Cambridge IGCSE™

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

CO-ORDINATED SCIENCES   **0654/52**

Paper 5 Practical Test   **February/March 2023**

                                                                      2 hours

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential instructions

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
Total	

This document has **16** pages.

1 You are going to investigate the nutrient content of two solutions, **A** and **B**.

Procedure

- Pour approximately 1 cm depth of solution **A** into a clean test-tube.
- Add an equal depth of Benedict's solution to solution **A** in the test-tube and place in a hot water-bath for approximately 3 minutes.
- Put a few drops of solution **A** into **two** clean wells in the spotting tile.
- Add a few drops of biuret solution to one of the wells containing solution **A**.
- Add a few drops of iodine solution to the other well containing solution **A**.

Repeat the procedure with solution **B** instead of solution **A**.

(a) Record in Table 1.1 the **final colours** observed.

Table 1.1

solution	final colour observed with Benedict's solution	final colour observed with biuret solution	final colour observed with iodine solution
A			
B			

[5]

(b) State the nutrients present in each solution.

solution **A** contains ....

....

....

solution **B** contains ....

....

....

[3]

[Total: 8]

2 You are going to investigate the vitamin C content of four different fruit juices, **E**, **F**, **G** and **H**.

DCPIP indicator is a blue solution that decolourises (turns colourless) when vitamin C is added to it.

Solutions containing a high concentration of vitamin C need only a few drops to turn the DCPIP colourless.

Solutions containing a low concentration of vitamin C need more drops to turn the DCPIP colourless.

(a) Read through the procedure in **(b)**.

Draw a table to record your results.

[2]

(b) Procedure

- Use a dropping pipette to place **two** drops of DCPIP into a clean well of the white spotting tile.
- Use a clean dropping pipette to add drops of fruit juice **E** to the well containing DCPIP.
- Count how many drops are needed to decolourise DCPIP and record the result in your table.
- If it does not decolourise, stop when the well is full, record the number of drops and write 'full' next to it.

Repeat the procedure using juices **F**, then **G**, then **H** instead of juice **E**. [4]

(c) Identify **one** source of error in this procedure and suggest an improvement.

error ....

improvement ....

....
[2]

(d) (i) A deficiency of vitamin C in the diet causes a disease called scurvy.

State which juice **E**, **F**, **G** or **H** is best at preventing scurvy. Explain your answer.

juice ....

explanation ....
[1]

(ii) An adult human needs 0.030 g of vitamin C every day to prevent scurvy.

A 125 cm^3 glass of an orange fruit juice contains 0.060 g of vitamin C.

Calculate the volume of this orange juice an adult human needs to drink every day to prevent scurvy.

Give your answer to **two** significant figures.

volume = ... cm^3 [2]

(iii) Suggest how an adult human, who drinks less than the volume of orange juice calculated in **(d)(ii)**, does **not** get scurvy.

.... [1]

[Total: 12]

3 You are going to investigate the neutralisation reaction of dilute hydrochloric acid and aqueous sodium hydroxide.

This reaction is exothermic. Thermal energy (heat) is given out and the temperature of the mixture increases.

When the reaction is finished no more thermal energy is given out.

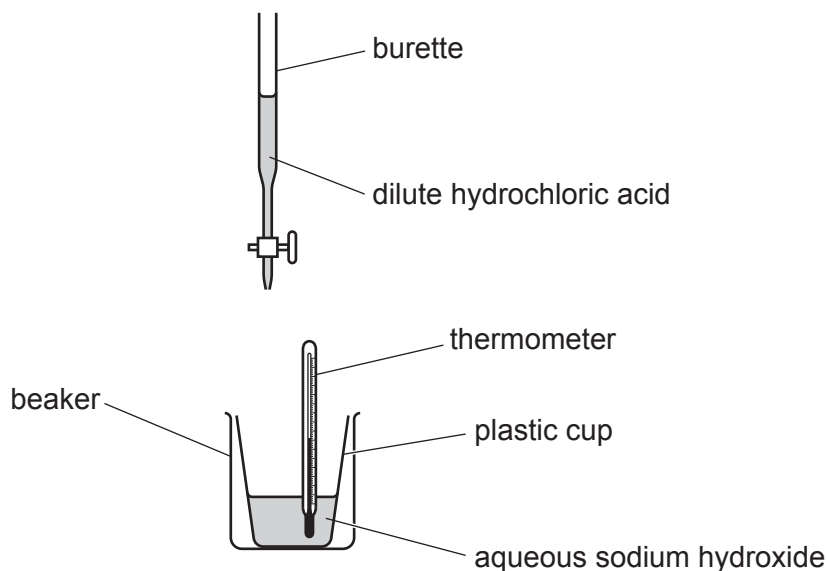You will use the assembled apparatus shown in Fig. 3.1.

Fig. 3.1

(a) Procedure

* Put the clean plastic cup into a glass beaker.
* Use the measuring cylinder to put $25\,cm^3$ of aqueous sodium hydroxide into the plastic cup.
* Record in Table 3.1 the temperature of the aqueous sodium hydroxide to the nearest $0.5\,°C$.
  This is T_0, the value for $0.0\,cm^3$ of dilute hydrochloric acid added.
* Fill the burette to the $0.0\,cm^3$ mark with dilute hydrochloric acid.
* Use the burette to add $5.0\,cm^3$ of dilute hydrochloric acid to the plastic cup.
* Stir the mixture and record the temperature in Table 3.1.
  This is the value for $5.0\,cm^3$ of dilute hydrochloric acid added.
* Continue adding $5.0\,cm^3$ portions of dilute hydrochloric acid, stirring and recording the temperature of the mixture until a total of $45.0\,cm^3$ of dilute hydrochloric acid has been added.

  Keep the contents of the plastic cup for Question 4.

Table 3.1

total volume of dilute hydrochloric acid added / cm^3	temperature / °C
0.0	
5.0	
10.0	
15.0	
20.0	
25.0	
30.0	
35.0	
40.0	
45.0	

[4]

(b) (i) On the grid, plot temperature on the vertical axis against total volume of dilute hydrochloric acid added.

Do **not** start the temperature axis at 0 °C.

The temperature scale needs to be 10 °C higher than the highest temperature recorded in Table 3.1.
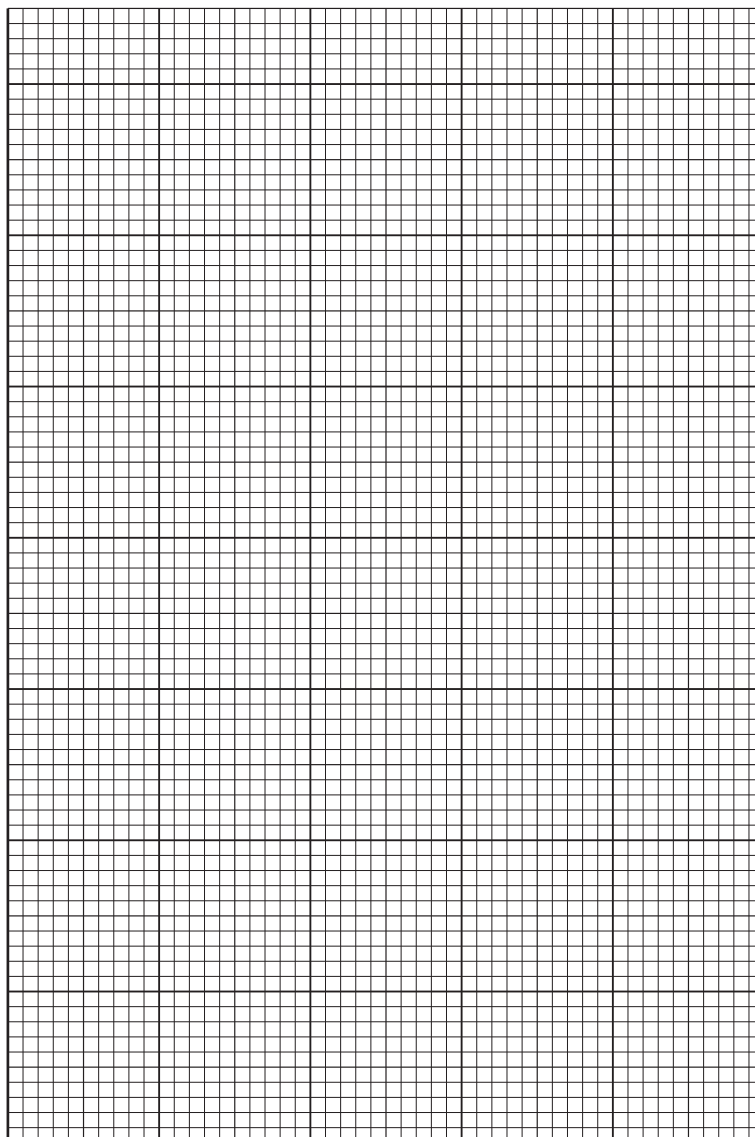
[3]

(ii) Complete the following steps and draw **two** lines of best fit on the graph.

- Draw the best-fit straight line through the increasing temperatures.
- Extrapolate the line past the highest point.
- Draw the best-fit straight line through the decreasing temperatures.
- Extrapolate the line past the highest point.

The maximum temperature T_{max} reached by the reaction is where the two lines intersect (cross).

Deduce the maximum temperature reached.

Show your working on the graph.

T_{max} = ... °C [4]

(iii) Where the lines intersect (cross) on the graph also shows the volume of dilute hydrochloric acid that exactly neutralises the $25\,cm^3$ of aqueous sodium hydroxide.

This is the point where the reaction is finished.

Use your graph to state the volume of dilute hydrochloric acid V that exactly neutralises the $25\,cm^3$ of aqueous sodium hydroxide.

V = ... cm^3 [1]

(c) Calculate the total increase in temperature, ΔT, for the reaction.

Use the equation:

$$\Delta T = T_{max} - T_0$$

T_0 is the temperature when $0.0\,cm^3$ of dilute hydrochloric acid was added.

ΔT = ... °C

Calculate the thermal energy H given out during the reaction.

Use the equation shown:

$$H = (25 + V) \times 4.2 \times \Delta T$$

where V is your answer in **(b)(iii)**.

H = ... J

[1]

(d) Thermal energy is lost to the air during the experiment.

Suggest **one** change to the apparatus that reduces the amount of thermal energy lost.

....

.... [1]

(e) After the reaction, the plastic cup is left on the bench for two hours.

Suggest the temperature of the mixture in the plastic cup after two hours.

temperature .... °C

Explain how you arrived at your answer.

....

.... [1]

[Total: 15]

4 You are going to test the substances from **Question 3**.

(a) Procedure

- Put approximately 1 cm depth of dilute hydrochloric acid into a clean test-tube.
- Add 3 drops of universal indicator solution.
- Record in Table 4.1 the colour observed.
- Use the pH colour chart to record in Table 4.1 the pH of the dilute hydrochloric acid.

Repeat the procedure using aqueous sodium hydroxide instead of dilute hydrochloric acid.

Table 4.1

substance	colour with universal indicator	pH
dilute hydrochloric acid		
aqueous sodium hydroxide		
contents of the plastic cup		

[3]

(b) When an acid is added to an alkali a neutralisation reaction occurs.

A neutral substance turns universal indicator green and has a pH of 7.

(i) Repeat the procedure in **(a)** using the contents of the plastic cup from the end of the reaction in **Question 3**.

Record your observation and the pH in Table 4.1. [1]

(ii) Explain why the reaction mixture from the plastic cup does **not** have a pH of 7.

....

.... [1]

[Total: 5]

5 You are going to investigate the resistance of series and parallel combinations of identical resistors.

The circuit shown in Fig. 5.1 has been assembled for you. Resistors R_1 and R_2 are connected in series.

(a) On Fig. 5.1, draw the symbol for a voltmeter and show how it is connected to measure the potential difference between point **X** and point **Y**.
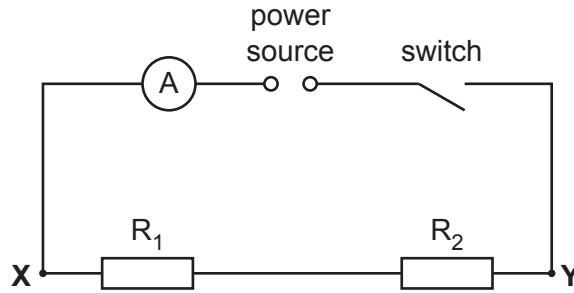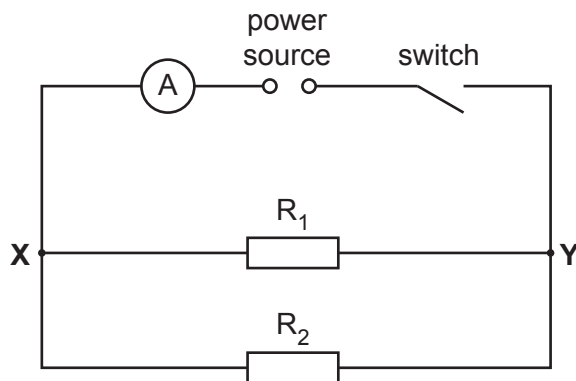

Fig. 5.1

[2]

(b) Procedure

- Connect the voltmeter to measure the potential difference between point **X** and point **Y**.
- Close the switch.

(i) Record the potential difference V and the current I.

V = ... V

I = ... A

[2]

- Open the switch.

(ii) Calculate the total resistance R_S between **X** and **Y**.

Use the equation shown.

$$R_S = \frac{V}{I}$$

Give the unit for your answer.

R_S = ... unit = ... [2]

(c) Procedure

- Disconnect the voltmeter.
- Connect the circuit as shown in Fig. 5.2.

Resistors R_1 and R_2 are now connected in parallel.

Fig. 5.2

- Reconnect the voltmeter to measure the potential difference between point **X** and point **Y**.
- Close the switch.

(i) Record the potential difference V and the current I.

$V =$ V

$I =$ .... A

[2]

- Open the switch.

(ii) Calculate the total resistance R_P between **X** and **Y** for the parallel circuit.

Use the equation shown.

$$R_P = \frac{V}{I}$$

$R_P =$ .... [1]

(d) Explain why it is good practice to open the switch between taking and recording readings from the ammeter and voltmeter.

....

.... [1]

(e) A student states that if each resistor is identical then $R_S = 4 \times R_P$.

Two quantities can be considered equal, within the limits of experimental error, if their values are within 10% of each other.

State if your results support the student's statement.

Justify your statement by doing a calculation using your values of R_S from **(b)(ii)** and R_P from **(c)(ii)**.

statement ....

justification ....

.... [2]

(f) Another student repeats the investigation using lamps instead of resistors.

The lamps are connected in series, as in Fig. 5.1, but they do **not** light up.

Suggest **one** observation that the student makes to check if one of the lamps is broken.

....

.... [1]

[Total: 13]

6   Water is heated from room temperature to its boiling point in a metal cooking pot.

Plan an experiment to investigate if the time taken for the water to reach its boiling point depends on the metal from which the cooking pot is made.

You are provided with:

*   a supply of cold water
*   a set of three cooking pots of the same size, one made of aluminium, one made of copper and one made of steel
*   a Bunsen burner, tripod and gauze
*   a measuring cylinder.

You may use any other common laboratory apparatus.

You are not required to do this investigation.

In your plan include:

*   any other apparatus needed
*   a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
*   the variables you will control
*   a results table to record your measurements (you are not required to enter any readings in the table)
*   how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

[7]

NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests 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.
bromide (Br^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white 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
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia (NH_3)	turns damp, red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green