1 An electric heater is to be made from nichrome wire. Nichrome has a resistivity of $1.0 \times 10^{-6}\,\Omega\,m$ at the operating temperature of the heater.
The heater is to have a power dissipation of 60 W when the potential difference across its terminals is 12 V.

(a) For the heater operating at its designed power,

(i) calculate the current,

current = ... A [2]

(ii) show that the resistance of the nichrome wire is 2.4 Ω.

(b) Calculate the length of nichrome wire of diameter 0.80 mm required for the heater.

length = ... m [3]

(c) A second heater, also designed to operate from a 12 V supply, is constructed using the same nichrome wire but using half the length of that calculated in **(b)**
Explain quantitatively the effect of this change in length of wire on the power of the heater.

....

....[3]

2 **(a)** **(i)** State what is meant by an *electric current*.

....

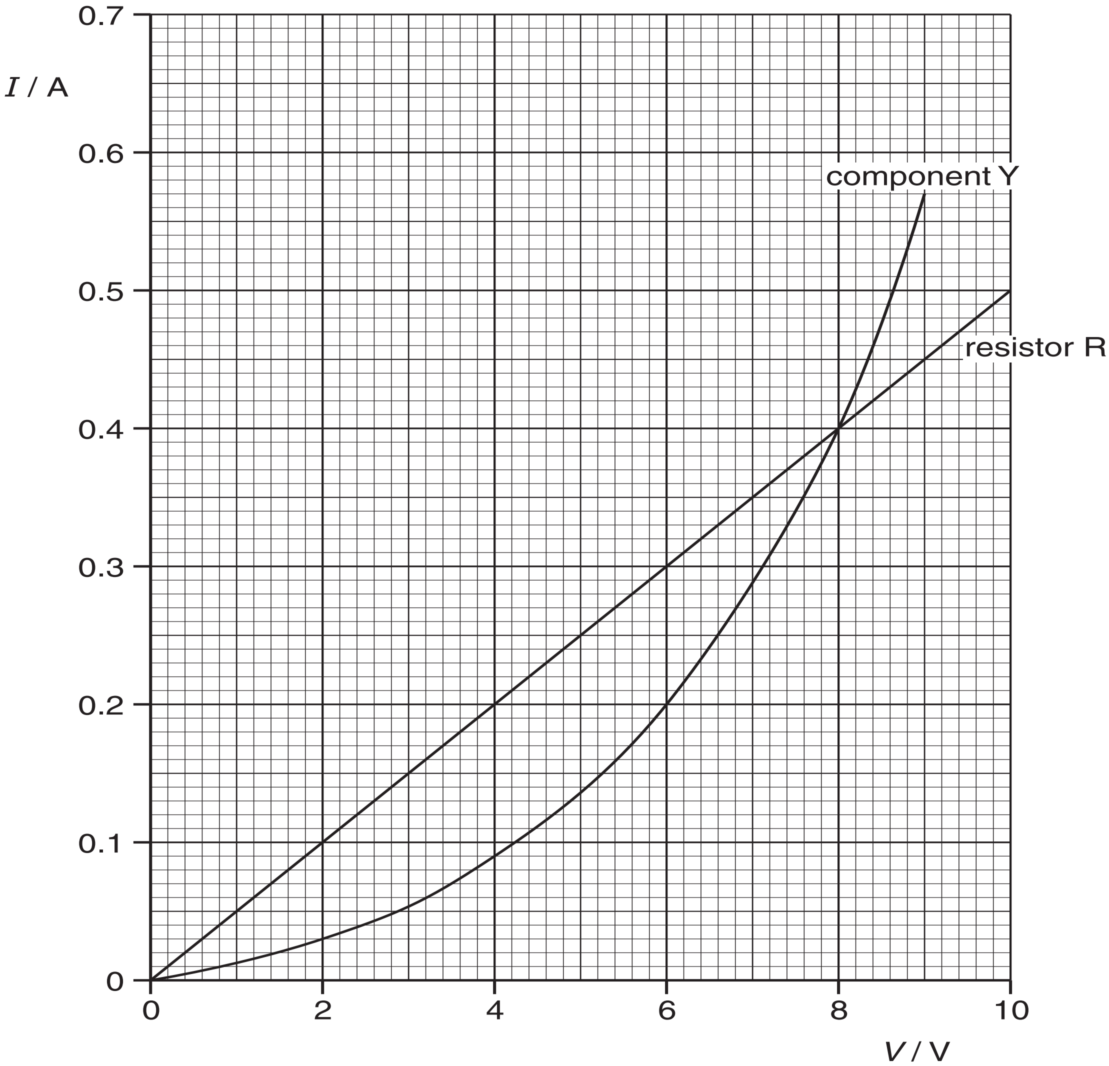
....[1]

(ii) Define *electric potential difference*.

....

....[1]

(b) The variation with potential difference V of the current I in a component Y and in a resistor R are shown in Fig. 6.1.



Use Fig. 6.1 to explain how it can be deduced that resistor R has a constant resistance of 20 Ω.

....[2]

(c) The component Y and the resistor R in **(b)** are connected in parallel as shown in Fig. 6.2.

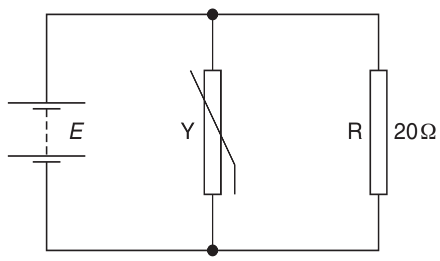


Fig. 6.2

A battery of e.m.f. E and negligible internal resistance is connected across the parallel combination.

Use data from Fig. 6.1 to determine

(i) the current in the battery for an e.m.f. E of 6.0 V,

current = ... A [1]

(ii) the total resistance of the circuit for an e.m.f. of 8.0 V.

resistance = ... Ω [2]

(d) The circuit of Fig. 6.2 is now re-arranged as shown in Fig. 6.3.

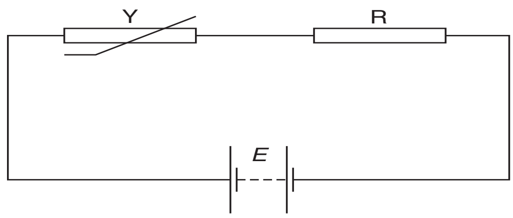


Fig. 6.3

The current in the circuit is 0.20 A.

(i) Use Fig. 6.1 to determine the e.m.f. E of the battery.

E = ... V [1]

(ii) Calculate the total power dissipated in component Y and resistor R.

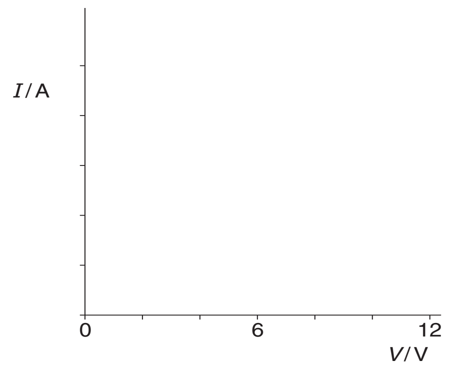
power = ... W [2]

3 **(a)** A lamp is rated as 12 V, 36 W.

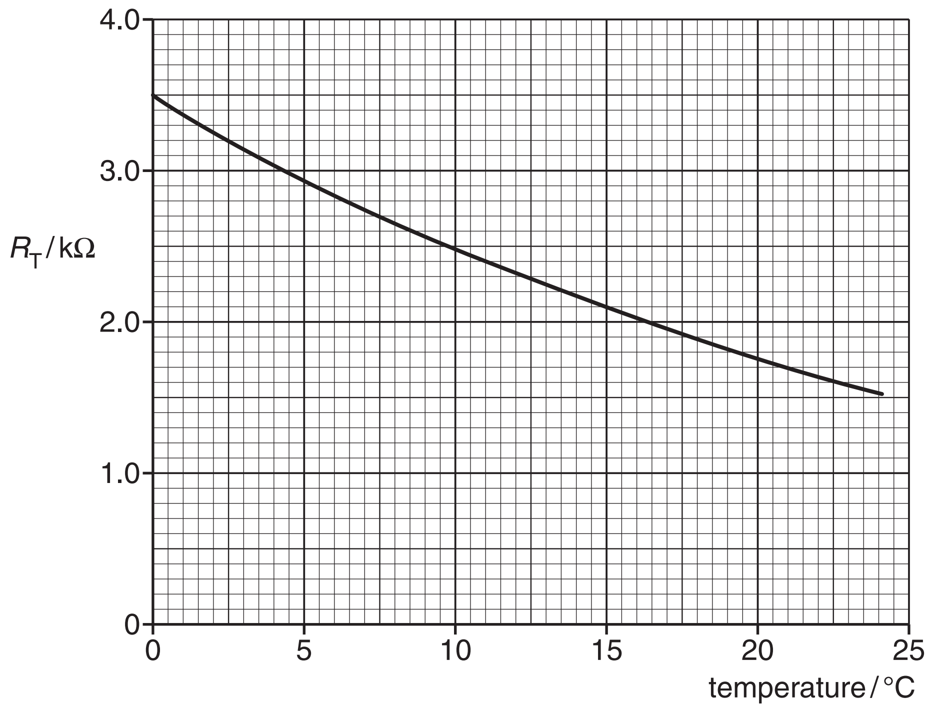
(i) Calculate the resistance of the lamp at its working temperature.

resistance = ... Ω [2]

(ii) On the axes of Fig. 6.1, sketch a graph to show the current-voltage (I–V) characteristic of the lamp. Mark an appropriate scale for current on the y-axis.



4 The variation with temperature of the resistance R_T of a thermistor is shown in Fig. 6.1.



The thermistor is connected into the circuit of Fig. 6.2.

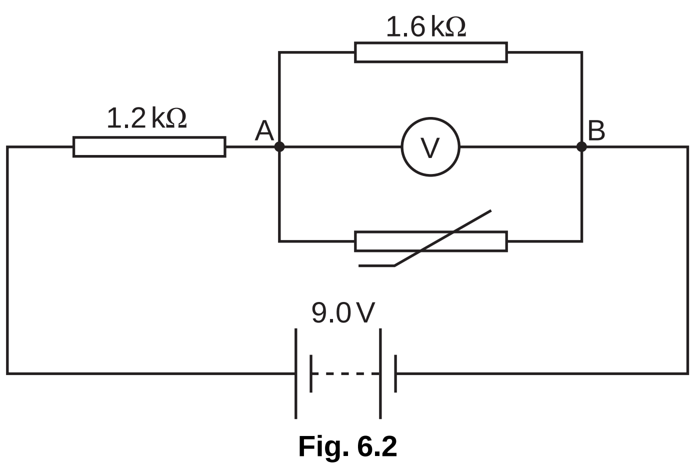


Fig. 6.2

The battery has e.m.f. 9.0 V and negligible internal resistance. The voltmeter has infinite resistance.

(a) For the thermistor at 22.5 °C, calculate

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the reading on the voltmeter.

voltmeter reading = ...V [2]

(b) The temperature of the thermistor is changed. The voltmeter now reads 4.0 V. Determine

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the temperature of the thermistor.

temperature = ... °C [2]

(c) A student suggests that the voltmeter, reading up to 10 V, could be calibrated to measure temperature.

Suggest two disadvantages of using the circuit of Fig. 6.2 with this voltmeter for the measurement of temperature in the range 0 °C to 25 °C.

1. ....

....

2. ....

....

....

[2]

5 **(a)** Define the *ohm*.

.... [1]

(b) Determine the SI base units of **resistivity**.

base units of resistivity = ... [3]

(c) A cell of e.m.f. 2.0V and negligible internal resistance is connected to a variable resistor R and a metal wire, as shown in Fig. 5.1.

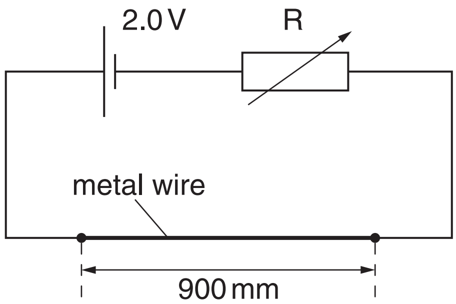


Fig. 5.1

The wire is 900mm long and has an area of cross-section of $1.3 \times 10^{-7}\,m^2$. The resistance of the wire is $3.4\,\Omega$.

Calculate the resistivity of the metal wire.

resistivity = ... [2]

6 Three cells of electromotive forces (e.m.f.) E_1, E_2 and E_3 are connected into a circuit, as shown in Fig. 6.1.

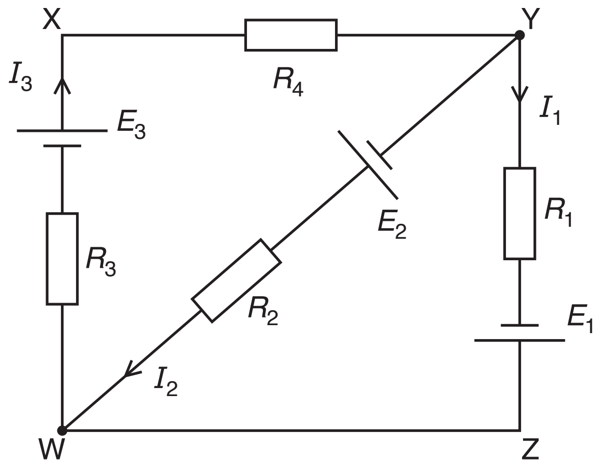


Fig. 6.1

The circuit contains resistors of resistances R_1, R_2, R_3 and R_4.
The currents in the different parts of the circuit are I_1, I_2 and I_3.
The cells have negligible internal resistance.

Use Kirchhoff's laws to state an equation relating

(a) I_1, I_2 and I_3,

....[1]

(b) E_1, E_3, R_1, R_3, R_4, I_1 and I_3 in loop WXYZW,

....

....[1]

(c) E_1, E_2, R_1, R_2, I_1 and I_2 in loop YZWY.

....

....[1]

[Total: 3]

7 **(a)** **(i)** State Kirchhoff's second law.

....

.... [1]

(ii) Kirchhoff's second law is linked to the conservation of a certain quantity. State this quantity.

.... [1]

(b) The circuit shown in Fig. 7.1 is used to compare potential differences.

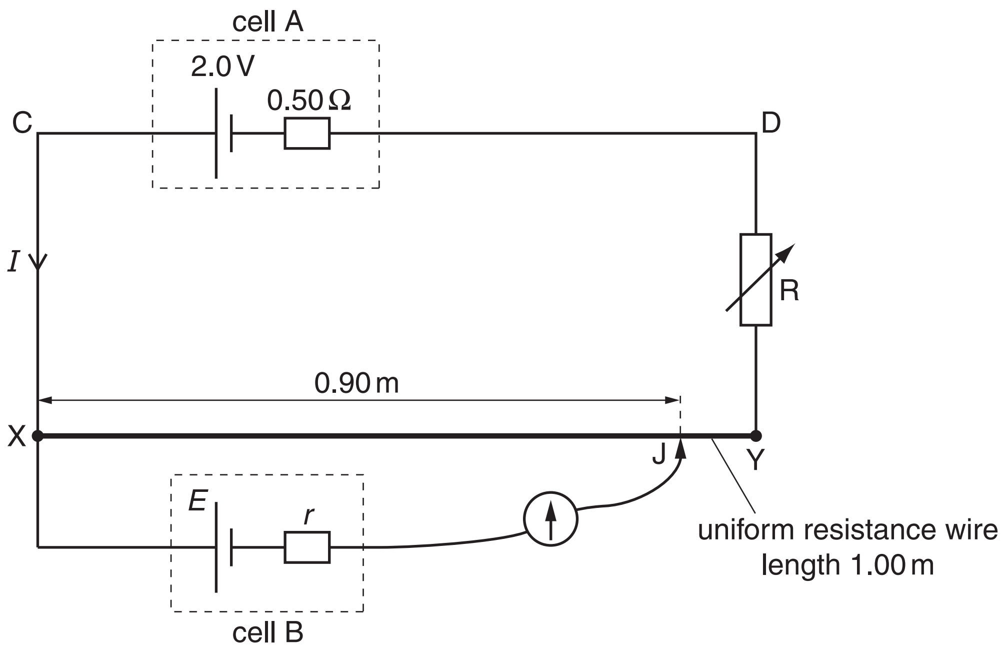


Fig. 7.1

The uniform resistance wire XY has length 1.00 m and resistance 4.0 Ω. Cell A has e.m.f. 2.0 V and internal resistance 0.50 Ω. The current through cell A is I. Cell B has e.m.f. E and internal resistance r.

The current through cell B is made zero when the movable connection J is adjusted so that the length of XJ is 0.90 m. The variable resistor R has resistance 2.5 Ω.

(i) Apply Kirchhoff's second law to the circuit CXYDC to determine the current I.

I = ... A [2]

(ii) Calculate the potential difference across the length of wire XJ.

potential difference = ... V [1]

(iii) Use your answer in **(ii)** to state the value of *E*.

E = ... V [1]

(iv) State why the value of the internal resistance of cell B is not required for the determination of *E*.

....

....[1]

[Total: 7]