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

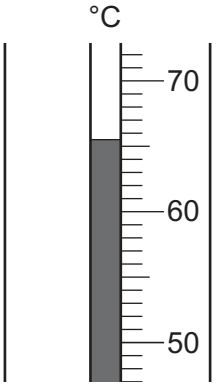


Fig. 1.3

(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]

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.

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**.

step 2 **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 = ... 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.

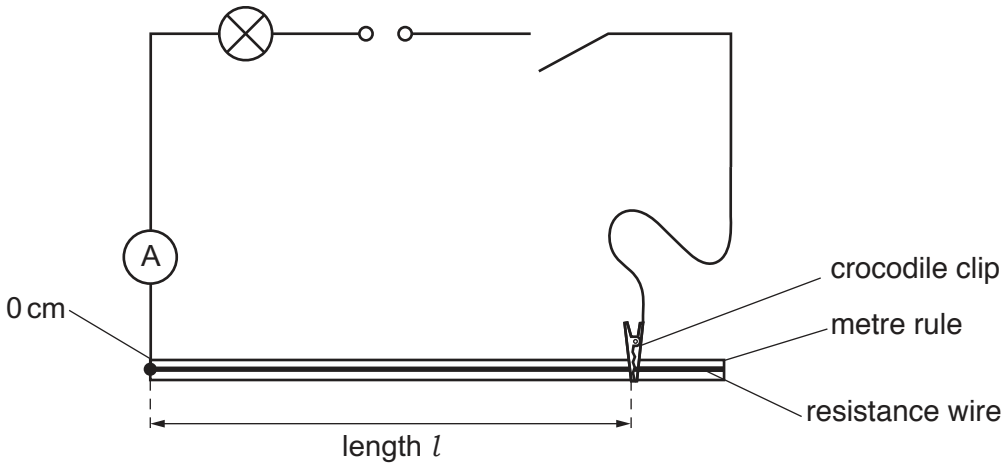


Fig. 4.1

(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 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.

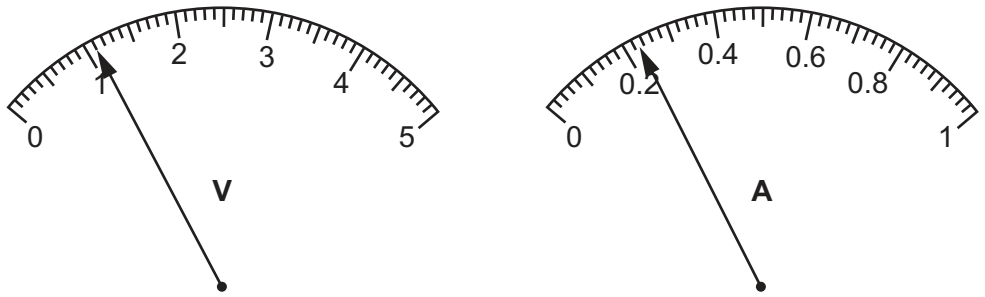


Fig. 4.2

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]

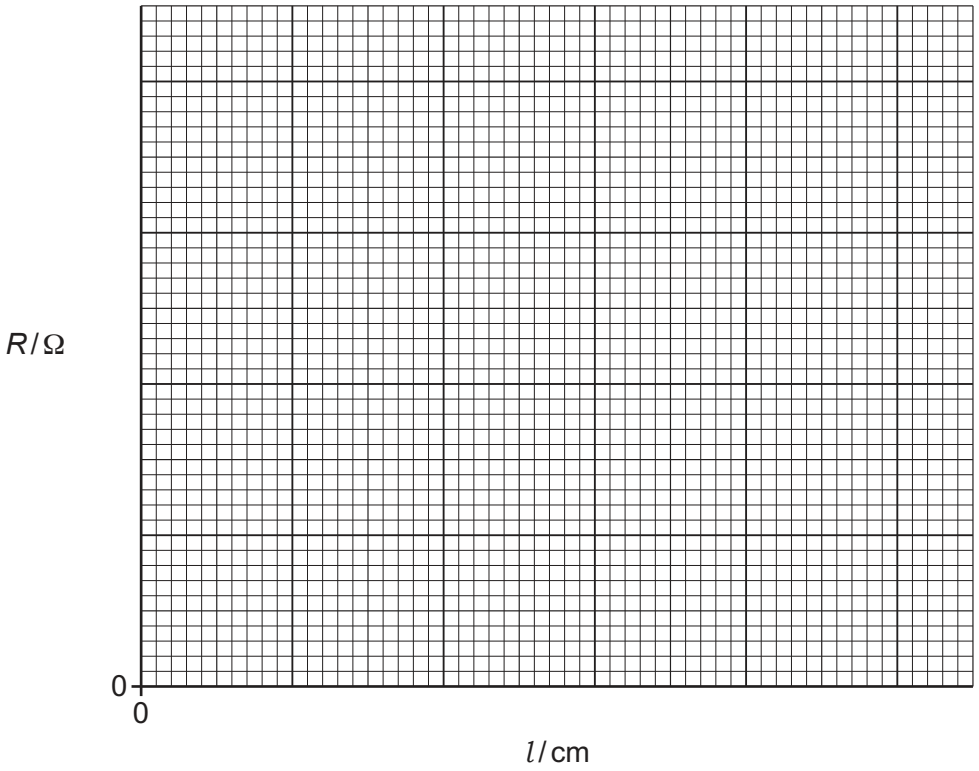
(b) Calculate the resistance R of the wire when length l = 45.0 cm.

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]