



CANDIDATE
NAME

--

CENTRE
NUMBER

--	--	--	--	--

CANDIDATE
NUMBER

--	--	--	--

0653/52

February/March 2024

1 hour 15 minutes

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

- 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.

For Examiner's Use	
1	
2	
3	
4	
Total	

This document has **12** pages. Any blank pages are indicated.

- 1 Penguins stand close together in a huddle, as shown in Fig. 1.1.



Fig. 1.1

You will investigate the effect on heat loss of standing together in a huddle. You will use test-tubes to represent the penguins.

The apparatus is assembled as shown in Fig. 1.2.

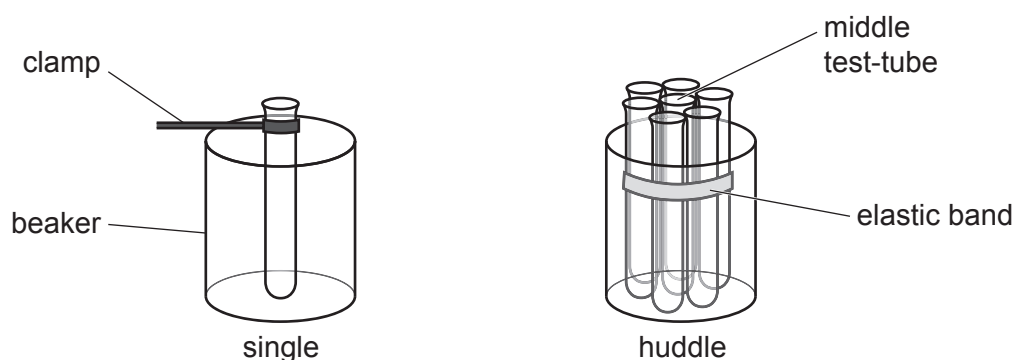


Fig. 1.2

Procedure

- Step 1** Fill **all** the test-tubes with hot water.
- Step 2** Put a thermometer in the single test-tube.
- Step 3** Put another thermometer in the middle test-tube of the huddle.
- Step 4** Record in Table 1.1 the temperature of the water in these two test-tubes for time = 0 minutes.
- Step 5** Start the stop-clock.
- Step 6** Measure the temperature in each of these two test-tubes every minute for a total of 5 minutes.

- (a) (i) Record in Table 1.1 the temperature readings.

Table 1.1

time / minutes	temperature / °C	
	single test-tube	middle test-tube
0		
1		
2		
3		
4		
5		

[3]

- (ii) Calculate the overall change in temperature for each of the two test-tubes after 5 minutes.

single test-tube = °C

middle test-tube = °C
[1]

- (iii) State a conclusion for your results in (a)(ii).

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

- (b) Suggest why it is better to use the change in temperature to compare the heat loss rather than the final temperature.

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

- (c) In this procedure you investigated the effect on heat loss of standing in a huddle.

Suggest one **other** variable that affects heat loss in penguins.

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

[Total: 7]

2 When a person exercises, their pulse rate changes.

Plan an investigation to determine the relationship between the intensity of exercise a person does and the change in their pulse rate.

You may use any common laboratory apparatus.

You are not required to do this investigation.

In your plan, include:

- the apparatus needed
- a brief description of the method and an explanation of any safety precautions you will take
- what you will measure
- which variables you will keep constant
- how you will process your results to draw a conclusion.

You may include a table that can be used to record the results if you wish.

You do **not** need to include any results in your table.

3 You are going to investigate some properties of solution **H**.

(a) Procedure

Step 1 Measure 10.0 cm^3 of solution **H** using a 10 cm^3 measuring cylinder.

Step 2 Pour this volume of solution **H** into a boiling tube.

Step 3 Measure the temperature of solution **H** to the nearest 0.5°C .

(i) Record your result in Table 3.1.

Table 3.1

temperature of solution H in step 3 / $^\circ\text{C}$	
highest temperature of mixture at end of step 5 / $^\circ\text{C}$	
temperature increase / $^\circ\text{C}$	

[1]

Step 4 Add **all** the aluminium foil provided to the boiling tube.

Step 5 Stir the mixture in the boiling tube and measure the highest temperature reached to the nearest 0.5°C .

(ii) Record your result in Table 3.1. [1]

Step 6 Filter the mixture from the boiling tube into a test-tube.

(iii) Describe the appearance of the residue in the filter paper and the filtrate in the test-tube.

residue

filtrate

[2]

(iv) Calculate the temperature increase between **step 3** and **step 5**.

Record your answer in Table 3.1. [1]

- (v) Calculate the amount of thermal (heat) energy released q .

Use the equation shown.

$$q = 10.0 \times 3.96 \times \text{temperature increase}$$

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

thermal energy released $q =$ J [2]

- (vi) Explain why the reaction mixture is stirred in **step 5**.

.....
 [1]

- (vii) The temperature increase is **not** as large as expected because thermal (heat) energy is transferred to the surroundings.

Suggest **one** improvement to the apparatus that will give a more accurate value for the thermal energy released.

.....
 [1]

(b) Procedure

- Add approximately 1 cm depth of solution **H** to a test-tube.
- Slowly add aqueous ammonia to the test-tube until there is no further change.

Record your observations.

.....

 [2]

(c) Procedure

- Add approximately 2 cm depth of solution **H** to a test-tube.
- Add approximately 1 cm depth of dilute nitric acid to the test-tube.
- Add five drops of aqueous silver nitrate to the test-tube.
- Leave for 3 minutes.

(i) Record your observations.

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

(ii) State the name of the salt dissolved in solution **H**.

Use information from your observations in **(b)** and **(c)(i)**.

..... [1]

[Total: 13]

BLANK PAGE

- 4 You will investigate how the resistance R of a resistance wire varies with its length l .

The circuit is assembled as shown in Fig. 4.1.

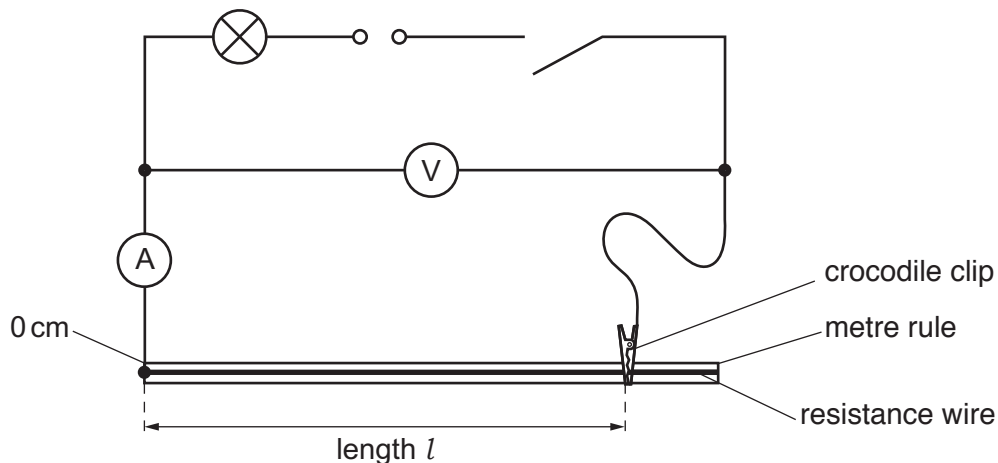


Fig. 4.1

(a) Procedure

- Close the switch.
- Place the crocodile clip on the resistance wire at a length $l = 15.0\text{ cm}$ from the 0 cm end of the metre rule.
- Measure the current I in the circuit and the potential difference V across the resistance wire.
- Open the switch.

- (i) Record your results in Table 4.1.

Table 4.1

length l of resistance wire /cm	current I /A	potential difference V /V	resistance R / Ω
15.0			
30.0			
45.0			
60.0			
75.0			

[2]

Repeat the procedure in (a) for the values of length l shown in Table 4.1.

- (ii) Record your results in Table 4.1.

[2]

- (b)** Calculate the resistance R of the wire for each length l .

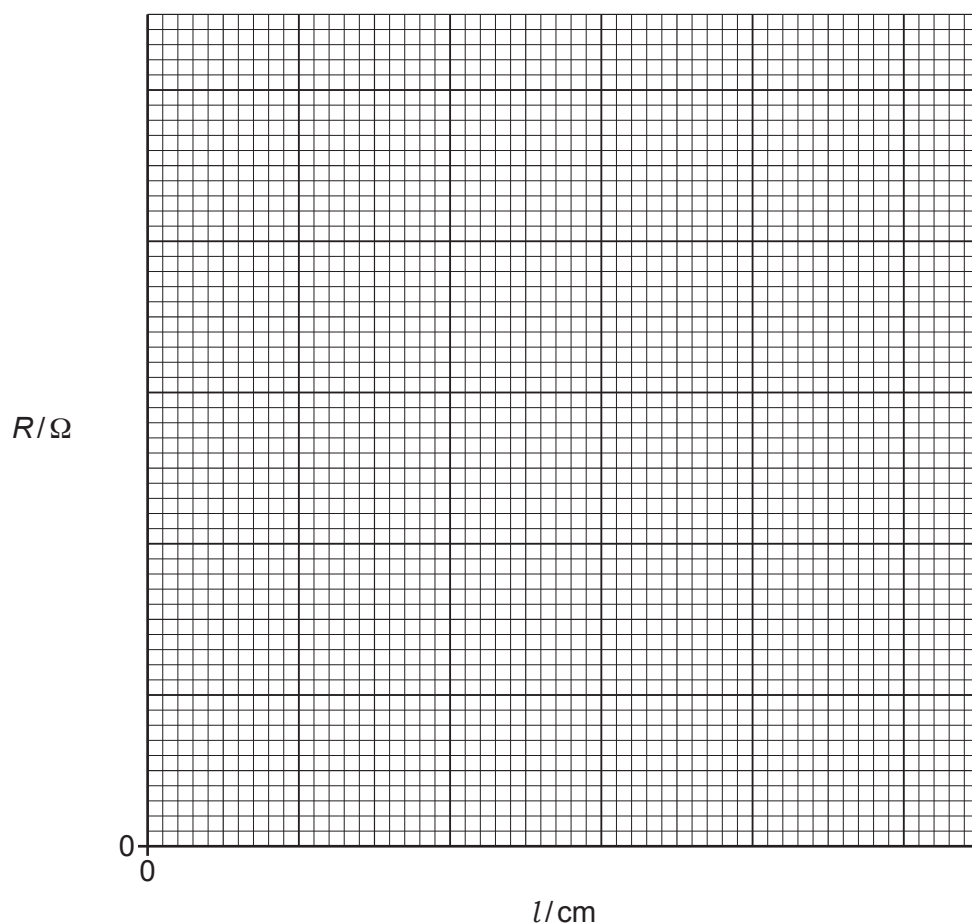
Use the equation shown.

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

Record your values of R in Table 4.1.

[2]

- (c) (i) On the grid, plot a graph of the resistance R on the vertical axis against length l .



[2]

- (ii) Draw the straight line of best fit.

[1]

- (iii) Calculate the gradient of the line.

Show on your graph the triangle you use to calculate the gradient.

gradient = [2]

- (iv) The gradient of the line is a measure of the resistance per unit length of the wire.

State the unit for the resistance per unit length of the wire.

unit = [1]

- (d) Another student repeats the same procedure carefully.

Suggest **one** practical source of error to explain why the other student may get measurements that are different to yours.

.....

..... [1]

[Total: 13]

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.
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

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.