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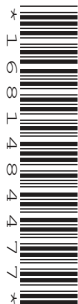</table>

PHYSICAL SCIENCE   **0652/51**

Paper 5 Practical Test   **October/November 2021**

                                                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.

<table>
<tr><td colspan="2">**For Examiner's Use**</td></tr>
<tr><td>1</td><td></td></tr>
<tr><td>2</td><td></td></tr>
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1   You are going to investigate different arrangements of resistors.

The circuit shown in Fig. 1.1 has been set up for you. The resistors in the arrangement between **P** and **Q** are identical. This is circuit **1**.
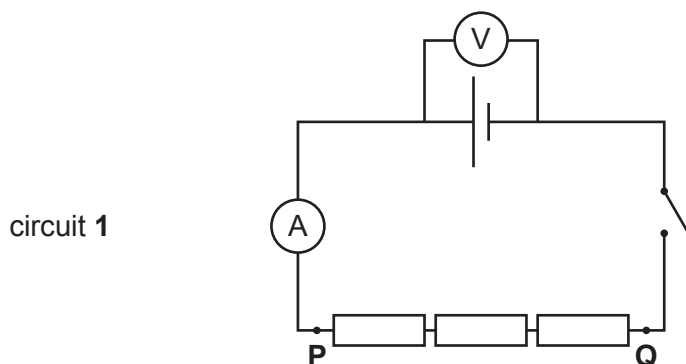

circuit **1**

Fig. 1.1

Refer to Fig. 1.1 when following the instructions.

(a) Procedure

- Close the switch.

- Measure the potential difference V and the current I in the circuit.

- Record the values for V and I in Table 1.1 in the row for circuit **1**.

- Open the switch.

- Remove the three resistors between **P** and **Q**. Keep the remainder of the circuit in place leaving the voltmeter and ammeter connected.

- Rearrange the three resistors to match the arrangement shown between **P** and **Q** in circuit **2** in Fig. 1.2.
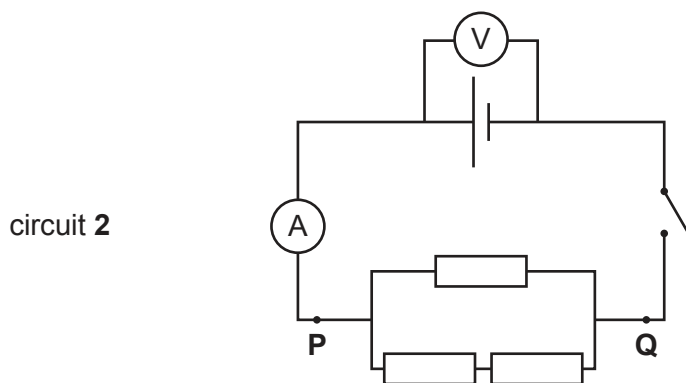

circuit **2**

Fig. 1.2

- Connect the new resistor arrangement between **P** and **Q**.

- Close the switch.

- Measure the potential difference V and current I for circuit **2**.

- Record the values in Table 1.1 in the row for circuit **2**.

- Open the switch.

Repeat this procedure for circuit **3** shown in Fig. 1.3.
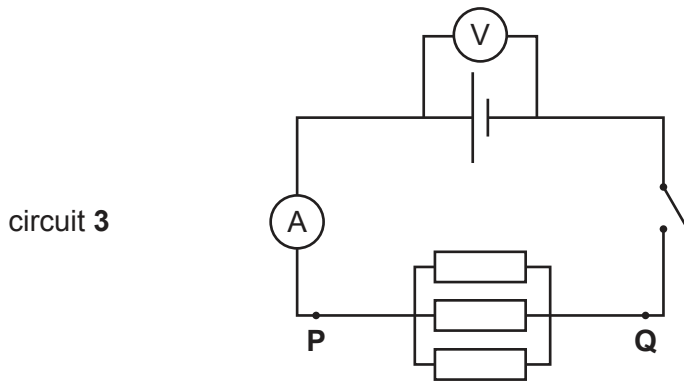
circuit **3**

Fig. 1.3

Table 1.1

circuit	resistor arrangement	V/V	I/A	R/Ω
1				
2				
3				

[3]

(b) Calculate the total resistance R for each circuit.

Use the equation:

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

Record, in Table 1.1, your values of R to a suitable number of significant figures.   [2]

(c) You are provided with an unknown arrangement of resistors, labelled **U**.

    (i) • Remove the three resistors between **P** and **Q**. Keep the remainder of the circuit in place leaving the voltmeter and ammeter connected.

        • Connect the unknown arrangement **U** between **P** and **Q**.

        • Close the switch.

        • Measure and record the potential difference V_U and current I_U.

        • Open the switch.

V_U = ... V

I_U = ... A

[1]

    (ii) Calculate the total resistance R_U for the unknown arrangement **U**.

Use the equation:

$$R_U = \frac{V_U}{I_U}$$

Record your value of R_U on the answer line.

R_U = ... Ω [1]

(d) The unknown arrangement **U** may be the same as one of the arrangements you have investigated.

Use the values in Table 1.1 and your answer to **1(c)(ii)** to determine if the unknown arrangement **U** is the same as the arrangement of resistors in circuit **1**, **2** or **3**.

Tick the box to show which circuit, if any, matches the unknown arrangement **U**.

☐ circuit **1**

☐ circuit **2**

☐ circuit **3**

☐ none of the above circuits

Justify your choice with reference to your results recorded in Table 1.1.

....

....

.... [1]

(e) A student suggests that there are other possible arrangements of the three resistors that can be investigated.

Draw **one** arrangement of the three resistors that is **different** to the resistor arrangements in circuits **1**, **2** and **3**.

[1]

[Total: 9]

2 You are going to determine the mass of a metre rule using a balancing method.

Refer to Fig. 2.1 when following the instructions.
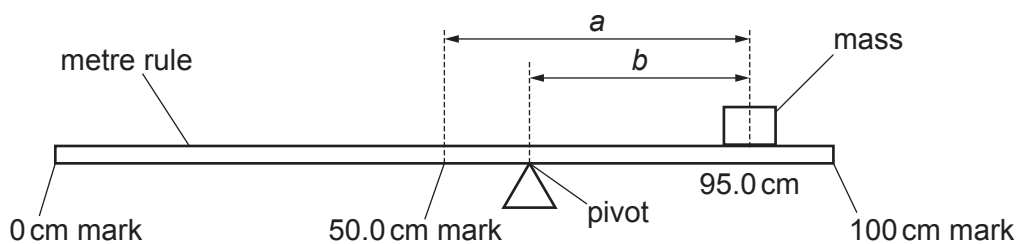
Fig. 2.1

(a) Procedure

- Place the metre rule on the pivot.

- Place the mass on the rule, with its centre at the 95.0 cm mark.

- Keep the mass at the 95.0 cm mark and adjust the position of the metre rule on the pivot until the metre rule is as near to being balanced as possible.

- Record in Table 2.1 the position of the pivot against the scale on the rule.

- Calculate the distance *b* between the centre of the mass and the pivot. Use the equation:

  b = position of the mass – position of pivot

Record your result for *b* in Table 2.1.

Repeat the procedure with the centre of the mass positioned at the 90.0 cm, 85.0 cm, 80.0 cm and 75.0 cm marks.

Table 2.1

position of the mass / cm	*a* / cm	position of the pivot / cm	*b* / cm
95.0	45.0		
90.0	40.0		
85.0	35.0		
80.0	30.0		
75.0	25.0		

[2]

(b) (i) On the grid, use the data and your results from Table 2.1 to plot a graph of a/cm (vertical axis) against b/cm.

You do not have to start your graph at the origin (0, 0).
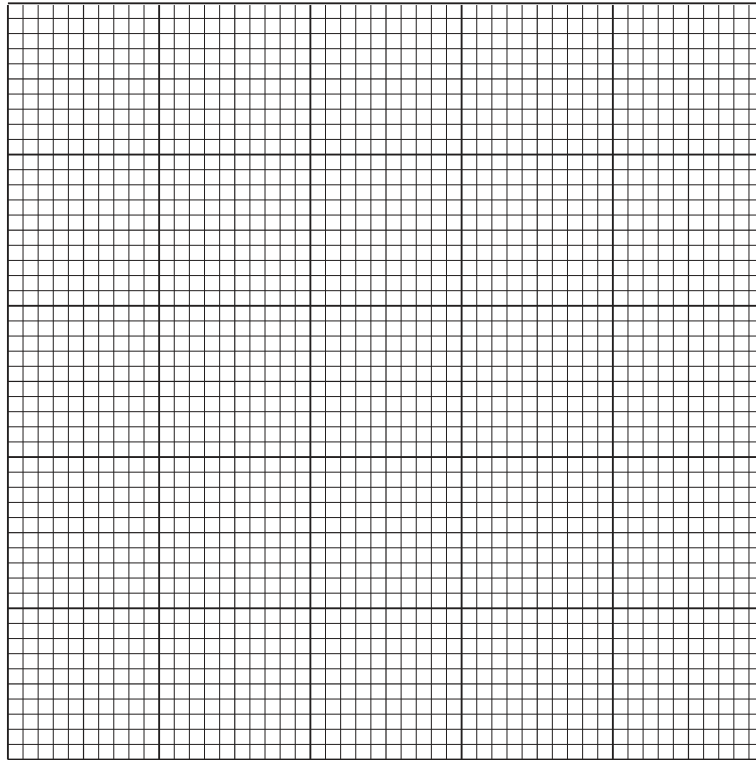
[3]

(ii) Draw the straight line of best fit for your plotted points. [1]

(c) (i) Calculate the gradient G of the line.

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

G = ... [2]

(ii) Calculate the mass M in g of the metre rule.

Use the equation:

$$M = \frac{200}{G-1}$$

Record the value for M on the answer line.

M = ... g [1]

(d) Suggest two reasons why the calculated value of the mass of the metre rule is unlikely to be the same as the actual mass of the metre rule.

reason 1 ....

....

reason 2 ....

....

[2]

[Total: 11]

Question 3 begins over the page

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3 In this investigation, you will:

- investigate the colours that make up universal indicator

- determine the relative concentrations of three alkalis

- identify two of the alkalis.

(a) Procedure

- Draw a horizontal pencil line 1 cm from the end of the piece of chromatography paper. This is called the base line.

- Place one drop of universal indicator on the middle of the line.

- Place about 1 cm depth of water in a beaker.

- Wrap the top of the chromatography paper around a glass rod and secure with a paper clip.

- Suspend the paper in the water so that the paper is dipping into the water but the water level is below the pencil line. If you need to add more water to the beaker, take the chromatography paper out of the beaker while you add the extra water. See Fig. 3.1.
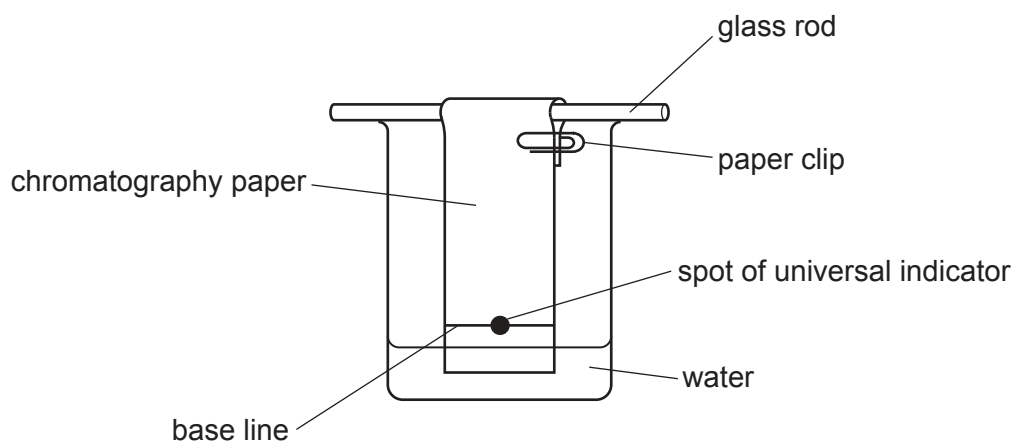
Fig. 3.1

- Leave the chromatography paper in the water until the water reaches **just below** the glass rod.

You should move ahead to start answering other parts e.g. **3(b)** and **3(c)** while you are waiting for the water to move up the chromatography paper.

- When the water reaches to just below the glass rod, take the chromatography paper out of the water and lay it on a clean white tile.

- Use a pencil to mark on the paper the level reached by the water. This is called the solvent front.

(i) Draw a large labelled diagram of the chromatogram.

Include in your diagram
- the base line
- the solvent front
- the initial position of the spot of universal indicator
- the colours produced.

[3]

(ii) State how many colours are in the universal indicator.

Explain how you decided how many colours there are.

number of colours ....

explanation ....

....

[1]

(b) Solutions **X**, **Y** and **Z** are samples of cleaning fluids. They are all alkalis.

You are going to find out how much dilute hydrochloric acid is needed to exactly neutralise each solution.

(i) **Procedure**

- Measure $25\,cm^3$ of solution **X** in a measuring cylinder and pour this into a conical flask.

- Add 5 drops of bromophenol blue indicator to the conical flask.

- Place the conical flask on a white tile.

- Use a clean dropping pipette to add drops of dilute hydrochloric acid to the conical flask, counting as you add them, until the bromophenol blue just turns green. You will need to swirl the flask between drops.

  If the colour goes yellow then you have added one drop too many. If it goes yellow subtract one drop from the number you have counted.

- Record the number of drops in Table 3.1.

- Rinse the conical flask with distilled water.

Repeat the procedure with solution **Y** and solution **Z**.

Table 3.1

solution	number of drops of dilute hydrochloric acid added
X	
Y	
Z	

[3]

(ii) List the three solutions in order of concentration, starting with the most concentrated.

most concentrated ....

....

least concentrated ....

[1]

(c) You are going to use aqueous copper sulfate to identify solution **X** and solution **Y**.

(i) **Procedure**

- Place 1 cm depth of solution **X** in a test-tube.
- Add a few drops of aqueous copper sulfate.
- Record the appearance of the contents of the test-tube in Table 3.2.
- Add excess aqueous copper sulfate to the same test-tube.
- Record the appearance in Table 3.2.

Repeat the procedure with solution **Y**. Use a clean test-tube.

Table 3.2

test	appearance	
	solution **X**	solution **Y**
few drops of aqueous copper sulfate		
excess aqueous copper sulfate		

[3]

(ii) State the identity of solution **X** and solution **Y**.

solution **X** is ....

solution **Y** is ....

[2]

[Total: 13]

4 When fuels burn they give out energy. This energy can be used for heating.

Ethanol and propanol are two alcohols which give out energy when they burn. They are both liquids.

Plan an experiment to compare the amount of thermal (heat) energy given out by each fuel when it burns.

You will need to use a spirit burner, as shown in Fig. 4.1.

A spirit burner is a glass bottle containing a volume of the fuel to be burnt and a string wick dipping into the fuel.

The fuel soaks the wick. When the wick is lit the fuel burns from the wick. More fuel moves up the wick to replace the fuel that is burnt.
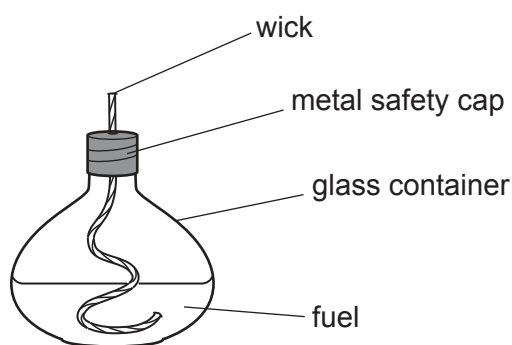
Fig. 4.1

You will also need samples of the fuels ethanol and propanol, and a supply of water. You may also use any apparatus commonly found in a school laboratory in your plan.

Your plan should include:

- the apparatus used
- a brief description of the method
- the variables to control
- the measurements you will make
- an explanation of how you will use your results to reach a conclusion.

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

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

You will **not** be doing this experiment.

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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 (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