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ANDERSON SECONDARY SCHOOL
Preliminary Examination 2024
Secondary Four Express

CANDIDATE NAME:

CLASS: /   INDEX NUMBER:

CHEMISTRY **6092/03**

Paper 3 Practical **16 August 2024**

1 hour 50 minutes

Candidates answer on the Question Paper

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Give details of the practical shift and laboratory where appropriate, in the boxes provided.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Answer **all** questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Qualitative analysis notes are printed on page 12.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Shift
Laboratory

For Examiner's Use	
1	
2	
3	
4	
Total	

1 (a) Read all the instructions carefully before starting the experiments in Question 1.

You are provided with salt solution **W** in a boiling tube. You will carry out tests on **W** to deduce its identity.

You should test and identify any gases evolved. Record all your observations in the table.

The volumes given below are approximate and should be estimated rather than measured, unless instructed otherwise.

test	observations
Test 1 Put about 1 cm depth of solution **W** in a clean test-tube. Add 1 cm depth of aqueous sodium hydroxide. Gently warm the mixture.	
Test 2 Put about 1 cm depth of solution **W** in a clean test-tube. Add an equal depth of dilute nitric acid and then add a few drops of aqueous barium nitrate.	
Test 3 Put about 1 cm depth of solution **W** in a clean test-tube. Add an equal depth of dilute nitric acid and then add a few drops of aqueous silver nitrate.	

[4]

(b) Deduce the identity of salt **W**.

……………………………………………………………………………………… [2]

[Total: 6]

2 Malic acid is a carboxylic acid found in apple juice.

The equation for the reaction between malic acid, $H_2C_4H_4O_5$, and potassium hydroxide, KOH, is shown.

$$2KOH + H_2C_4H_4O_5 \rightarrow K_2C_4H_4O_5 + 2H_2O$$

The concentration of aqueous malic acid is determined by titration with aqueous potassium hydroxide, KOH(aq).

Thymolphthalein is used to determine the end-point of the titration.

P is aqueous malic acid.

Q is 0.100 mol/dm^3 KOH(aq).

(a) **(i)** Put **P** into the burette.

Pipette 25.0 cm^3 of **Q** into a conical flask and titrate it with **P** using three drops of thymolphthalein as the indicator.

The end-point is when the solution remains colourless permanently.

Record your titration results in an appropriate format in the space provided. Repeat the titration as many times as necessary to achieve consistent results.

Results

[5]

(ii) Use your titration results to obtain the average volume of **P** used.
Show clearly how you obtained this volume.

average volume of **P** = ……………………… [1]

(b) Calculate the amount, in moles, of potassium hydroxide in 25.0 cm^3 of **Q**.

amount of potassium hydroxide = …………… mol [1]

(c) Calculate, the amount, in moles, of malic acid present in the average volume of **P**.

amount of malic acid = ………………. mol [1]

(d) Use your answer to **(c)** to calculate the concentration of malic acid in **P**.

concentration of malic acid in **P** = ………………. mol/dm^3 [1]

The average concentration of malic acid in apple juice is 4.50 g/dm^3.

(e) Calculate the average concentration of malic acid in apple juice in mol/dm^3.

[A_r: H,1; C,12; O,16]

average concentration of malic acid = ……………… mol/dm^3 [2]

(f) Use your answers from **(d)** and **(e)** to calculate the average volume, in dm^3, of apple juice which contains the same mass of malic acid as 200 cm^3 of **P**.

average volume of apple juice = ………………. dm^3 [2]

(g) Suggest why accurate titration of apple juice with potassium hydroxide usually produces an average concentration higher than your answer from **(e)**.

……………………………………………………………………………………….

………………………………………………………………………………………. [1]

[Total: 14]

3 Read through the entire procedure before you begin this question.

You are to determine the enthalpy change for the reaction of a known volume and concentration of copper(II) sulfate and an excess of powdered zinc.
The reaction is as follow:

$$Cu^{2+}(aq) + Zn(s) \longrightarrow Zn^{2+}(aq) + Cu(s)$$

R is 0.800 mol/dm^3 copper(II) sulfate, $CuSO_4$.
T is powdered zinc, Zn.

(a)
- Remove the cap from the container with solid **T**.
- Weigh the container with solid **T**. Record the mass.
- Nest the polystyrene cup in a beaker.
- Measure and transfer 30.0 cm^3 of solution **R** into the polystyrene cup.
- Place the thermometer into the solution.
  Measure and record the initial temperature of the solution in the table provided. This is the temperature at time zero minutes.
- Start the stopwatch. Measure and record the temperature of the solution every half minute for 2 minutes.
- At 2.5 minutes, add all the solid **T** into the solution and stir the mixture gently with the thermometer.
- Measure and record the temperature of the mixture at 3 minutes and every half minute until 9 minutes. Stir the mixture between the thermometer readings.
- Reweigh the container with any residual solid **T**. Record the mass.
- Calculate and record the mass of solid **T** added to solution **R**.
- Empty the content in the polystyrene cup into the container marked as "**waste**". Do **not** pour the content into the sink.

Results

time / minutes	0	0.5	1	1.5	2	2.5	3	3.5	4
temperature / °C									

time / minutes	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
temperature / °C										

[3]

(b) **(i)** Plot your results on the grid with temperature on the *y*-axis and time on the *x*-axis. Note that the scale for temperature should extend at least 10°C above your highest recorded temperature.

Complete the graph by drawing **two** straight lines of best-fit through the points on your graph. The first line should be for the temperature before adding **T** and the second for the **cooling** of the mixture.

Extend these two lines to 2.5 minutes.
Draw a vertical line at 2.5 minutes to connect these lines. [4]

(ii) Use your lines from **(b)(i)** to determine the theoretical rise in temperature at 2.5 minutes.

theoretical rise in temperature = ………….°C [1]

(c) **(i)** Calculate the amount, in moles, of copper(II) sulfate in solution **R** that was added to the solution in the polystyrene cup in **(a)**.

amount of copper(II) sulfate = ………………… mol [1]

(ii) Show that the amount of zinc you added was in excess.
[A_r of zinc: 65]

[2]

(d) The formula for heat energy is as follow:

$$\text{heat energy} = m \times c \times \theta$$

where m : mass of solution (g)
c : specific heat capacity (J/g°C)
θ : rise in temperature (°C)

Use your answer to **(b)(ii)** to calculate the heat energy, in joules, given out when **T** was added to **R**. Give your final answer correct to 3 significant figures.
You can assume that the mass of solution is 30 g and the specific heat capacity is 4.18 J/g°C.

heat energy = …………….. J [1]

(e) Hence, calculate the enthalpy change of reaction, ΔH, for the reaction carried out in **(a)**. Give your final answer correct to 3 significant figures. Show your working clearly.

ΔH = …. ……………… kJ/mol [2]
sign value

(f) What type of reaction occurs when zinc reacts with aqueous copper(II) sulfate?

……………………………………………………………………………………… [1]

(g) In addition to the temperature change, state **one** other observation when zinc reacts with aqueous copper(II) sulfate.

……………………………………………………………………………………… [1]

[Total: 16]

4 The label on a bottle of orange drink states ‘this drink contains no artificial colours’.

However, a chemist thinks that the orange colour in the drink is a mixture of two artificial colours:
- Sunset Yellow E110
- Allura Red E129.

Plan an experiment to show that the orange colour in the drink does **not** contain these two artificial colours.

Your plan should describe the use of common laboratory apparatus and samples of E110, E129 and the orange colouring from the drink.

You can assume that all apparatus normally found in a school laboratory is available.

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.... [4]

[Total: 4]

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Test for anions

anion	*test*	*test result*
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
iodide (I^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt

Test for aqueous cations

cation	*effect of aqueous sodium hydroxide*	*effect of aqueous ammonia*
aluminium (Al^{3+})	white ppt., soluble in excess giving a colourless solution	white ppt., insoluble in excess
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
lead(II) (Pb^{2+})	white ppt., soluble in excess giving a colourless solution	white ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

[Lead(II) ions can be distinguished from aluminium ions by the insolubility of lead(II) chloride]

Test for gases

gas	*test and test result*
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	gives white ppt. with limewater (ppt. dissolves with excess CO_2)
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint
sulfur dioxide (SO_2)	turns aqueous acidified potassium manganate(VII) from purple to colourless