1)

(a) Fig. 2.1 shows combinations of resistors connected to a power supply of e.m.f. E.

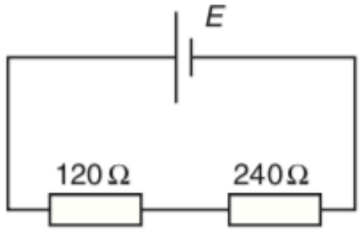


Fig. 2.1a

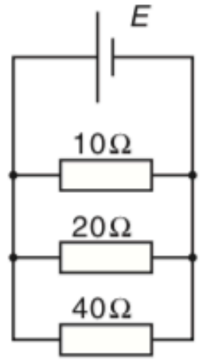


Fig. 2.1b

(i) For the circuit of Fig. 2.1a

1 calculate the total resistance R_s

R_s = ... Ω **[1]**

2 state one electrical quantity which is the same for both resistors.

.... **[1]**

(ii) For the circuit of Fig. 2.1b

1 calculate the total resistance R_p

R_p = ... Ω **[2]**

2 state one electrical quantity which is the same for all the resistors.

.... **[1]**

(b) Fig. 2.2 shows the I–V characteristics of two electrical components, a resistor, line **R** and a thermistor, line **T**.

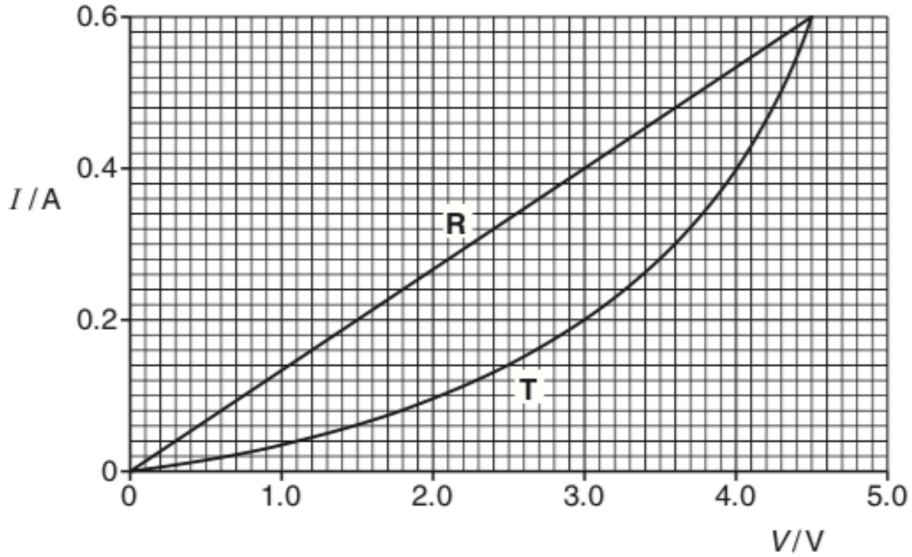


Fig. 2.2

(i) State Ohm's law. Use Fig. 2.2 to explain why component **R** obeys Ohm's law.

....

....

....

....

.... **[3]**

(ii) The resistor and the thermistor can be connected to a variable voltage supply of negligible internal resistance in two ways as shown in Fig. 2.3a and Fig. 2.3b.

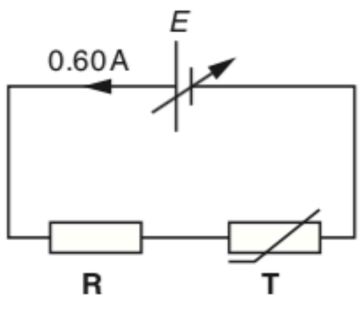


Fig. 2.3a

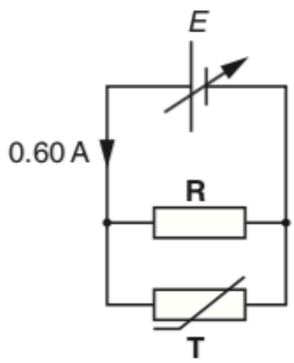


Fig. 2.3b

The voltage of the supply is varied in each circuit until the current drawn from it is 0.60 A. Use data from Fig. 2.2 to explain why the e.m.f. *E* of the supply is

1 9.0V in Fig. 2.3a

....

....

.... **[2]**

2 3.0V in Fig. 2.3b.

....

....

....

.... **[2]**

(iii) The thermistor is now connected on its own across the terminals of the supply set at 4.5V. Fig. 2.4 shows the variation of current *I* with time *t* from the moment the thermistor is connected to the supply.

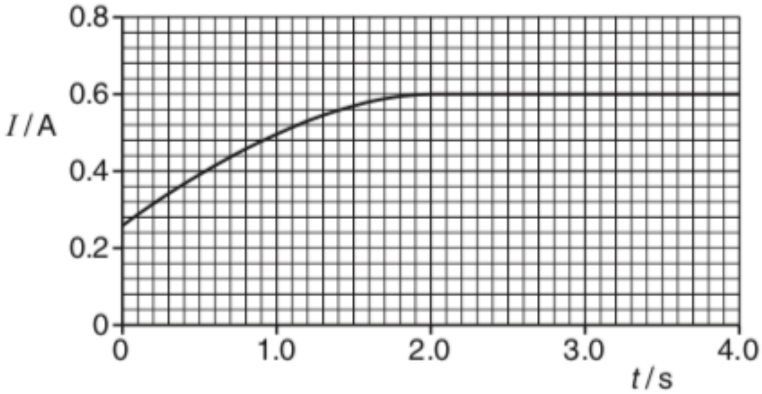


Fig. 2.4

Explain the shape of the graph in Fig. 2.4.

....

....

....

....

....

....

....

....

.... **[3]**

[Total: 15]

2)

(a) The following electrical quantities are often used when analysing circuits. Draw a straight line from each quantity on the left-hand side to its correct units on the right-hand side.

potential difference	$C\,s^{-1}$
resistance	$J\,C^{-1}$
power	$V\,A^{-1}$
current	$J\,s^{-1}$

[3]

(b) Fig. 3.1 shows a battery of e.m.f. 6.0V and negligible internal resistance connected in series with a thermistor and a 560 Ω resistor.

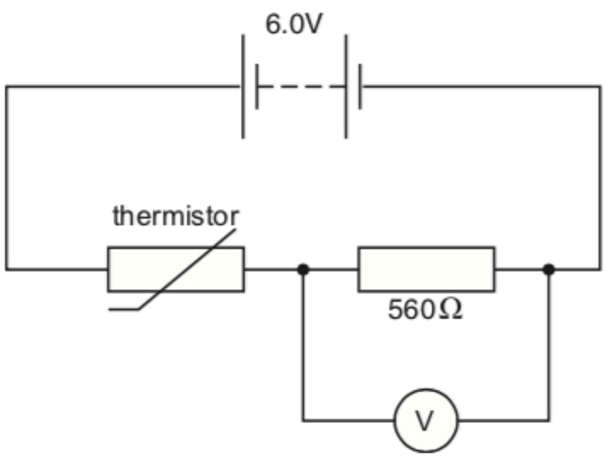


Fig. 3.1

The voltmeter across the resistor has infinite resistance.

(i) The reading on the voltmeter is 2.4 V. Calculate the resistance R_T of the thermistor.

R_T = ... Ω **[3]**

(ii) Calculate the current in the circuit.

current = ... A **[1]**

(c) The variation of resistance with temperature for this thermistor is shown in the graph of Fig. 3.2.

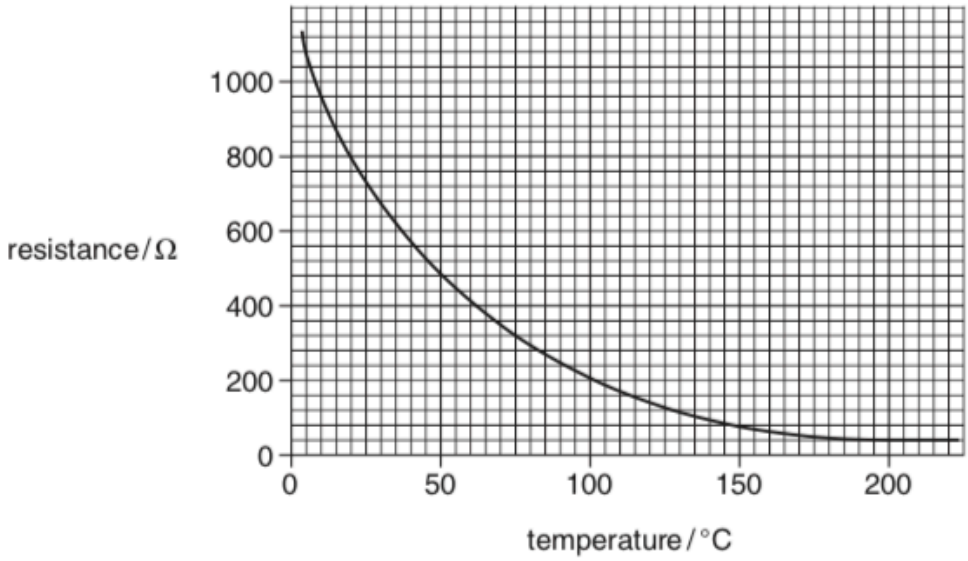


Fig. 3.2

(i) Use the graph to determine the temperature of the thermistor when its resistance is 800 Ω.

temperature = ... °C **[1]**

(ii) State and explain, without calculation, how the reading of the voltmeter in Fig. 3.1 will change as the temperature of the thermistor increases to 80 °C.

....

....

....

....

.... **[3]**

(iii) The circuit of Fig. 3.1 can be used as a temperature sensor. Temperature sensors are used in the kitchen to control the internal temperatures of ovens (typically 200 °C) and refrigerators (typically 4 °C). Use the graph of Fig. 3.2 to suggest in which device this sensor would be more suitable.

In your answer you should link the information from the graph to the working of the sensor.

....

....

....

....

.... **[3]**

[Total: 14]

3)

Fig. 4.1 shows part of a circuit where three resistors are connected together.

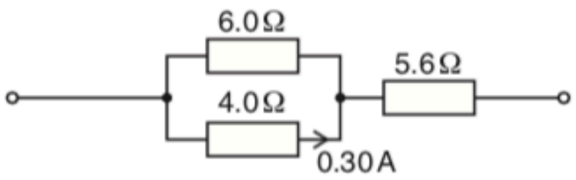


Fig. 4.1

The current in the 4.0Ω resistor is 0.30A.

(a) Explain why the current in the 6.0Ω resistor is 0.20A.

....

....

....

....

.... **[2]**

(b) **(i)** State the law which enables you to calculate the current in the 5.6Ω resistor.

....

.... **[1]**

(ii) Calculate the current in the 5.6Ω resistor.

current = ... A **[1]**

(c) Calculate the total resistance *R* of the combination of resistors.

R = ... Ω **[3]**

4)

(a) Kirchhoff's laws can be used to analyse any electrical circuit. State each of Kirchhoff's laws and the physical quantity associated with each law that is conserved in the circuit.

(i) Kirchhoff's first law

....

....

....

....

.... **[2]**

(ii) Kirchhoff's second law

....

....

....

....

.... **[2]**

(b) The circuit in Fig. 3.1 consists of a battery of e.m.f. 45 V and negligible internal resistance and three resistors.

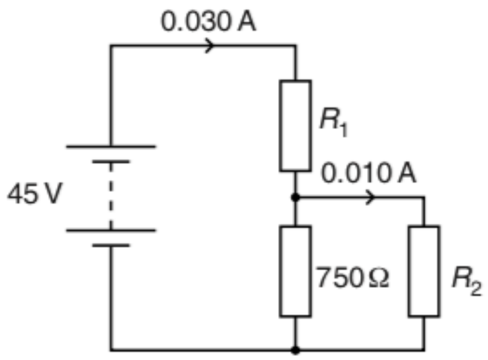


Fig. 3.1

The resistors have resistances R_1, R_2 and 750 Ω. The current in the resistor of resistance R_1 is 0.030 A. The current in the resistor of resistance R_2 is 0.010 A.

Calculate

(i) the current I in the 750 Ω resistor

I = ... A **[1]**

(ii) the p.d. V across the 750 Ω resistor

V = ...V **[1]**

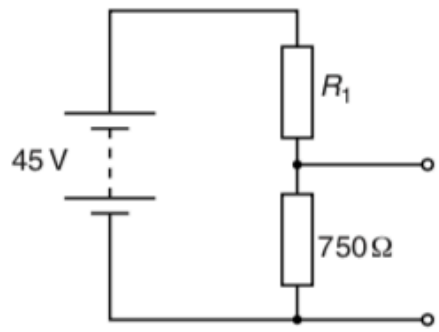
(iii) the resistances R_1 and R_2.

R_1 = ... Ω

R_2 = ... Ω
[2]

(c) The resistor of resistance R_2 is replaced in Fig. 3.1 by a light dependent resistor (LDR).

(i) Draw the circuit symbol for an LDR on Fig. 3.2 to complete this new circuit.



[1]

Fig. 3.2

(ii) The resistance of the LDR falls from about 1.5 kΩ to about 400 Ω as the light intensity increases. State and explain, without calculation, how the potential difference across the 750 Ω resistor varies as the intensity of the light incident on the LDR increases.

....

....

....

....

....

....

....

.... **[3]**

(iii) It is suggested that the LDR in the circuit of Fig. 3.2 is used to monitor changes in the light intensity.

1 Draw a suitable electrical meter in the LDR branch of the circuit on Fig. 3.2 to measure these changes.

2 State the electrical meter that you have chosen and suggest a sensible maximum scale reading.

....

....

....

[3]

[Total: 15]

5)

This question is about the use of a thermistor fitted inside a domestic oven as a temperature sensor in a potential divider circuit.

Fig. 2.1 shows the potential divider circuit in which the component $\mathbf{R_2}$ is connected in parallel to the input of an electronic circuit that switches the mains supply to the heating element in the oven on or off.

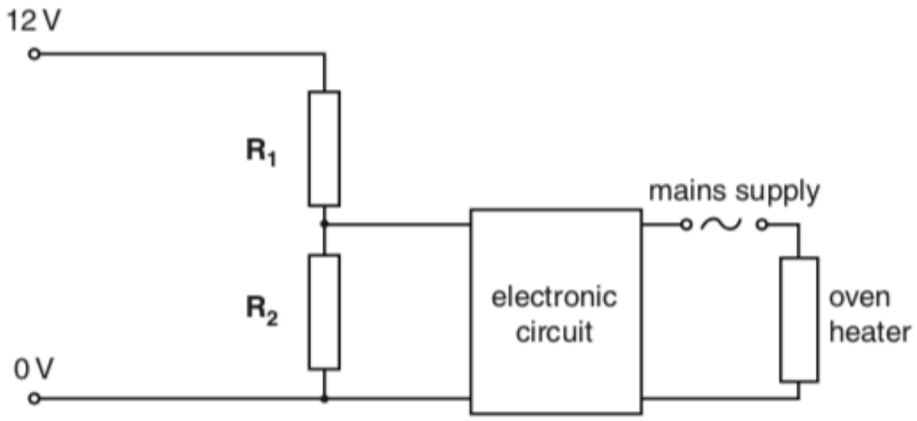


Fig. 2.1

(a) $\mathbf{R_1}$ is a variable resistor and $\mathbf{R_2}$ is the thermistor. The circuit symbols for $\mathbf{R_1}$ and $\mathbf{R_2}$ are incomplete. Complete these circuit symbols on Fig. 2.1. **[2]**

(b) It is required that the p.d. across the thermistor $\mathbf{R_2}$ is 7.0 V when at a temperature of 180 °C. The variation of resistance with temperature for $\mathbf{R_2}$ is shown in Fig. 2.2.

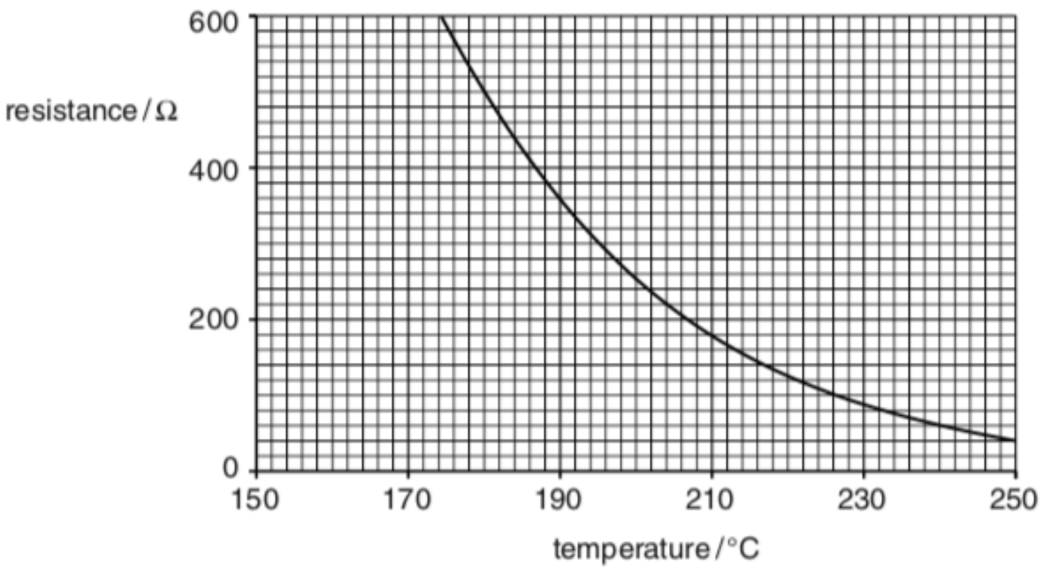


Fig. 2.2

(i) Use Fig. 2.2 to determine the resistance of $\mathbf{R_2}$ at a temperature of 180 °C.

resistance = ... Ω **[1]**

(ii) When the temperature is 180 °C the p.d. across $\mathbf{R_2}$ is 7.0 V. Calculate the current in $\mathbf{R_2}$.

current = ... A **[1]**

(iii) The electronic circuit draws a negligible current. Show that the resistance of the variable resistor $\mathbf{R_1}$ must be about 350 Ω.

[2]

(iv) $\mathbf{R_2}$ is heated slowly. Show that the p.d. across $\mathbf{R_2}$ must fall to about 5.0 V when the temperature of $\mathbf{R_2}$ reaches 200 °C.

[2]

(c) The thermistor $\mathbf{R_2}$ is fitted inside the oven. When the p.d. across $\mathbf{R_2}$ falls to 5.0 V the oven heater switches off. The oven cools until the p.d. across $\mathbf{R_2}$ rises to 7.0 V when the heater switches on again.

$\mathbf{R_1}$ is adjusted to 250 Ω. Calculate the temperatures at which the oven heater is switched on and off.

temperature on .... °C

temperature off .... °C **[4]**

6)

This question is about the use of a light-dependent resistor (LDR) as a light sensor in a potential divider circuit. Fig. 3.1 shows how the resistance of a particular LDR varies with light intensity.

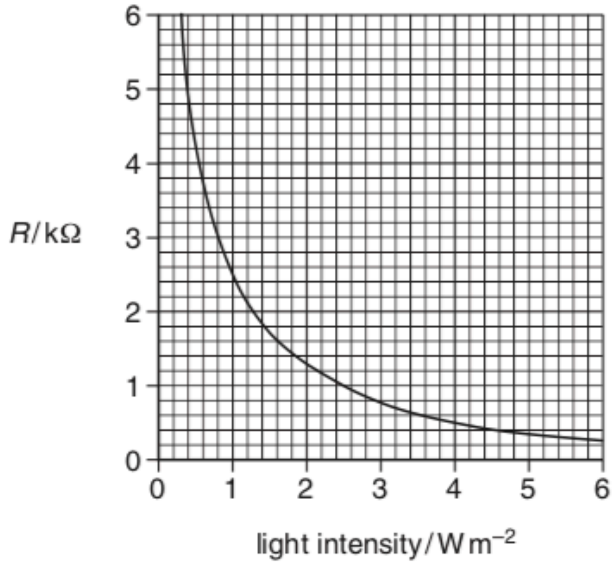


Fig. 3.1

(a) Explain the term *intensity*.

....

.... **[1]**

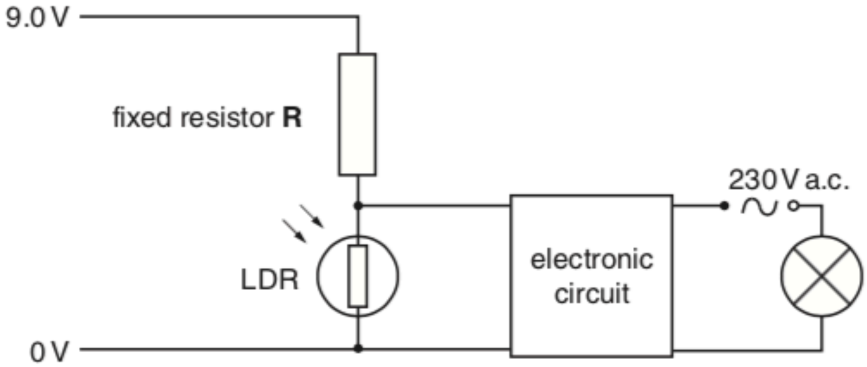
(b) The intensity of daylight is about 10 W m^{-2} and at night time is about 0.1 W m^{-2}. Describe how the resistance of the LDR changes during the day compared with how it changes at night.

....

....

.... **[2]**

(c) Fig. 3.2 shows a light-sensing potential divider circuit where the LDR is connected in parallel to the input of an electronic circuit that operates a 230 V mains lamp.



The electronic circuit draws a negligible current. The potential difference across the LDR must be at least 5.0V to activate the circuit and switch on the lamp. The lamp is switched on when the light intensity falls to $1.0\,W\,m^{-2}$.

(i) Use Fig. 3.1 to determine the resistance of the LDR at a light intensity of $1.0\,W\,m^{-2}$.

resistance = ... kΩ **[1]**

(ii) Calculate the current in the LDR in Fig. 3.2 for the p.d. across it to be 5.0V.

current = ... A **[2]**

(iii) Show that the resistance of the fixed resistor **R** in Fig. 3.2 is 2.0 kΩ.

[1]

(d) The lamp switches off when the light intensity reaches $2.5\,W\,m^{-2}$. Calculate the p.d. across the LDR when this happens.

potential difference = ... V **[3]**

(e) Explain why the LDR must be shielded or be at some distance from the lamp when it switches on.

....

....

....

.... **[2]**

[Total: 12]

7)

(a) The following electrical quantities are often used when analysing circuits. Draw a straight line from each quantity on the left-hand side to its correct units on the right-hand side.

potential difference	$C\,s^{-1}$
resistance	$J\,C^{-1}$
power	$V\,A^{-1}$
current	$J\,s^{-1}$

[3]

(b) Fig. 3.1 shows a battery of e.m.f. 6.0V and negligible internal resistance connected in series with a thermistor and a 560 Ω resistor.

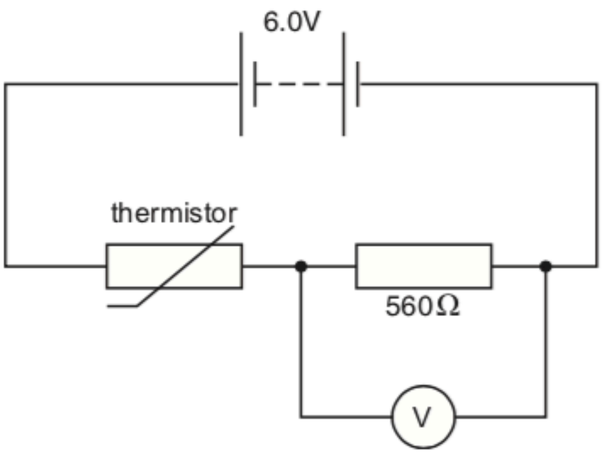


Fig. 3.1

The voltmeter across the resistor has infinite resistance.

(i) The reading on the voltmeter is 2.4 V. Calculate the resistance R_T of the thermistor.

R_T = ... Ω **[3]**

(ii) Calculate the current in the circuit.

current = ... A **[1]**

(c) The variation of resistance with temperature for this thermistor is shown in the graph of Fig. 3.2.

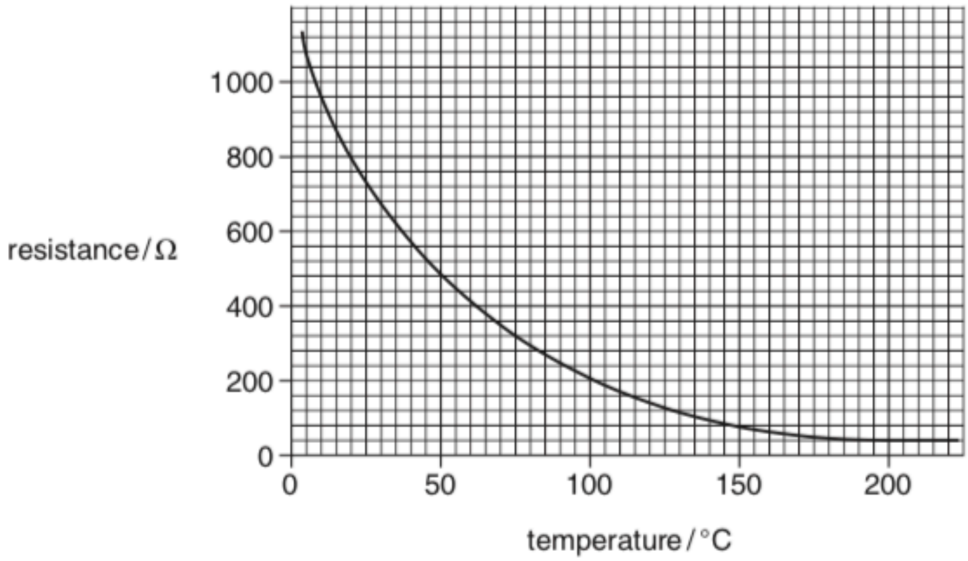


Fig. 3.2

(i) Use the graph to determine the temperature of the thermistor when its resistance is 800 Ω.

temperature = ... °C **[1]**

(ii) State and explain, without calculation, how the reading of the voltmeter in Fig. 3.1 will change as the temperature of the thermistor increases to 80 °C.

....

....

....

....

.... **[3]**

(iii) The circuit of Fig. 3.1 can be used as a temperature sensor. Temperature sensors are used in the kitchen to control the internal temperatures of ovens (typically 200 °C) and refrigerators (typically 4 °C). Use the graph of Fig. 3.2 to suggest in which device this sensor would be more suitable.

In your answer you should link the information from the graph to the working of the sensor.

....

....

....

....

.... **[3]**

[Total: 14]