THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

ADVANCED CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

132/3A **CHEMISTRY 3B**

(For Both School and Private Candidates)

Time: 3 Hours **ANSWERS** **Year: 2014**

Instructions

1. This paper consists of THREE questions.

2. Answer all questions.

1. You are provided with the following:

L: 0.02 M potassium permanganate

K: 6.3 g/dm³ hydrated oxalic acid

M: 1 M sulphuric acid

Thermometer

Theory:

The reaction between potassium permanganate solution and oxalic acid is very slow and so the titration must be heated to about 80°C. In this reaction, the MnO_4^- ions act as oxidizing agent while $C_2O_4^{2-}$ ions act as reducing agent.

Procedure:

(i) Pipette 25 cm³ or 20 cm³ of solution L into a conical flask.

(ii) Add 25 cm³ or 20 cm³ of solution M in a conical flask containing solution L.

(iii) Warm the mixture to about 80°C.

(iv) Titrate the mixture against solution K until a permanent pink colour appears in the conical flask.

(v) Record the titre volume and repeat titration to obtain three readings.

(vi) Record the volume of the pipette used.

Questions:

(a) Write a half equation for the reduction of MnO_4^- ions to Mn^{2+} ions in acidic solution.

Answer: $MnO_4^- + 8H^+ + 5e^- \text{-----> } Mn^{2+} + 4H_2O$

(b) Write a half equation for the oxidation of $C_2O_4^{2-}$ to CO_2.

Answer: $C_2O_4^{2-} \text{-----> } 2CO_2 + 2e^-$

(c) Write an ionic equation to show the oxidation of $C_2O_4^{2-}$ to CO_2 by MnO_4^- ions in acidic solution.

Answer: $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \text{-----> } 2Mn^{2+} + 10CO_2 + 8H_2O$

(d) Deduce the value of x in hydrated ammonium iron (II) sulphate.

MnO_4^- oxidizes Fe^{2+} to Fe^{3+} according to:

$MnO_4^- + 5Fe^{2+} + 8H^+ \text{-----> } Mn^{2+} + 5Fe^{3+} + 4H_2O$

Using standard data and molar masses, value of x can be deduced after titration. (Actual calculation needs volume of L and titre values.)

(e) Suggest two advantages and disadvantages of using $KMnO_4$ in volumetric analysis.

Advantages:

- Acts as self-indicator

- Gives sharp endpoint (pink)

Disadvantages:

- Unstable in presence of sunlight

- Can react with organic matter, making standardization difficult

2. You are provided with the following:

U: 0.05 M hydrogen peroxide

V: 0.3 M potassium iodide

W: 0.25 M sulphuric acid

X: 0.3 M sodium thiosulphate

Y: Starch solution

Distilled water

Stop watch

Theory:

Hydrogen peroxide oxidizes iodide ions to form iodine. The iodine formed reacts with thiosulphate as per the reactions:

$H_2O_2 + 2H^+ + 2I^- \text{-----> } I_2 + 2H_2O$

$2S_2O_3^{2-} + I_2 \text{-----> } S_4O_6^{2-} + 2I^-$

Time taken for blue colour to appear corresponds to the completion of thiosulphate reaction.

Table 1: Mixture Composition

Mixture	X/cm³	Water/cm³
A	5	20
B	10	15
C	15	10
D	20	5
E	25	0

Assuming time values (t) observed in seconds:

A: 86 s

B: 43 s

C: 29 s

D: 22 s

E: 17 s

Calculate 1/t for each:

Mixture t (s) 1/t (s^{-1})

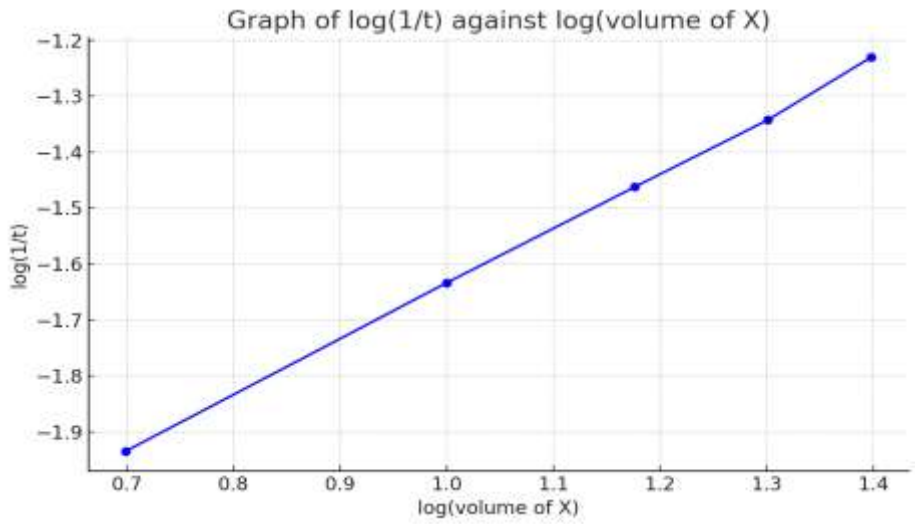
A	86	0.0116
B	43	0.0233
C	29	0.0345
D	22	0.0455
E	17	0.0588

(a) Tabulated Results:

Mixture	Volume of X (cm^3)	Water (cm^3)	Time t (s)	1/t (s^{-1})
A	5	20	86	0.0116
B	10	15	43	0.0233
C	15	10	29	0.0345
D	20	5	22	0.0455
E	25	0	17	0.0588

(b) Plot a graph of log(1/t) against log(volume of X):

Volume X (cm^3)	1/t (s^{-1})	log(X)	log(1/t)
5	0.0116	0.6990	-1.9355
10	0.0233	1.0000	-1.6320
15	0.0345	1.1761	-1.4624
20	0.0455	1.3010	-1.3410
25	0.0588	1.3979	-1.2304



(c) Calculate the gradient of the graph:

Choose two points:

(1.0000, -1.6320) and (1.3979, -1.2304)

Gradient = $(y_2 - y_1)/(x_2 - x_1)$

= (-1.2304 + 1.6320)/(1.3979 - 1.0000)

= 0.4016 / 0.3979

= 1.01

(d) Order of reaction with respect to X = 1.01 ≈ 1

(e) Simple procedure to determine order with respect to U:

- Keep volume of V, W, X, Y constant

- Vary volume of U (hydrogen peroxide) in separate runs

- Immediately add mixture to starch-containing solution

- Record time taken for blue colour to appear

- Plot log(1/t) against log(volume of U)

- Gradient of the graph gives order with respect to U

3. You are provided with sample H containing one cation and one anion. Carry out the experiments described in Table 3. Record carefully your observations, make appropriate inferences and finally identify the anion and cation present in sample H.

Table 3: Table of results

S/n

(a) Observe the appearance of sample H.

Observation: White crystalline solid

Inference: Salt is likely a simple inorganic compound

(b) Heat a little sample H in a dry test tube.

Observation: Colourless gas evolved, turns lime water milky

Inference: Presence of carbonate (CO_3^{2-})

(c)(i) To one portion add NaOH.

Observation: White precipitate soluble in excess

Inference: Presence of Al^{3+} ion

(ii) To the second portion, add freshly prepared $FeSO_4$ solution followed by conc. H_2SO_4 slowly through the side of the test tube.

Observation: Brown ring formed at junction of two liquids

Inference: Presence of NO_3^- ion

(iii) To the third portion, add lead ethanoate and boil.

Observation: White precipitate formed

Inference: Confirmation of carbonate ion ($PbCO_3$)

(d)(i) Perform confirmatory test for:

Cation

Observation: White ppt with NaOH, soluble in excess

Inference: Confirmed Al^{3+}

(ii) Anion

Observation: Brown ring test positive

Inference: Confirmed NO_3^-

Conclusion

(i) The cation in sample H is Al^{3+}

(ii) The anion in sample H is NO_3^-

(iii) The molecular formula for sample H is $Al(NO_3)_3$

(iv) Balanced chemical equation for experiment (b):

$CO_3^{2-} + 2H^+ \text{-----> } CO_2 + H_2O$