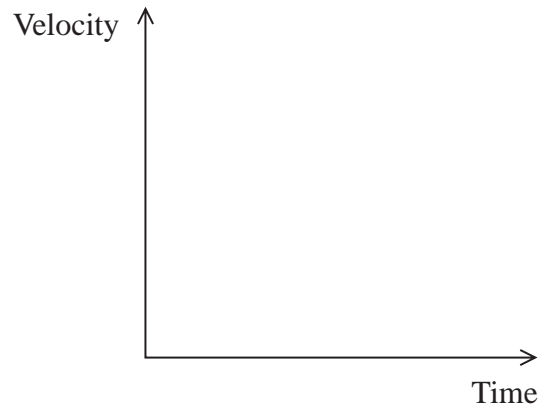


1 Raindrops reach terminal velocity within a few metres of starting to fall.

(a) (i) On the axes below, sketch a velocity-time graph for the motion of a raindrop.

(2)



(ii) Explain why terminal velocity is reached.

(3)

(iii) Suggest why the upthrust acting on a raindrop is often considered to be negligible.

(1)

(b) After reaching terminal velocity, a raindrop took 2.6 minutes to fall 1100 m to the ground.

(i) Calculate the terminal velocity of the raindrop.

(2)

Terminal velocity =

- (ii) Calculate the radius of the raindrop. You may assume that Stokes' law applies to the raindrop.

viscosity of air = 1.8×10^{-5} Pa s
density of water = 1.0×10^3 kg m⁻³

(3)

Radius of raindrop =

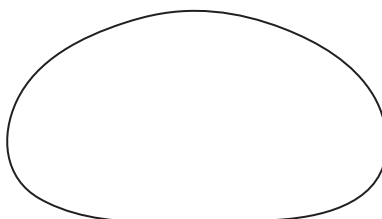
- (c) The shape of the raindrop depends on its velocity.

Once at terminal velocity the raindrop is flat at the bottom due to laminar air flow around it and remains curved at the top due to turbulent air flow.

Add to the diagram below to show the air flow around the falling raindrop.

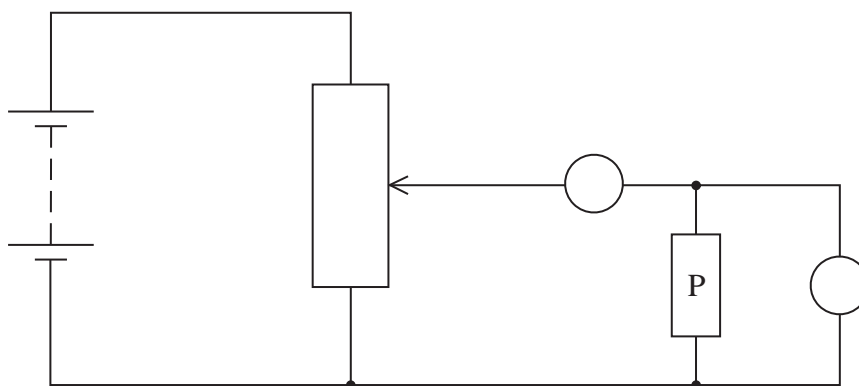
(2)

Direction of
motion of
raindrop



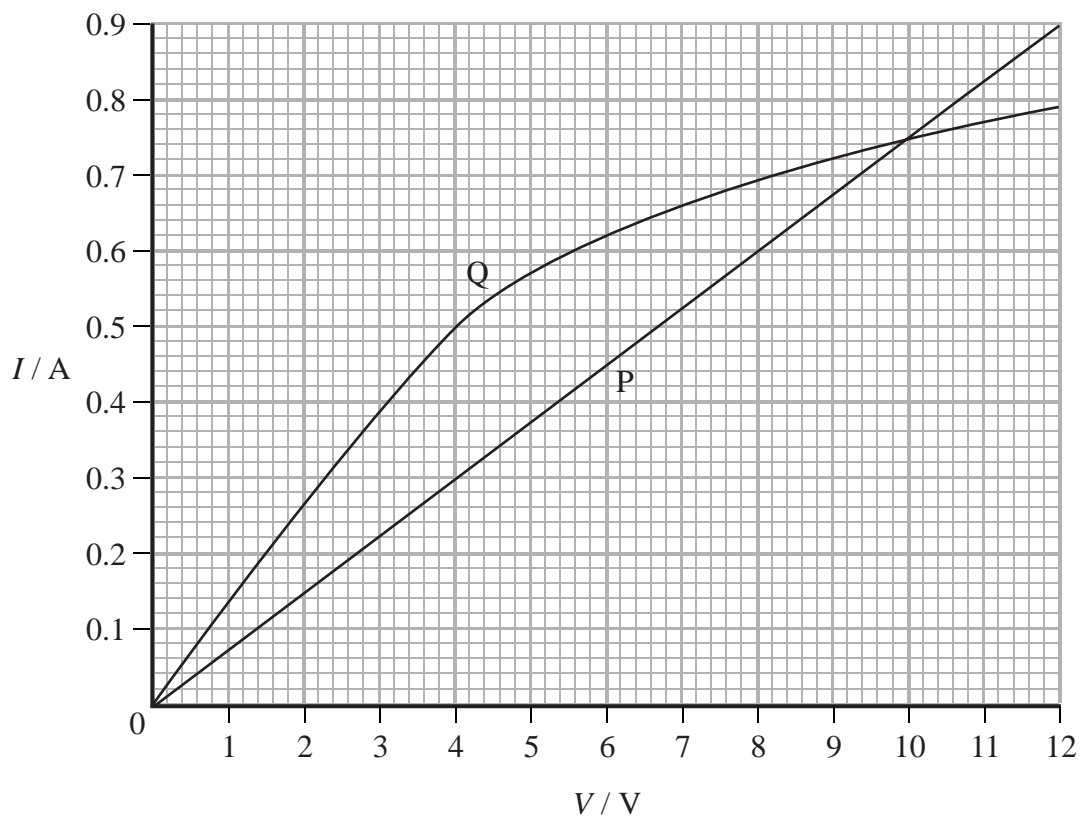
(Total for Question = 13 marks)

- 2 (a) The diagram shows the circuit used to investigate how the current varies with potential difference for an electrical component P. The circuit contains an ammeter and a voltmeter.



- (i) On the diagram, label the ammeter A and the voltmeter V. (1)
- (ii) The position of the contact of the potential divider is moved so that the reading on the voltmeter becomes zero. Label this position Z. (1)

(b) The graph shows how the current I varies with potential difference V for two electrical components P and Q.



(i) State the value of the current for which the resistance of P is the same as the resistance of Q and determine this value of resistance.

(3)

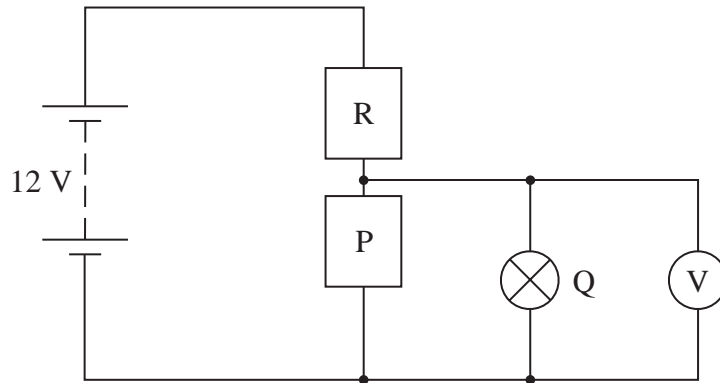
Current =

Resistance =

*(ii) Component Q is a filament lamp. Explain the shape of its graph.

(3)

- (c) A potential divider consisting of component P and a resistor R is connected to a 12 V supply. The lamp Q and a voltmeter are connected to the circuit as shown.



The supply has a negligible internal resistance. The reading on the voltmeter is 4.0 V.

- (i) Use the graph in part (b) to determine the current in the resistor R.

(2)

Current =

- (ii) Calculate the resistance of the resistor R.

(2)

Resistance =

(iii) The lamp Q is removed.

Explain, without further calculation, how the voltmeter reading would change.

(3)

(Total for Question = 15 marks)

- 4 A student carries out an investigation to determine how the resistance of a metal varies with temperature.
A resistor is made from a coil of wire. The resistor is placed in a beaker of hot water as shown in the photograph. The resistance is measured for different temperatures of the water as it cools.



- (a) (i) Explain two precautions the student should take to ensure that her results are accurate.

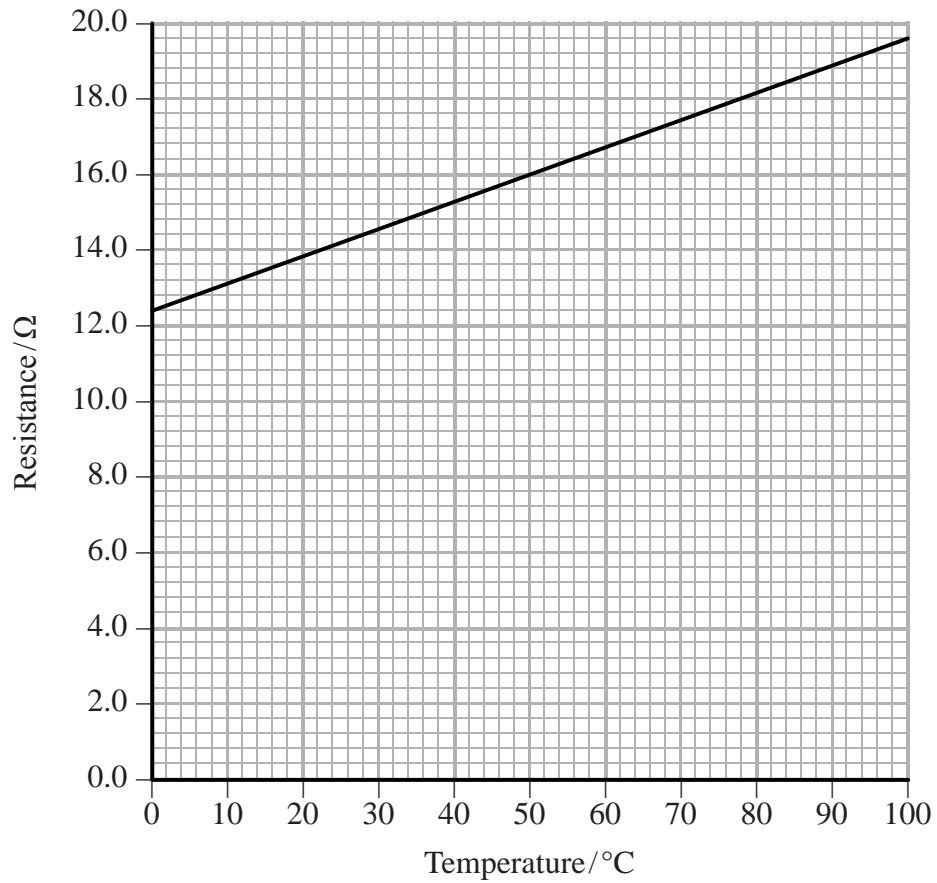
(2)

- (ii) The student used a thermometer and ohmmeter.

State why it would have been better to use a temperature sensor and resistance sensor attached to a data logger.

(1)

(b) The results of the investigation are shown in the graph.



(i) The graph shows that resistance is **not** directly proportional to temperature in °C. State how the graph shows this.

(1)

(ii) Explain the graph in terms of the structure of the metal.

(4)

(c) The resistance of the coil of wire is 12.4Ω at 0°C .

Calculate the length of wire in the coil.

resistivity of the metal = $9.71 \times 10^{-8} \Omega \text{ m}$

diameter of wire = $8.13 \times 10^{-5} \text{ m}$

(3)

Length =

(d) The resistor from the investigation is placed in series with a fixed resistor of resistance 24Ω . A potential difference of 12 V is applied across the two resistors in series.

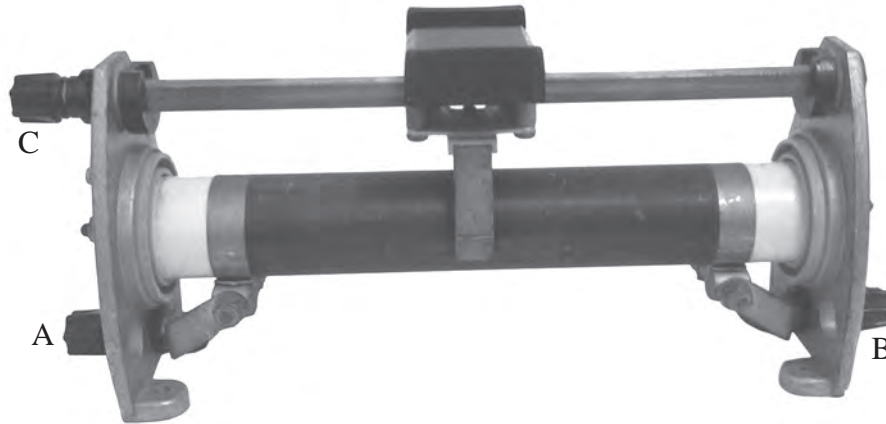
Using information from the graph in (b), determine the temperature for which the potential difference across the resistor from the investigation will be 4.5 V .

(3)

Temperature =

(Total for Question = 14 marks)

5 Photograph 1 shows a rheostat (a variable resistor).

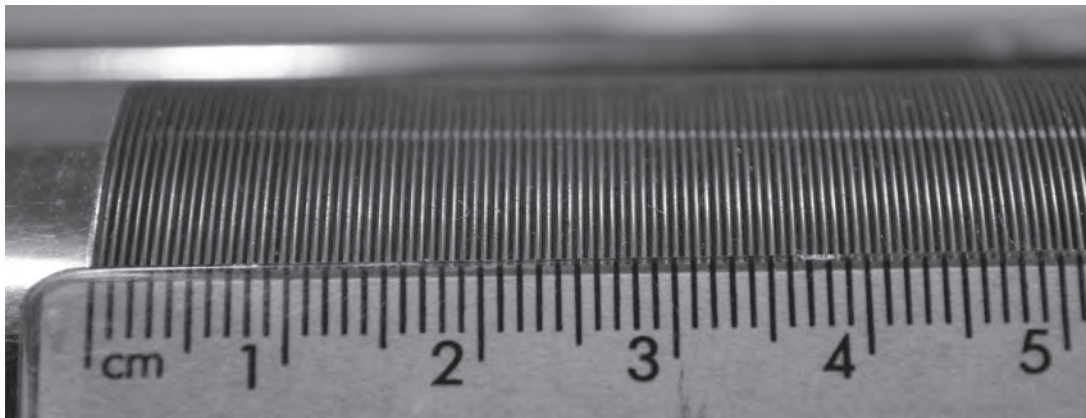


Photograph 1

The rheostat is made of a long resistance wire coiled around an insulating cylinder. The turns of wire are also separated from each other by insulation of negligible thickness. The ends of the wire are connected to the sockets A and B at either end and there is a sliding contact in the centre connected to the socket C. The resistance between A and C is varied by moving the sliding contact.

- (a) A student decides to determine the resistivity of the material from which the wire is made by measuring the dimensions of the wire and its resistance.

Photograph 2 shows a section of the rheostat and a scale.



Photograph 2

- (i) Take measurements from the photograph and use them to show that the cross-sectional area of the wire is about $2 \times 10^{-7} \text{ m}^2$.

(3)

(ii) Calculate the resistivity of the material from which the wire is made.

resistance of wire = 22Ω

length of wire = 12 m

(3)

Resistivity =

(iii) Suggest an advantage for the student of using a photograph rather than taking direct measurements.

(1)

(b) The coil of the rheostat is 10.2 cm long. A potential difference of 12 V is applied across AB and the slider C is 7.0 cm from the end of the coil near A.

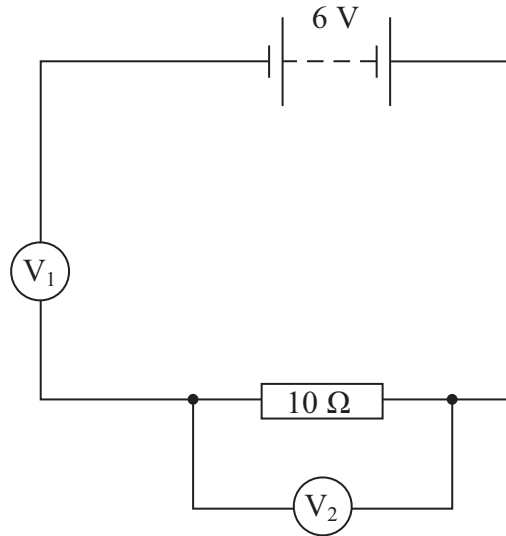
Calculate the potential difference across AC.

(2)

Potential difference =

(Total for Question = 9 marks)

6 The diagram shows a circuit set up by a student.



(a) Both voltmeters have a resistance of $10\text{ M}\Omega$. The reading on V_1 is 6 V and the reading on V_2 is zero.

Explain these readings.

(2)

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(b) The student replaces the $10\ \Omega$ resistor with a resistor of unknown resistance R . The reading on V_1 is now 4 V .

Calculate the value of R .

(3)

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.....

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R