



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/62

February/March 2024

1 hour

No additional materials are needed.

- 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 [].

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

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



Fig. 1.1

A student investigates the effect on heat loss of standing together in a huddle. The student uses test-tubes to represent the penguins.

Procedure

The student:

- assembles the apparatus as shown in Fig. 1.2

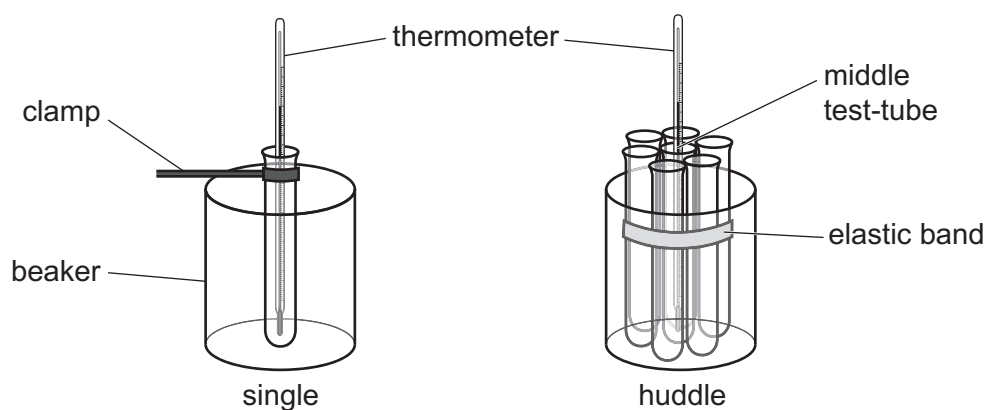


Fig. 1.2

- fills all of the test-tubes with hot water
- records in Table 1.1 the temperature readings on the two thermometers every minute for a total of 5 minutes.

- (a) Fig. 1.3 shows the reading on the thermometer at 4 minutes in the middle test-tube of the huddle.

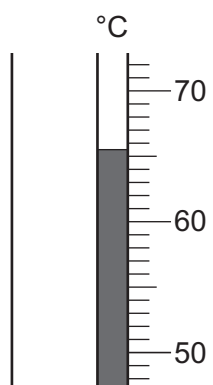


Fig. 1.3

- (i) Record in Table 1.1 the temperature shown in Fig. 1.3 to the nearest 0.5 °C.

Table 1.1

time / minutes	temperature / °C	
	single test-tube	middle test-tube
0	78.0	76.5
1	72.5	72.0
2	67.5	69.5
3	62.0	67.0
4	58.0	
5	56.0	64.5

[1]

- (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 answer to (a)(ii).

.....

..... [1]

- (iv) Predict the change in temperature for one of the **outer** test-tubes of the huddle.

Give a reason for your answer.

temperature change °C

reason

[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 the effect on heat loss of standing in a huddle is investigated.

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

.....

..... [1]

- (d) The test-tubes are left for a further 24 hours.

Suggest why the two test-tubes have the same temperature as each other after 24 hours.

.....

..... [1]

[Total: 7]

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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.

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.

..... [7]

- 3 A student investigates some of the properties of solution **H**.

(a) **Procedure**

The student:

- Step 1** pours solution **H** into a boiling tube
- Step 2** records the temperature of solution **H**
- Step 3** adds pieces of aluminium foil to the boiling tube
- Step 4** stirs the mixture in the boiling tube
- Step 5** records the highest temperature reached
- Step 6** filters the mixture from the boiling tube into a test-tube.

Fig. 3.1 shows the temperature readings in **step 2** and **step 5**.



Fig. 3.1

- (i) Record in Table 3.1 these temperature readings to the nearest 0.5 °C.

Table 3.1

temperature of solution H in step 2 /°C	
highest temperature of mixture at end of step 5 /°C	
temperature increase/°C	

[2]

- (ii) Calculate the temperature increase between **step 2** and **step 5**.

Record your answer in Table 3.1.

[1]

- (iii) 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 (heat) energy released $q = \dots\dots\dots$ J [2]

- (iv) Explain why the reaction mixture is stirred in **step 4**.

.....
 [1]

- (v) 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]

- (vi) Draw a diagram to show the assembled apparatus used to filter the mixture in **step 6**.

Label the apparatus, the filtrate and the residue.

[3]

(b) Solution **H** contains copper(II) ions.

- (i) The student adds aqueous ammonia slowly to solution **H** until there is no further change.

State the observations the student makes.

.....
..... [2]

- (ii) The student adds dilute nitric acid and then aqueous silver nitrate to solution **H**.

The student observes a white precipitate.

Identify the anion (negative ion) present in solution **H**.

Tick (✓) **one** box.

carbonate	☐	chloride	☐
nitrate	☐	sulfate	☐

[1]

[Total: 13]

- 4 A student investigates how the resistance R of a resistance wire varies with its length l .

The student uses the circuit shown in Fig. 4.1.

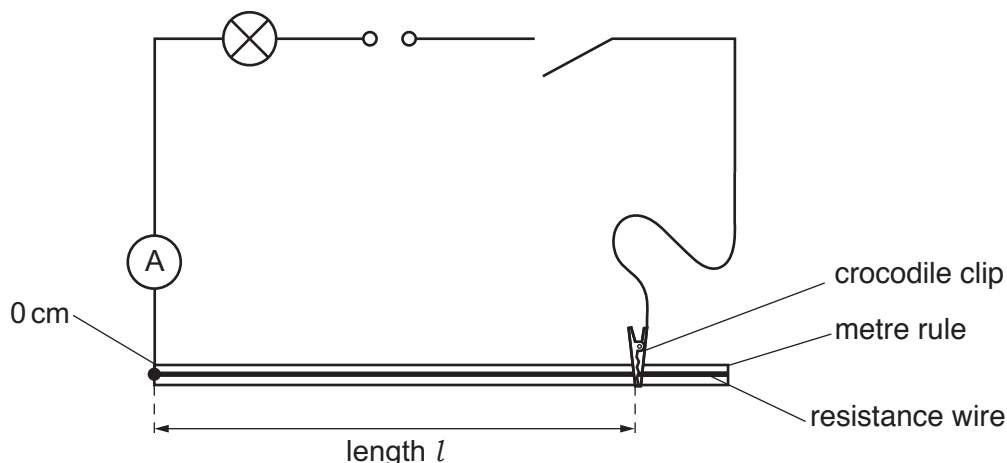


Fig. 4.1

- (a) (i) The student connects a voltmeter to measure the potential difference across a length l of the resistance wire.

On Fig. 4.1, draw the symbol for a voltmeter connected to measure the potential difference across the resistance wire. [1]

- (ii) The student:

- closes the switch
- places the crocodile clip on the resistance wire at a length $l = 15.0\text{ cm}$ from the 0 cm end of the metre rule
- records in Table 4.1 the current I in the circuit and the potential difference V across the resistance wire
- opens the switch.

The student then repeats this procedure for the values of length l shown in Table 4.1.

Suggest why the switch is opened after each measurement.

.....
 [1]

(iii) Fig. 4.2 shows the readings on the voltmeter and ammeter when length $l = 45.0$ cm.

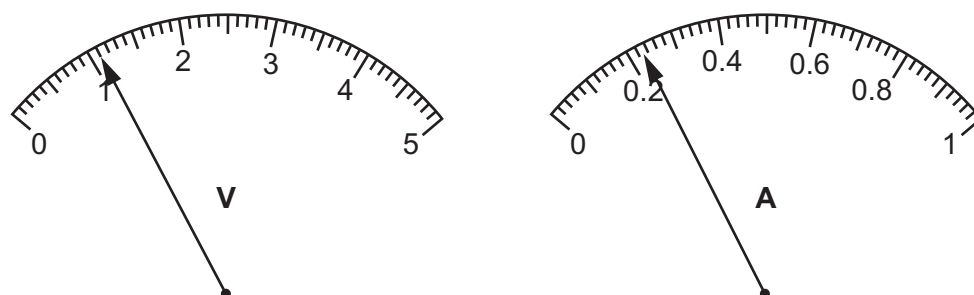


Fig. 4.2

Record in Table 4.1 the potential difference V and the current I shown in Fig. 4.2.

Table 4.1

length l of resistance wire /cm	potential difference V /V	current I /A	resistance R / Ω
15.0	0.45	0.27	1.7
30.0	0.80	0.25	3.2
45.0			
60.0	1.40	0.21	6.7
75.0	1.60	0.20	8.0

[2]

(b) Calculate the resistance R of the wire when length $l = 45.0$ cm.

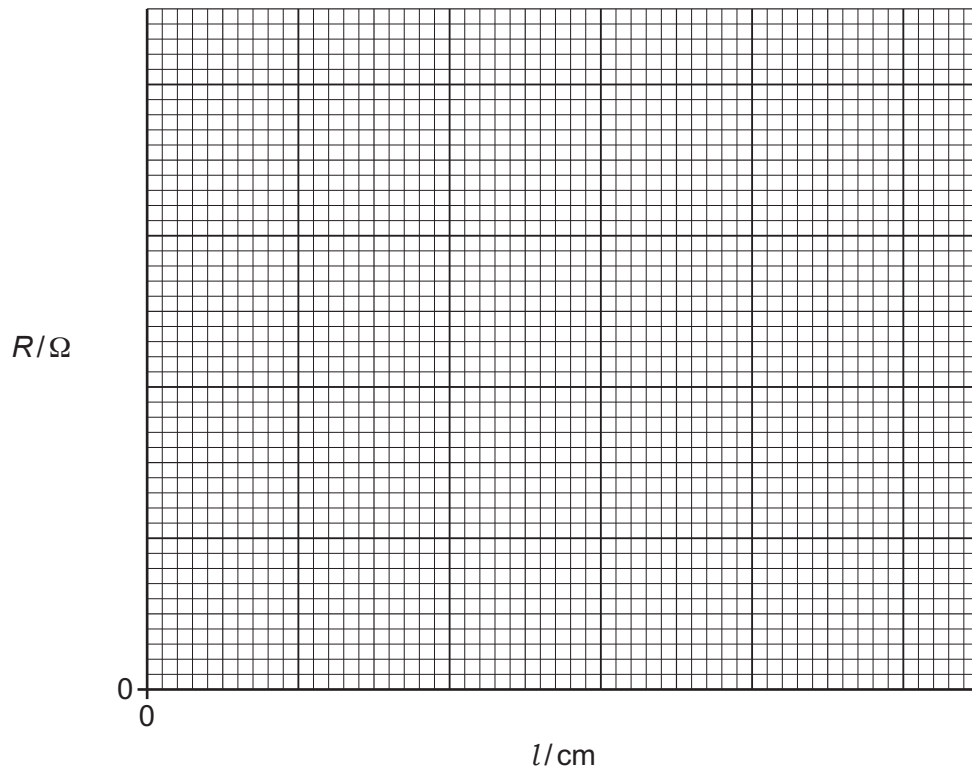
Use the equation shown.

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

Record your value of R in Table 4.1.

[1]

- (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) The student repeats the measurements for each length l .

Suggest how repeating the measurements allows the student to evaluate the quality of the data.

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

- (e) Another student repeats the investigation carefully.

Suggest **one** practical source of error to explain why this student gets measurements that are different to the results in Table 4.1.

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

[Total: 13]

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