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PHYSICAL SCIENCE

0652/51

Paper 5 Practical Test

October/November 2022

1 hour 15 minutes

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 40.
- 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.

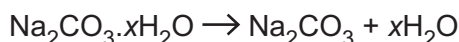
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This document has **16** pages. Any blank pages are indicated.



1 You are going to find the value of x in the formula of sodium carbonate crystals, $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$.

A weighed sample of sodium carbonate crystals is heated until all of the water has been removed.



The anhydrous sample (sample with no water) is weighed.

The value of x can be calculated using the equation shown:

$$x = \frac{\text{amount H}_2\text{O}}{\text{amount Na}_2\text{CO}_3}$$

- (a)
- Weigh the empty evaporating basin.
 - Record the mass to the nearest 0.1 g in Table 1.1.
 - Place the sample of sodium carbonate crystals into the evaporating basin.
 - Record, in Table 1.1, the mass of the evaporating basin and sodium carbonate crystals to the nearest 0.1 g.
 - Heat the sodium carbonate crystals carefully with a burner for 5 minutes.
 - Allow the evaporating basin to cool for a few minutes.
 - Weigh the evaporating basin and anhydrous sodium carbonate, Na_2CO_3 .
 - Record, in Table 1.1, the mass of the evaporating basin and anhydrous sodium carbonate to the nearest 0.1 g.

Table 1.1

mass of empty evaporating basin g
mass of evaporating basin and sodium carbonate crystals ($\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$) before heating g
mass of evaporating basin and anhydrous sodium carbonate (Na_2CO_3) after heating g

[3]

(b) (i) Calculate the mass of anhydrous sodium carbonate, Na_2CO_3 .

Use the equation:

$$\text{mass anhydrous sodium carbonate} = \text{mass of evaporating basin and anhydrous sodium carbonate} - \text{mass of empty evaporating basin}$$

$$\text{mass of anhydrous Na}_2\text{CO}_3 = \text{..... g [1]}$$

3

- (ii) Calculate the amount (number of moles) of Na_2CO_3 .

Use the equation:

$$\text{amount anhydrous Na}_2\text{CO}_3 = \frac{\text{mass anhydrous Na}_2\text{CO}_3}{106}$$

$$\text{amount of anhydrous Na}_2\text{CO}_3 = \dots\dots\dots [1]$$

- (iii) Calculate the mass of water, H_2O , given off.

Use the equation:

$$\text{mass water} = \text{mass of evaporating basin and sodium carbonate crystals} - \text{mass of evaporating basin and anhydrous sodium carbonate}$$

$$\text{mass of H}_2\text{O} = \dots\dots\dots \text{ g } [1]$$

- (iv) Calculate the amount (number of moles) of H_2O .

Use the equation:

$$\text{amount H}_2\text{O} = \frac{\text{mass H}_2\text{O}}{18}$$

$$\text{amount of H}_2\text{O} = \dots\dots\dots [1]$$

- (v) Calculate the value of x in $\text{Na}_2\text{CO}_3 \cdot x\text{H}_2\text{O}$.

Use your answers to (b)(ii), (b)(iv) and the equation:

$$x = \frac{\text{amount H}_2\text{O}}{\text{amount anhydrous Na}_2\text{CO}_3}$$

$$x = \dots\dots\dots [1]$$

- (c) (i) Explain in detail why repeating the experiment and calculating an average would increase the accuracy of the value of x .

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

- (ii) Identify **two other** major sources of error in this experiment. For each source of error suggest how the experiment can be improved to make the value of x more accurate.

The changes suggested must be possible in a school or college laboratory.

error 1
.....
improvement 1
.....
error 2
.....
improvement 2
..... [2]

[Total: 11]

Question 2 begins over the page

2 You are going to identify three colourless solutions, **A**, **B** and **C**.

- (a) • Pour about 1 cm depth of solution **A** in a clean test-tube.
• Add universal indicator.

Record the colour in Table 2.1.

- Repeat with solution **B** and solution **C**.

[1]

- (b) • Pour about 1 cm depth of solution **A** into two clean test-tubes.
• Add a few drops of dilute nitric acid followed by a few drops of aqueous silver nitrate to one test-tube.
• Add a few drops of dilute nitric acid followed by a few drops of aqueous barium nitrate to the second test-tube.

Record your observations in Table 2.1.

- Repeat with solution **B** and solution **C**.

[2]

Table 2.1

test	placed in solution A	placed in solution B	placed in solution C
colour of universal indicator			
dilute nitric acid and aqueous silver nitrate			
dilute nitric acid and aqueous barium nitrate			

(c) Identify solution **A**.

solution **A** is [1]

- (d) • Place the wooden splint soaked in solution **B** into a blue burner flame.

Record the first colour seen in Table 2.2.

There is no flame colour with solution **C**.

[1]

- (e) • Place about 2 cm depth of solution **B** into a clean test-tube.
 • Add aqueous copper(II) sulfate until it is in excess.

Record your observations in Table 2.2.

- Repeat with solution **C**.

[2]

Table 2.2

test	solution B	solution C
flame colour		none
add aqueous copper(II) sulfate until it is in excess		

- (f) Identify solutions **B** and **C**.

solution **B** is

solution **C** is

[2]

[Total: 9]

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- 3 In this experiment, you will determine the resistance of a resistor **X**.

Fig. 3.1 shows most of a circuit that is set up for you. The circuit contains a slide wire to which a crocodile clip can be attached.

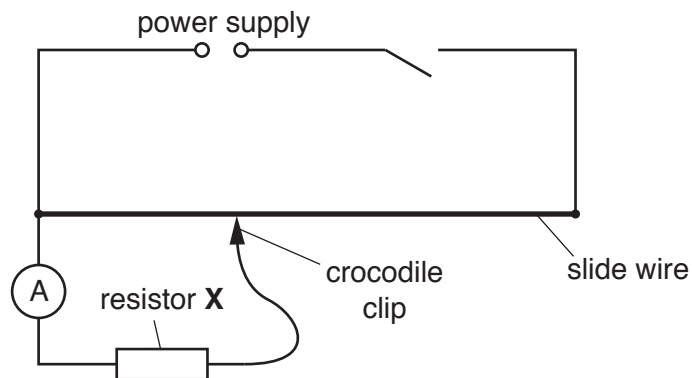


Fig. 3.1

A voltmeter in the circuit is used to measure the potential difference across resistor **X**.

- (a) The voltmeter has been omitted from the diagram of the circuit in Fig. 3.1.

Complete the circuit diagram Fig. 3.1 by adding the symbol for a voltmeter in the correct position to measure the potential difference across resistor **X**. [1]

- (b) (i) • Close the switch.
- Adjust the position of the crocodile clip on the slide wire until the potential difference V across the resistor is 0.4V .

Record the value of the current I in Table 3.1.

[1]

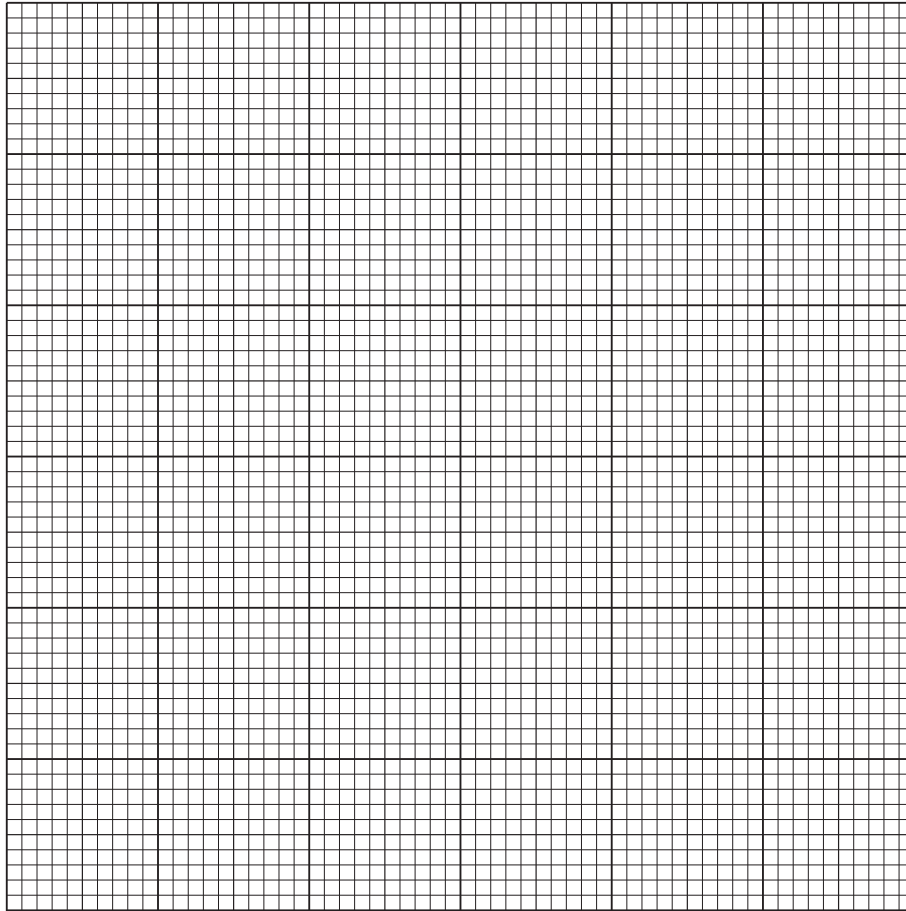
- (ii) • Repeat the procedure in (b)(i) for values of $V = 0.6\text{V}$, 0.8V , 1.0V and 1.2V .
- Open the switch.

[1]

Table 3.1

V/V	I/A
0.4	
0.6	
0.8	
1.0	
1.2	

- (c) (i) Plot a graph of current I (vertical axis) against potential difference V .



[3]

- (ii) Draw the line of best fit.

[1]

- (d) (i) Calculate the gradient G of the line.

Show all working and indicate clearly on your graph the points you use to calculate the gradient.

$$G = \dots\dots\dots [2]$$

- (ii) The resistance of resistor X , R_x , is equal to $1/G$.

Use your value of G from (d)(i) to calculate R_x .

Give your answer to a suitable number of significant figures.

$$R_x = \dots\dots\dots \Omega [2]$$

(iii) Resistor **X** was chosen from a selection of resistors with values $4.7\ \Omega$ or $5.1\ \Omega$.

Use your value of R_x to identify the actual resistance of resistor **X** from the list.

Tick the box to indicate your choice.

- $4.7\ \Omega$
- $5.1\ \Omega$
- either of these
- neither of these

Explain your choice with reference to your calculated value for R_x .

.....

.....

[1]

(e) The resistance of resistor **X** can be determined by taking a single pair of values of current I , and potential difference V from Table 3.1, and using the equation $R = V/I$.

Suggest **one** reason why plotting a graph gives a more accurate value of resistance.

.....

..... [1]

[Total: 13]

- 4 A student suggests that the starting temperature of hot water affects its rate of cooling.

The following equipment is available to the student:

a supply of water
an electric kettle
thermometer
250 cm³ beaker
250 cm³ measuring cylinder
stopwatch
clamp, boss and stand.

Plan an experiment to investigate the relationship between the starting temperature of water and its rate of cooling.

Your plan should include:

- a brief description of the method, including how you will obtain a range of starting temperatures
- the measurements you will make
- the variables to control
- the table you will draw to record your results, with column headings (you are **not** required to enter any readings in the table)
- an explanation of how you would use your results to reach a conclusion.

A diagram is not required but you may draw one if it helps to explain your plan.

.....

.....

.....

.....

.....

.....

NOTES FOR USE IN QUALITATIVE ANALYSIS

Test for anions

<i>anion</i>	<i>test</i>	<i>test result</i>
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.

Test for aqueous cations

<i>cation</i>	<i>effect of aqueous sodium hydroxide</i>	<i>effect of aqueous ammonia</i>
ammonium (NH_4^+)	ammonia produced on warming	–
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt. or very slight white ppt.
copper (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

Test for gases

<i>gas</i>	<i>test and test result</i>
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

<i>metal ion</i>	<i>flame colour</i>
lithium (Li ⁺)	red
sodium (Na ⁺)	yellow
potassium (K ⁺)	lilac
copper(II) (Cu ²⁺)	blue-green

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