To be Coordinated by Chemistry Educators' Society (CES)

Name KIBUGO DENNIS

Signature _____ personal number _____

Total weighted Score		
Initials		

P525/2
CHEMISTRY
PAPER 2
APRIL 2026
3Hrs. 15min

UGANDA ADVANCED CERTIFICATE OF EDUCATION

PRE-REGESTRATION EXAMINATIONS 2026

S6 CHEMISTRY PRACTICAL

PAPER 2 (P525/2)

3Hours and 15minutes

INSTRUCTIONS TO CANDIDATES

This paper consists of two **compulsory items**, 1 and 2. Both items are compulsory. Responses to these items are to be written in the spaces provided in this booklet. Use **blue** or **black ink**.

All working **must** be clearly shown.

Mathematical tables and silent non-programmable scientific calculators may be used.

You are **not** allowed to use reference books (i.e. text books, booklets on **qualitative analysis** etc.).

You are advised to carefully read the items, make sure you have all the apparatus that you may need and then **plan** appropriately before starting.

Item one			Item two		
Basis Code	Weighted Score	Scorer's initials	Basis Code	Weighted Score	Scorer's initials
A			A		
H			H		
V			V		
P			P		
R			R		
D			D		
Dr			Dr		
I			I		
C			C		
Total Weighted Score	$\frac{x}{40}$		Total Weighted Score	$\frac{x}{60}$	

Item 1.

During water treatment, a chelate (dye) is added in the final stages to remove chlorophenol contaminants from water in Namanve's industrial area communities. This was revealed by the production manager to a group of senior five chemistry learners during their field visit to the plant.

To demonstrate this in class, their chemistry teacher recommended to use manganate(VII) solution as the dye. However, the effectiveness of the demo depends on the concentration of the dye used. Suitable dye should have a molar concentration of above **1M**.

Learners have found some manganate(VII) solution in the laboratory and are curious to know whether the dye is suitable for the demonstration.

The teacher recommended using a redox titration between hot acidified sodium oxalate solution at 60°c (acidified with equal volume of sulphuric acid) with manganate(VII) solution.

Manganate(VII) ions are reduced according to the following equation

$$MnO_4^-{}_{(aq)} + 8H^+{}_{(aq)} + 5e \longrightarrow Mn^{2+}{}_{(aq)} + 4H_2O_{(l)}$$

Oxalate ions are oxidised too according to the following equation

$$C_2O_4^{2-}{}_{(aq)} \longrightarrow 2CO_{2\,(g)} + 2e$$

However, learners lack some knowledge on how this can be done and have approached you for some guidance.

Where necessary; (Na =23, O =16, H=1, C = 12)

You are provided with;

- **DA1** - which is a sample of the dye.
- **DA2**- which is **2M** sulphuric acid
- Solid **Q** - which is sodium oxalate of which exactly 1.4g are to be dissolved in 250cm^3 of distilled water to make a solution, **DA3**.
- Some apparatus

Task; As a member of senior six chemistry class 2026,

(a) Plan and design an experiment to guide the learners on the dye provided. (In your design include; aim, hypothesis, variables, safety precautions and procedure).

Aim; An experiment to determine the molar concentration of manganate(VII) solution (dye) by titrating it with a fixed volume of acidified sodium oxalate solution (A1, A2) (02)

Hypothesis; The molar concentration of the dye is above 1M based on it's titration with a fixed volume of acidified sodium oxalate solution. (H1, H2) (02)

Variables.

Independent; Volume of acidified sodium oxalate solution pipetted (V_1)

Dependent; Volume of manganate(VII) solution (dye) required for endpoint (V_2)

Controlled; Volume of acidified sodium oxalate solution used.

Accept; Volume of acidified DA3 used that was maintained constant (03)

Safety precautions;

(1) Swallowing of the acidic solution during pipetting causing irritation of the throat since it's corrosive and this can be mitigated by using a pipette filler to avoid direct contact of the chemical with the mouth. (R_1)

(2) Solutions pouring onto the skin or eyes causing irritations since they are corrosive. This can be mitigated by careful transfer of solutions in apparatus and wearing personal protective gears such as lab coats, closed shoes, glasses (R_2) (02)

(3) Breakage of the glassware such as conical flask, burette and pipette that can cut causing injury and pain. This can be mitigated by careful placing of the glassware in the middle of a flat surface / clamping the burette with care on a retort stand.

Any 2 RISKS with respective mitigations.

Procedure.

(a) Using a weighing balance, 1.4g of solid Q weighed and transfered into a clean beaker. Using a measuring cylinder, 100.0 cm^3 of distilled water was measured and added to the solid in the beaker. The mixture was stirred using a stirrer until all the solid completely dissolved.

(b) This solution was transfered into a clean 250.0cm^3 volumetric flask and topped up to the mark using distilled water. The resultant solution was labelled DA3 using labels

(c) 25.0cm^3 of DA3 was pipetted into a conical flask and 25.0cm^3 that was measured using a measuring cylinder was added to DA3; and mixture heated to 60°C using a heat source and tripod stand.

(d) This hot solution was titrated with DA1 from the burette until an end point was attained

(e) The titre value was noted and recorded.

(f) Procedures (c) to (e) were repeated two times to obtain consistent results.

(g) Results were tabulated.

Pm 7/8

Pc

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05

(b) Carry out the experiment. (Include at least 3 data sets)

Mass of beaker + solid Q = 42.4g

Mass of beaker alone = 41.0g

Mass of solid Q = 1.4g

Volume of pipette used = 25.0cm^3

Experiment	1	2	3
Final burette reading (cm^3)	20.70	30.80	25.80
Initial burette reading (cm^3)	0.00	10.00	5.00
Volume of DA1 used (cm^3)	20.70	20.80	20.80

(7Dr + 2D) = 07

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(c) Analyse and interpret your data and hence a recommendation.

Values to be used to Calculate average volume of DA1 used = 20.80, 20.80cm^3

Average volume of DA1 used = $\left(\frac{20.80 + 20.80}{2}\right)$ = 20.80cm^3

Molar mass of $Na_2C_2O_4$ = (23x2) + (12x2) + (16x4) = 134g

134g contain 1 mole of $Na_2C_2O_4$

1.4g contain $\left(\frac{1.4 \times 1}{134}\right)$ moles of $Na_2C_2O_4$

= 0.010448 moles of $Na_2C_2O_4$

Allow any other correct alternative flow of the calculation.

$250\,cm^3$ of solution contain 0.0104448 moles of $Na_2C_2O_4$ Im

$25.0\,cm^3$ of solution contain $\left(\frac{0.0104448 \times 25.0}{250}\right)$ moles of $Na_2C_2O_4$ Im

$= 1.0448 \times 10^{-3}$ moles of $Na_2C_2O_4$ Im

Equation;

$2MnO_{4(aq)}^- + 16H_{(aq)}^+ + 5C_2O_{4(aq)}^{2-} \rightarrow 2Mn_{(aq)}^{2+} + 10CO_{2(g)} + 8H_2O_{(l)}$ Im

Since 5 moles of $C_2O_4^{2-}$ react with 2 moles of MnO_4^- Im

1.0448×10^{-3} moles of $C_2O_4^{2-}$ react with $\left(\frac{2 \times 1.0448 \times 10^{-3}}{5}\right)$ moles of MnO_4^- Im

4.179×10^{-4} moles of MnO_4^- Im

$20.80\,cm^3$ of solution contain 4.179×10^{-4} moles of MnO_4^- Im

$1000\,cm^3$ of solution contain $\left(\frac{4.179 \times 10^{-4} \times 1000}{20.80}\right)$ moles of MnO_4^- Im

$= 0.02\ mol\,dm^{-3}$ Im

Awarded $Im \geq 16$

Data Interpretation; The molar concentration of MnO_4^- solution (dye) is 0.02M Ia 01

Conclusion;

The molar concentration of the dye provided is 0.02M which is not greater than 1M C1

Recommendation; The dye found in the laboratory should not be used for the teacher's demonstration. C2 02

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Score	19

Item 2

A mock examination body received an A-level chemistry practical sample from a new supplier, but the labels on it are unclear and hard to read. The management can no longer contact the supplier.

The chief moderator of the paper is uncertain on whether the ions in the sample correspond to those specified in the exam. The exam requires a sample with two cations and one anion. Zinc, Calcium and Iodide are among the ions.

To prevent compromising with the quality of the mock body, he seeks to identify the specific ions in the sample before distributing it to different schools, by conducting a qualitative analysis on it.

Preliminary tests done on the sample revealed that it completely dissolves in water, one of the cations is insoluble in excess sodium hydroxide solution and the filtrate gives a positive test with lead(II) nitrate solution.

He gave the sample to your chemistry teacher, who passed the task on to you because he was tied up in staff meetings.

You are provided with;

- Sample **J**
- Some laboratory test reagents
- Some apparatus

Task; As a chemistry learner;

a) Plan and design an experiment to guide the team. (In your design include; aim, hypothesis, variables and safety precautions)

Aim; An experiment to identify the cations and anion present in Sample J (A1) using qualitative analysis techniques. (A2) (02)

Hypothesis; Sample J contains two cations and one anion (H1) that can be identified through confirmatory tests (H2) basing on qualitative analysis techniques. (02)

Variables;

Independent; Test reagents added to Sample J (V1) (03)

Dependent; Observations made (Vd) in a test (such as colour changes, precipitates, gas evolution, solubility)

Controlled; Amount of Sample J and test reagents used (Vc) keeping them

Safety precautions.

(1) Acids and alkalis among the test reagents can cause skin irritations and allergies since they contain chemicals that are corrosive. This can be mitigated by careful transfer of these solutions and use of protective gears such as lab coats, closed shoes, face masks goggles to reduce direct contact with skin

(2) Burns from heating substances that can cause scalds hence injury and pain. This can be mitigated by using test tube holders during heating

02

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b) Carry out the experiment and record your observations and deductions.(Include heating of the sample in your tests)

Test procedure	Observations	Deductions
Two spatula endfuls of sample J were heated in a dry test tube gently and then strongly until there was no further change using heat source.	- J is a white solid - A colourless condensate that turns white anhydrous $CuSO_4$ blue - Colourless gas that turns moist blue litmus paper red and acidified $K_2Cr_2O_7$ from orange to green. - Yellow residue when hot and white on cooling	Non transition metal ions present - Water of crystallisation from hydrated compound. Acidic gas. SO_2 from SO_4^{2-} ZnO ∴ Zn^{2+}
About $5cm^3$ of distilled water was added to two spatula endfuls of sample J in a test tube. The mixture was shaken well until it completely dissolved. To the resultant solution, sodium hydroxide solution was added dropwise until in excess. Filtration was done and both residue and filtrate were kept.	Colourless solution white precipitate insoluble in excess - white residue - Colourless filtrate	Ba^{2+}, Ca^{2+}, Mg^{2+}, Zn^{2+}, Al^{3+}, Pb^{2+} Ba^{2+}, Ca^{2+}, Mg^{2+} Ba^{2+}, Ca^{2+}, Mg^{2+} Zn^{2+}, Al^{3+}, Pb^{2+}

To the filtrate, dilute nitric acid was added dropwise until the solution was just acidic. The resultant solution was divided into 5 portions in 5 different test tubes.	white precipitate Soluble in acid forming a colourless solution	Zn^{2+}, Al^{3+}, Pb^{2+} In.
(i) To the first portion, dilute sodium hydroxide solution was added dropwise until in excess.	white precipitate soluble in excess forming a colourless solution	Zn^{2+}, Al^{3+}, Pb^{2+} In.
(ii) To the second portion, ammonia solution was added dropwise until in excess.	white precipitate soluble in excess forming a colourless solution	Zn^{2+} In.
(iii) To the third portion, a half-spatula endful of solid ammonium chloride was added followed by 3 drops of disodium hydrogenphosphate solution followed by excess ammonia solution.	White precipitate Soluble in excess forming a colourless Solution	Zn^{2+} In. confirmed.
(iv) To the 4th portion, 4 drops of lead(II) nitrate solution were added and then heated.	White precipitate insoluble on heating	SO_4^{2-} In.
(v) To the 5th portion, Barium nitrate solution was added (followed by dilute nitric acid.)	white precipitate insoluble in acid	SO_4^{2-} In. Confirmed.

Dr ≥ 18
D ≥ 2

Im ≥ 25

added	The residue was washed with dilute nitric acid little at atime until it completely dissolved. The resultant solution was divided into 4 portions	White residue completely dissolved forming a colourless solution	Ba^{2+}, Ca^{2+}, Mg^{2+}
(I)	To the 1st portion, Sodium hydroxide solution was added dropwise until in excess.	White precipitate insoluble in excess	Ba^{2+}, Ca^{2+}, Mg^{2+}
(II)	To the 2nd portion, ammonia solution was added dropwise until in excess.	White precipitate Insoluble in excess	Ba^{2+}, Mg^{2+}
(III)	To the 3rd portion, 3 drops of dilute Sulphuric acid were added.	No observable change	Mg^{2+}
	To the 4th portion, a half spatula endful of solid ammonium chloride was added followed by 3 drops of disodium hydrogenphosphate solution followed by excess ammonia solution.	White precipitate Insoluble in excess	Mg^{2+} Confirmed

Ia (01)

Data Interpretation; Sample J contains Mg^{2+} and Zn^{2+} as cations and SO_4^{2-} as anion

b) Guide the moderator to make a feasible decision. C1

Since the required Ca^{2+} and I^- ions for the exam are not present in Sample J, i advise the moderator not to distribute it to various schools. C2 (02)

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END.

Confidential information.

In addition to the fittings and substances ordinarily contained in a chemistry laboratory, each candidate will require;

1 Retort stand with a clamp
2 Conical flasks.
Filter funnel
1 Measuring cylinder (100 or 50cm^3 capacity)
1 Volumetric flask (250cm^3 capacity)
5 plastic beakers
1 Pipette (20 or 25cm^3 capacity)
1 Burette
8 Test tubes
1 boiling tube
1 filter paper
Thermometer (-10-110°c)
Spatula

Candidates should have access to;

-Heat source
-Common reagents for identifying gases, cations and anions
-Weighing balance reading to at least 1 decimal point

The school should stock the following

-Distilled water
-Masking tape for labeling

Preparations

- **DA1** is **0.02M** potassium manganate(VII) solution
- **DA2** is 2M sulphuric acid
- Solid Q is sodium oxalate crystals.
- 100cm^3 of **DA1** per each learner
- 100cm^3 of **DA2** per each learner
- 1.6g of Solid Q
- Sample **J** is a mixture of **$ZnSO_4$** and **$MgSO_4$** in a ratio of **2:1** respectively.

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