UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
SCHOOL OF EDUCATIONAL DEVELOPMENT AND OUTREACH
INSTITUTE OF EDUCATION

FIVE-SEMESTER BACHELOR OF EDUCATION (SANDWICH) PROGRAMME
LEVEL 400, END-OF-FIRST SEMESTER EXAMINATIONS, JUNE 2023

MARKING SCHEME

COURSE CODE: CHE 310SW
COURSE TITLE: PRACTICAL (PHYSICAL/INORGANIC) CHEMISTRY II

Answer ALL the questions.
(60 MARKS)

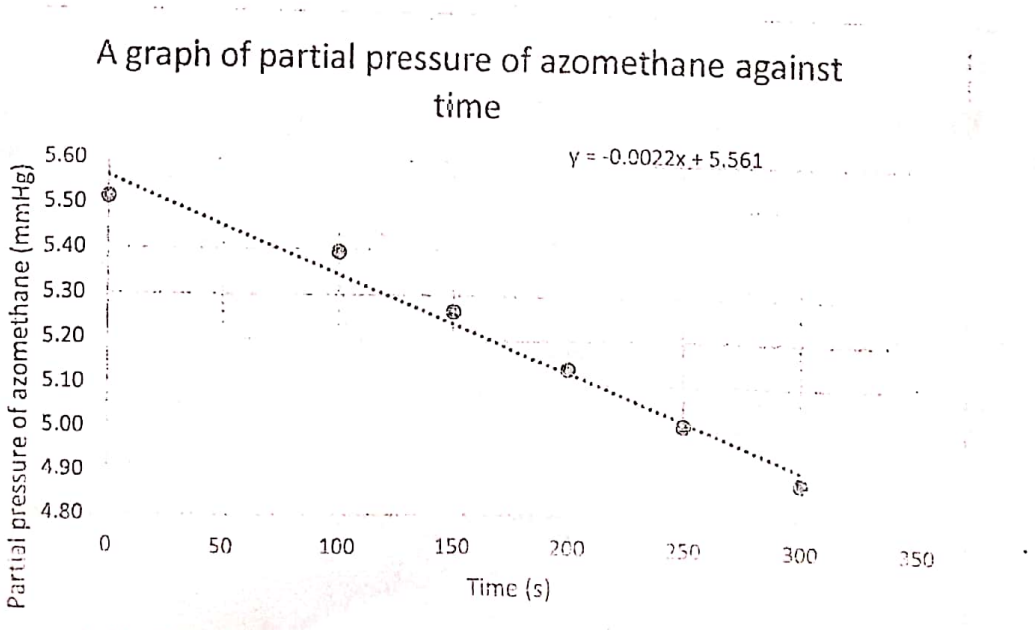
1. The rate of decomposition of azomethane ($C_2H_6N_2$) was studied by monitoring the partial pressure of the reactant as a function of time.

$C_2H_6N_2(g) \longrightarrow N_2(g) + C_2H_6(g)$ *[50 marks]*

Partial pressure of azomethane (mmHg)	Time (s)
248	0
220	100
193	150
170	200
150	250
132	300

a. Plot a first order graph for this data.

Answer



b. What is the molecularity of the reaction?

Answer

The reaction is unimolecular

c. What is the rate constant for the decomposition of azomethane?

Answer

The rate constant , k, is the slope of the curve = $0.0022\ s^{-1}$

d. What is the half-life for the decomposition of azomethane?

Answer

For a first order reaction, $t_{1/2} = \frac{0.693}{k} = \frac{0.693}{0.0022} = 312\ s$

e. Determine the partial pressure for this reaction after 120 s of decomposition.

Answer

From the integral first order reaction,

$\ln P_t = -kt + \ln P_o$

$= -0.0022 \times 120 + 5.51 = 5.25$

$P_t = e^{5.25} = 190.6$ mmHg

f. What is the relationship between rate constant and rate of reaction?

Answer

The higher the rate constant, the faster the rate of reaction

2. Eriochrome black T is a known indicator used in the determination of water hardness. Show how this indicator changes colour from blue to wine at the end point of a complexometric titration.

[10 marks]

Answer

Eriochrome black T, which is originally blue in colour, forms a wine red complex when added to a sample containing calcium or magnesium according to the reaction.

$HIn^{2-} + Ca^{2+} \longrightarrow CaIn^{-} + H^{+}$ (1)

Blue — Wine red

During the titration process, the Na_2EDTA is added from the burette and takes away all the Ca^{2+} and Mg^{2+} from the Eriochrome Black T. When the equivalent point is reached, when all the Ca^{2+} and Mg^{2+} have been complexed by the EDTA (H_2Y^{2-}), the colour changes back to blue (the original colour of Eriochrome Black T) according to equation (2).

$CaIn^{-} + H_2Y^{2-} \longrightarrow CaY^{2-} + H^{+} + HIn$ (2)

Wine red — Blue

HCl -> $H^+ + Cl^-$

JUNE 2023
CHE 208SW
PHYSICAL CHEMISTRY II
1 HOUR 30 MINUTES

Candidate's Index Number
@ Zeqnye
Signature:

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21ST JUNE 2023 PHYSICAL CHEMISTRY II 2:30 PM - 4:00 PM

SECTION B
(40 MARKS)

Attempt TWO questions from this Section.

1. **20 marks**

a. Calculate the pH of 0.06 M aniline ($C_6H_5NH_2$)(a weak base) solution. (Given K_b ($C_6H_5NH_2$) = 3.8×10^{-10}). Assume the auto ionization of water has negligible effect on the pH of the solution.

b A solution is prepared by dissolving 2.0 g NaOH in 500 mL of distilled water. Calculate the pH of the solution.

2. **20 marks**

a. What is a buffer solution? Calculate the pH of a buffer system made up of 0.15 M NH_3/0.35 M NH_4Cl ($K_b = 1.8 \times 10^{-5}$)

b. Calculate the pOH of each of the following solutions:
   i. 0.002 M HCl
   ii. 0.042 M NaOH
   iii. 2.4×10^{-4} M $Ba(OH)_2$

3. **20 marks**

a. The pH of a 0.060 M weak monoprotic acid is 3.44. Calculate the K_a of the acid.

b. Use NH_3 and its conjugate acid NH_4^+ to derive the relationship between K_a and K_b

NH_4^+ ⟶ NH_3 + H^+