO_4$ (P1)

0.05 M oxalic acid in 0.5 M $H_2SO_4$ (P2)

Temperatures: 50°C, 60°C, 70°C, 80°C

Time (sec): 23, 16, 8, 4

**(a) Complete the table:**

| Temperature (K) | Time (s) | 1/T ($K^{-1}$) | 1/t ($s^{-1}$) | log(1/t) |
|---|---|---|---|---|
| 323 | 23 | 0.00310 | 0.0435 | −1.3617 |
| 333 | 16 | 0.00300 | 0.0625 | −1.2041 |
| 343 | 8 | 0.00292 | 0.125 | −0.9031 |
| 353 | 4 | 0.00283 | 0.25 | −0.6021 |

**(a) Write a balanced ionic equation for the reaction.**

$5C_2O_4^{2-}(aq) + 2MnO_4^-(aq) + 16H^+(aq) \rightarrow 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(l)$

**(c) Explain the relationship between temperature and reaction time.**

As temperature increases, the time taken for the reaction decreases. This is because higher temperatures increase the kinetic energy of the reacting particles, leading to more frequent and energetic collisions, thus speeding up the reaction.

**(d) Plot a graph of log(1/t) as a function of 1/T.**

**(e) Determine the activation energy (Ea)**

From Arrhenius equation:
$\log(1/t) = \log A - (Ea/2.303R)(1/T)$

Slope (m) = $-Ea/2.303R$

Using two points:

$(-0.6021 - (-1.3617)) / (0.00283 - 0.00310)$
$= 0.7596 / (-0.00027)$
$= -2810$

$Ea = 2.303 \times 8.314 \times 2810$
$Ea = 53751$ J/mol
$Ea \approx 53.75$ kJ/mol

**3. Qualitative Analysis — Lead (II) Nitrate sample X**

| Test | Observation | Inference |
|---|---|---|
| (i) Appearance | White crystalline solid | Possible lead salt |
| (ii) Action of heat | Melts and decomposes to brown fumes | Presence of nitrate ($NO_3^-$) |
| (iii) Action of dilute $H_2SO_4$ | White precipitate formed | Lead sulfate ($PbSO_4$) formed |
| (iv) Action of concentrated $H_2SO_4$ | White precipitate formed | Lead sulfate ($PbSO_4$) |
| (v) Flame test | Blue flame | Lead salt |
| (vi) Solubility in water | Soluble | Confirms lead nitrate |
| (vii) Action of dilute HCl on solution | White precipitate ($PbCl_2$) | Confirming $Pb^{2+}$ cation |
| (viii) Aqueous ammonia then ammonium oxalate | White precipitate formed | Presence of $Pb^{2+}$ (lead oxalate) |

**(a) What are the cation and anion present in the water source?**
**Cation:** $Pb^{2+}$
**Anion:** $NO_3^-$

**(b) Write the reaction equation to indicate what took place in test (iii):**

$Pb(NO_3)_2(aq) + H_2SO_4(aq) \rightarrow PbSO_4(s) + 2HNO_3(aq)$