

233/3
CHEMISTRY
PAPER 3
PRACTICAL
JULY / AUGUST 2014

KIBWEZI DISTRICT FORM 4 INTER-SCHOOLS EXAMINATION 2014
Kenya Certificate of Secondary Education
CHEMISTRY
PAPER 3
CONFIDENTIAL

A. Each candidate should have the following:

1. Solid A- Measure exactly 2.0g of oxalic acid.
2. Solution B – 60cm³ of 0.5M oxalic acid.
3. Solution C – 50cm³ of 0.25M sodium hydroxide solution.
4. Solution D – 100cm³ of 0.02M acidified KMnO₄ solution.
5. Burette – 50ml.
6. 25 ml pipette.
7. Pipette filler.
8. 250cm³ volumetric flask.
9. 50ml measuring cylinder.
10. Thermometer (-10⁰C – 110⁰C).
11. 2 – conical flasks.
12. 100ml plastic beaker.
13. Accessible to about 500cm³ of distilled water.
14. Means of labeling.
15. 10cm³ of solution F.
16. Solid G – 0.5g of oxalic acid.
17. A boiling tube.
18. Test tube holder
19. 6 test tubes.
20. 10cm³ measuring cylinder.
21. Filter paper and filter funnel.
22. Metallic spatula.
23. Boiling tube.

B. Accessible to the following:

1. Source of heat.
2. 2M sodium hydroxide solution.
3. 2M ammonia solution.
4. 2M Nitric acid.
5. 2M hydrochloric acid solution.
6. Universal indicator paper and a chart.

NB:

- All the bench solution above be supplied with a dropper.
- Solution F is a mixture of Al₂(SO₄)₃ and Cu(NO₃)₂ in the ratio 1 : 1.

Name _____ Index No. _____

Candidate's Signature _____

Date _____

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2 ¼ HOURS

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INSTRUCTIONS TO CANDIDATES

- (a) Write your name and Index number in the space provide above.
- (b) Answer ALL the questions in the spaces provided.
- (c) This paper has 2 questions. You have 2 ¼ hours for the paper. The first ¼ hours will be used to check the apparatus.
- (d) Mathematical tables and silent calculators may be used.
- (e) All working MUST be clearly shown where necessary.

FOR EXAMINER'S USE ONLY

| QUESTION | MAXIMUM SCORE | CANDIDATE'S SCORE |
|--------------------|---------------|-------------------|
| 1 | 22 | |
| 2 | 18 | |
| TOTAL SCORE | 40 | |

This paper consists of 7 printed pages

Turn Over

1. You are provided with:
 - Solid A, 2.0g of dibasic acid, H_2X
 - Solution B, 0.5M solution of the dibasic acid, H_2X .
 - Solution C, sodium hydroxide solution.
 - Solution D, 0.02M acidified potassium manganate (VII) solution.

You required to determine:

- (a) The heat of reaction of solid A H_2X with sodium hydroxide solution.
- (b) The number of moles of solution E that reacts with 2 moles of acidified potassium manganate (VII) solution.

Procedure 1 (a)

Place 40cm^3 of distilled water into 100ml beaker. Measure the initial temperature of water and record in table 1 below. Add all the solid A provided at once. Stir the mixture carefully with the thermometer until **all** the solid dissolves. Measure the final temperature and record in table 1.

Table 1

| | |
|--|--|
| Temperature ($^{\circ}\text{C}$) | |
| Initial temperature ($^{\circ}\text{C}$) | |

(1½ marks)

- (a) Determine the change in temperature, ΔT .

(1 mark)

- (b) Calculate the:

- (i) heat change when H_2X dissolves in water. (Assume the heat capacity of the solution is $4.2\text{ J/g}^{\circ}\text{C}$ and density of the solution is 1 g/cm^3)

(1 mark)

- (ii) the molar heat of solution, ΔH_1 solution of the acid H_2X .
(Molar mass of the acid H_2X is 126g.

(2 marks)

Procedure 1 (b):

Place 40cm³ of solution B into 100ml beaker. Measure the initial temperature and record in **table II** below. Measure 40cm³ of sodium hydroxide, solution C. Add all the 40cm³ of solution C at once to solution. Stir the mixture carefully with the thermometer. Measure the final temperature reached and record in table II. (Keep remaining solution B for use in procedure II). Table II

| | |
|--------------------------|--|
| Temperature (°C) | |
| Initial temperature (°C) | |
| | |

(1 ½ marks)

(a) Determine the change in temperature, ΔT .

(1 mark)

(b) Calculate the:

(i) heat change for the reaction. (Assume the heat capacity of the solution is 4.2 J/g/°C and density of the solution is 1gcm³)

(1 mark)

(ii) heat for the reaction of one mole of the acid H₂X with sodium hydroxide, ΔH_2 .

(2 marks)

(c) Given that the $\text{H}_2\text{X}_{(s)} + 2\text{OH}^-_{(aq)} \longrightarrow 2\text{H}_2\text{O}_{(l)} + \text{X}^{2-}_{(aq)}$
Determine ΔH_3 using an energy cycle diagram.

(2 marks)

Procedure II

Measure exactly 15cm^3 of solution B and put in a 250ml volumetric flask. Add water as you shake up to the mark. Labelled as solution E. Using a pipette filler, pipette 25cm^3 of solution E and place in a conical flask. Warm solution E to boiling. Fill the burette with solution D and titrate with hot solution E. Stop just when a permanent change in colour. Record your results in the **table III** below. Repeat the procedure to complete the table **III** below.

TABLE III

| | I | II | III |
|---|---|----|-----|
| Final burette reading (cm^3) | | | |
| Initial burette reading (cm^3) | | | |
| Volume of solution D used (cm^3) | | | |

(a) Calculate the average volume of solution D used.

(4 marks)
(1 mark)

(b) Calculate the number of moles of solution D reacting.

(1 mark)

(c) Calculate the number of moles of solution E used.

(1 ½ marks)

(d) Calculate the number of moles of E which react with 2 moles of potassium manganate (VII) (2 marks)

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MARKING SCHEME

Procedure 1 (a) – Table 1

(a) Complete table (½ mark)

- Final temperature must be lower than initial temperature otherwise penalize fully.
- For initial temperature values $\geq 40^{\circ}$ or $\leq 10^{\circ}$ are treated as unrealistic values 0° penalize (½ mark)

(b) Complete table (½ mark)

- Accept all readings in whole numbers or 1 d.p either '0' – '5' used consistently.
- Reject inconsistently.

(c) Accuracy (½ mark)

- Compare students value (initial value) with S.V. and if within $\pm 2^{\circ}\text{C}$ award (½ mk) otherwise award zero.

(a) $\Delta T = \text{Final temperature} - \text{initial temperature.}$

NB: (Insist on the correct answer as per the table).

(b) (i) $\Delta H = MC\Delta T$

$$= 40 \times 4.2 \times \Delta T$$

$$= \text{C.A.J}$$

Conditions

- Accept an error of ± 2 units in the 3rd digit if answer is in J or 3rd d.p if in KJ, otherwise penalize (½ mark).
- Award 1 mark for correct substitution and ignore the formular.
- Penalize (½ mark) for wrong units shown, otherwise ignore units.
- Don't penalize if ΔH sign is missing or omitted.

(b) (ii) $2\text{g} \longrightarrow \text{ans c (i) above.}$

$126\text{g} \longrightarrow ?$

$$= \frac{\text{Ans c (i)} \times 126}{2}$$

$$= \text{C.A. J/mol}$$

Conditions

- If wrong units are given or omitted in final answer, penalize (½ mark)
- Accept arithmetic error of ± 2 units in the 4th digits if in joules OR 2nd d.p if in KJ.
- Correct sign (+ve) must be shown for ΔH_1 , otherwise penalize (½ mark)
- Do not penalize if ΔH sign is missing or not shown.

This paper consists of 5 printed pages

Turn Over

Procedure II (b) – Table II

NB: The marking of table II is done as that of table I except for complete table, the final temperature must be higher than the initial temperature.

Calculations

(a) $\Delta H = \text{Final temperature} - \text{initial temperature}$

(b) (i) $\Delta H = 80 \times 4.2 \times \Delta T$
 $= \text{C.A.J}$

Conditions

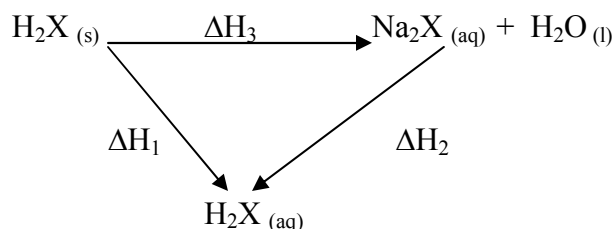
Accept an error of ± 2 units in the 4th digit if answer is in joules or 3rd d.p if answer is in KJ. Other conditions remains as for b(i) in procedure (a)

(ii) Moles reacting $= \frac{0.5 \times 40}{1000} = 0.02 \text{ moles}$

$$\Delta H_2 = \frac{\text{Ans b (i)} \times 1}{0.02}$$

$= \text{C..AJ}$

(c) $\Delta H_3 = \Delta H_1 - \Delta H_2$
 $= \text{C.A.J}$



Conditions

- Negative (-ve) value must be shown on correct answer otherwise penalize (½ mark).
- Correct units must be used i.e J/mol OR KJ/mol otherwise penalize (½ mark).
- Penalize (½ mark) for wrong answer.
- For correct substitution without formula, you will credit (1 ½ marks) as step II.

NB: Capital J and small k MUST be used

Procedure II – Table III

(i) TITRATION

Consider the table below.

| | I | II | III |
|---------------------------------|------|------|------|
| Final burette reading | 15.2 | 30.4 | 45.8 |
| Initial burette reading | 0.0 | 15.4 | 31.0 |
| Titre volume (cm ³) | 15.2 | 15.0 | 14.8 |

Marks are awarded as follows:

A. Complete table award 1 mark

- (i) Complete table with 3 titrations done award 1 mark
(ii) Incomplete table with two titrations done – award ½ mark
(iii) Incomplete table with only one titration done – award 0 mark

Penalties

- (i) Wrong arithmetic
- (ii) Inverted table
- (iii) Burette readings beyond 50.0cm³ unless explained
- (iv) Unrealistic titre values i.e below 1.0cm³ or in hundreds

NOTE: Penalize ½ mark each to a maximum of ½ mark i.e penalize ½ mark once.

B. Decimal place award 1 mark

- (i) Accept only 1 or 2 d.p used consistently, otherwise penalize FULLY i.e. award zero.
- (ii) If 2 d.p are used the 2nd d.p. MUST be either “0” or “5” otherwise penalize fully.
 - (ii) Accept inconsistently in the use of zeros as initial burette e.g 0.0, 0.00,0.000 etc

NB: Decimal place is tied to 1st and 2nd rows ONLY of the table.

C. Accuracy award 1 mark

Compare the candidates titre values with the school values (S.V) and tick the chosen value if it earns a mark.

Conditions

- (i) If at least is within ± 0.1 of the S.V award – 1 mark
- (ii) If no value is within ± 0.1 of the S.V but at least one value is within ± 0.2 of the S.V award ½ mark
- (iii) Otherwise award zero mark.

NOTE: If there is arithmetic error in the table, compare the S.V with the correctly worked out titre value and award accordingly.

D. Principles of averaging – 1 mark

Values averaged must be shown and must be within ± 0.1 of each other

Conditions

- (i) If 3 consistent titrations are done, are consistent and averaged – award 1 mark.
- (ii) If 3 titrations are done but only 2 are possible and are averaged – award 1 mark.
- (iii) In only 2 titrations are done, are consistent and averaged – award 1 mark
- (iv) If 3 titrations are possible and only 2 are averaged – award 0 mark.
- (v) If only 3 titrations are done, are inconsistent and are averaged – award 0 mark.
- (vi) If only 2 titrations are done, are inconsistent and are averaged – award 0 mark.
- (vii) If only 1 titration done – award 0 mark

Penalties

- (i) Penalize ½ mark for wrong arithmetic in average titre value if error is outside ± 2 units in the second decimal place.
- (ii) Penalize 1/2mark if no working is shown but correct answer is given.
- (iii) Penalize fully if no working and if answer shown is wrong.
- (iv) Accept rounding off value (average titre value) to 2 d.p otherwise penalize ½ mark for rounding off to 1 d.p or whole number.

NOTE: (i) Accept answer (average titre) to 1 d.p or whole number if it works out exactly and credit fully.

E. Final answer – 1 mark

(Tied to correctly averaged titre value)

Compare the candidates correct average titre value with S.V and

- (i) If within ± 0.1 of S.V – award 1 mark
- (ii) If within ± 0.2 of S.V – award $\frac{1}{2}$ mark
- (iv) If beyond ± 0.2 of S.V – award 0 mark

NOTE:

- (a) Where there are two possible pairs of titres that can be averaged, use the pair that is closest to the S.V and credit accordingly.
- (b) If wrong values are averaged pick the correct vales if any following the principles of averaging, average and award accordingly.

(b) Calculations

$$\frac{0.2 \times \text{average titre}}{1000} \quad \checkmark \frac{1}{2}$$
$$= \text{C.A.} \quad \checkmark \frac{1}{2}$$

Penalties

- For wrong transfer of average titre, penalize $\frac{1}{2}$ mark
- If an arithmetic error which is beyond ± 2 units in the 5th d.p is omitted penalize $\frac{1}{2}$ mark.
- Accept rounding off to 4th or 5th d.p.
- If units are not shown

NB: Ignore if units are not shown

(c) Moles of B in $15\text{cm}^3 = \left(\frac{15}{1000} \times 0.5 \right) \checkmark \frac{1}{2}$

$$= 7.5 \times 10^{-3} \text{mol}$$

$250\text{cm}^3 \rightarrow 7.5 \times 10^{-3} \text{mol}$

$25\text{cm}^3 \rightarrow ?$

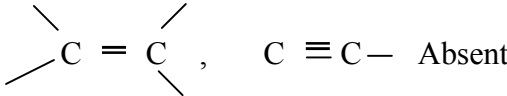
$$= \frac{7.5 \times 10^{-3} \times 25}{250} \quad \checkmark \frac{1}{2}$$
$$= 7.5 \times 10^{-3} \text{mol} \quad \checkmark \frac{1}{2} \qquad 1 \frac{1}{2}$$

(d) $\frac{\text{Ans (c)}}{\text{Ans (b)}} \checkmark \frac{1}{2} = \text{C.A} \checkmark 1$ 2

Conditions / Penalties

- For wrong transfer if ans (c) or (b) penalize ($\checkmark \frac{1}{2}$ mark)
- If strange values are used / is used award zero.
- The answer must be rounded off to a whole number, otherwise penalize fully.

Question 2 (a)

| | Observation | Inferences |
|-----------|---|---|
| 2 (a) (i) | Blue ppt / residue, colourless filtrate ½ mark | Cu^{2+} present Condition: - Each inference tied to the observation penalize full for any contradiction ½ mark |
| (ii) | No white ppt formed / no effervescence / no bubbles 1 mark | Absence of SO_3^{2-} or CO_3^{2-} ½ mark |
| (iii) | White ppt, soluble in excess ½ mark | Zn^{2+} , Pb^{2+} or Al^{3+} ✓ ½ For all 3 give 1 mk, 2 give ½ mk |
| (iv) | White ppt insoluble in excess 1 mk | Pb^{2+} or Al^{3+} Accept Zn^{2+} absent ½ mk |
| (v) | No white ppt formed - Accept filtrate remains colourless - Rej. No observable change No ppt formed – No change ½ mk | Al^{3+} present Accept, Pb^{2+} absent ½ mark |
| (vi) | White ppt formed Colourless filtrate ½ mark | SO_4^{2-} present penalize if SO_3^{2-} or CO_3^{2-} mentioned as absent ½ mark |
| | Blue ppt dissolve Dissolve blue solution Penalize ½ mk if solution not mentioned ½ mk | Cu^{2+} present ½ mark |
| | | |
| (b) (i) | Burns with a luminous / sooty / smoky flame ½ mark | Unsaturated hydrocarbon Accept $\text{C} \equiv \text{C}-$ or $\text{C}-\text{C}=\text{C}$ Rej $\text{C} \equiv \text{C}$, $\text{C} = \text{C}$ 1 mark |
| (ii) | Partially soluble in water ½ mark | Polar hydrocarbon ½ mark |
| (iii) | KMnO_4 solution remain purple Rej: solution turns purple, solution remains purple |  , $\text{C} \equiv \text{C}-$ Absent |
| (iv) | pH = 5.0 Penalties Reject pH value below 4.0 Reject value in words Accept pH value range 4.0 – 6.5 | Weak acid 1 mark Accept – COOH Reject words such as acid / acidic / organic acid / H^+ ions If the term 'weak' is not mentioned penalized fully. |