1 **(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.

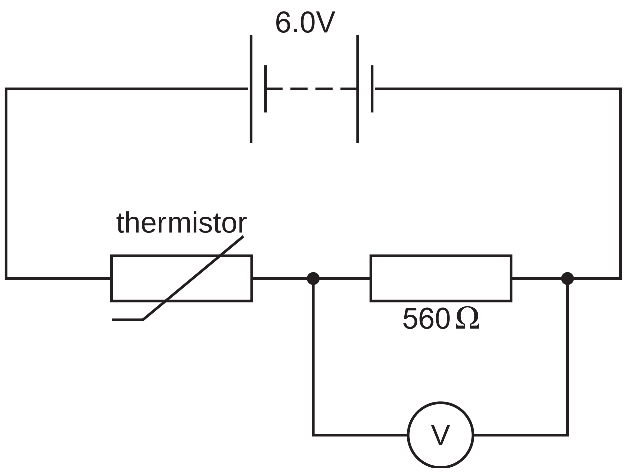

Fig. 3.1

The voltmeter across the resistor has infinite resistance.

(i) The reading on the voltmeter is 2.4V. 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.

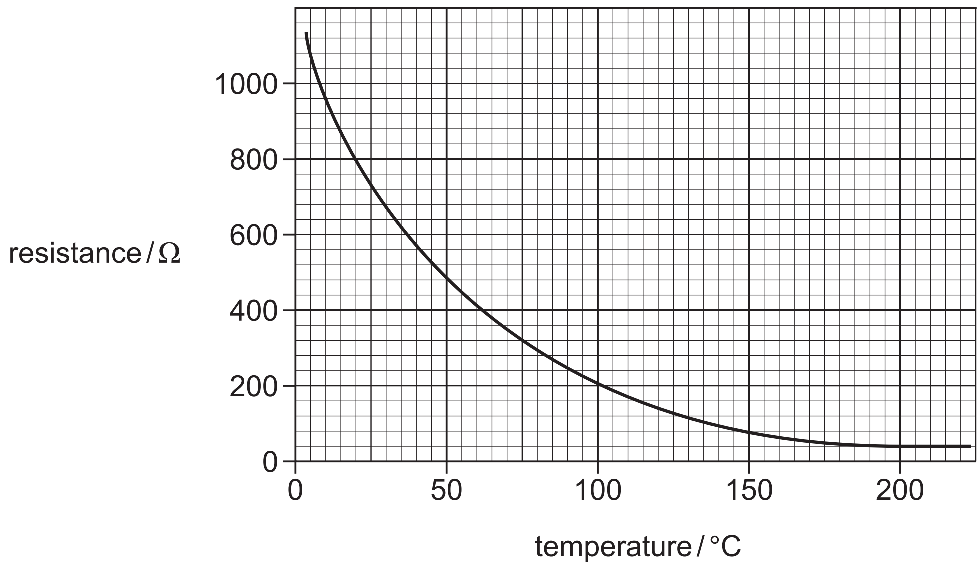

Fig. 3.2

(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]

2 **(a)** Define the *resistivity* ρ of a metal wire.

....

....

.... **[2]**

(b) In the UK the National Grid is used to transmit electric power. Each pylon supports 24 cables. See Fig. 2.1. Each cable consists of 38 strands of aluminium. See Fig. 2.2.

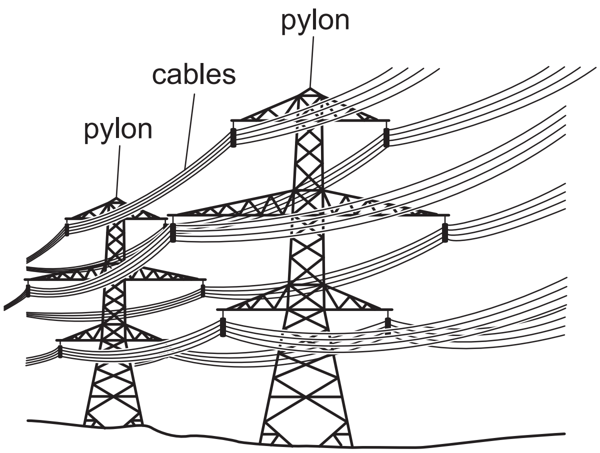

Fig. 2.1

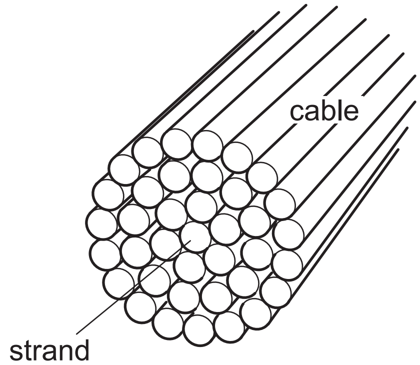

Fig. 2.2

(i) The resistance per km of a cable is 0.052 $\Omega\ \text{km}^{-1}$. Explain why the resistance per km of a single strand is approximately 2.0 $\Omega\ \text{km}^{-1}$.

....

....

.... **[2]**

(ii) The resistivity of aluminium is 2.6 x 10^{-8} Ω m. Calculate the cross-sectional area *A* of a single strand of the cable.

A = …………………..m^2 **[2]**

(c) The input voltage to each cable in Fig. 2.1 is 400 kV. The cable carries a current of 440 A. Calculate

(i) the input power to one cable

input power = ... W **[2]**

(ii) the number of cables required to transmit the power from a 2000 MW power station

number of cables = ...**[1]**

(iii) the power lost as heat per km of cable

lost power = ...**[3]**

(iv) the percentage of the input power that is available at a distance of 100 km from the power station.

percentage of power =...............................% **[2]**

[Total: 14]

3 Fig. 3.1 shows a circuit containing a battery of e.m.f. 12V, two resistors, a light-dependent resistor (LDR), an ammeter and a switch **S**. The battery has negligible internal resistance.

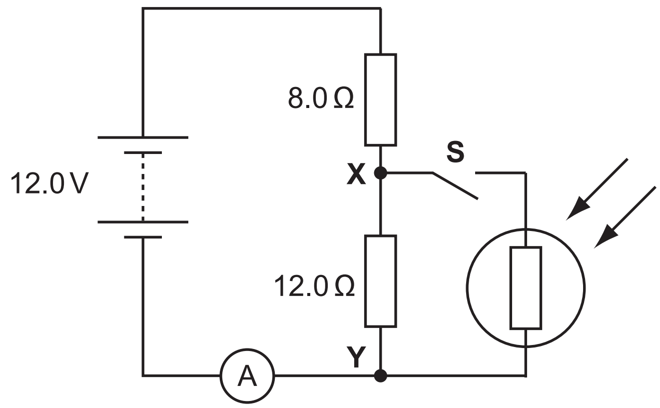

Fig. 3.1

(a) When the switch **S** is open, show that the potential difference between the points **X** and **Y** is 7.2V.

[2]

(b) The switch **S** is now closed. Describe and explain the change to each of the following when the intensity of light falling on the LDR is increased:

(i) the ammeter reading

....

....

.... **[2]**

(ii) the potential difference across **XY**.

....

....

.... **[2]**

[Total: 6]

4 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.

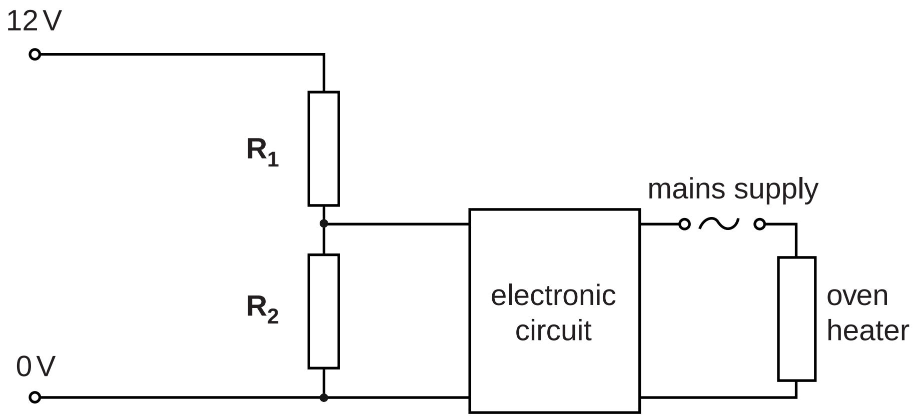

Fig. 2.1

(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.

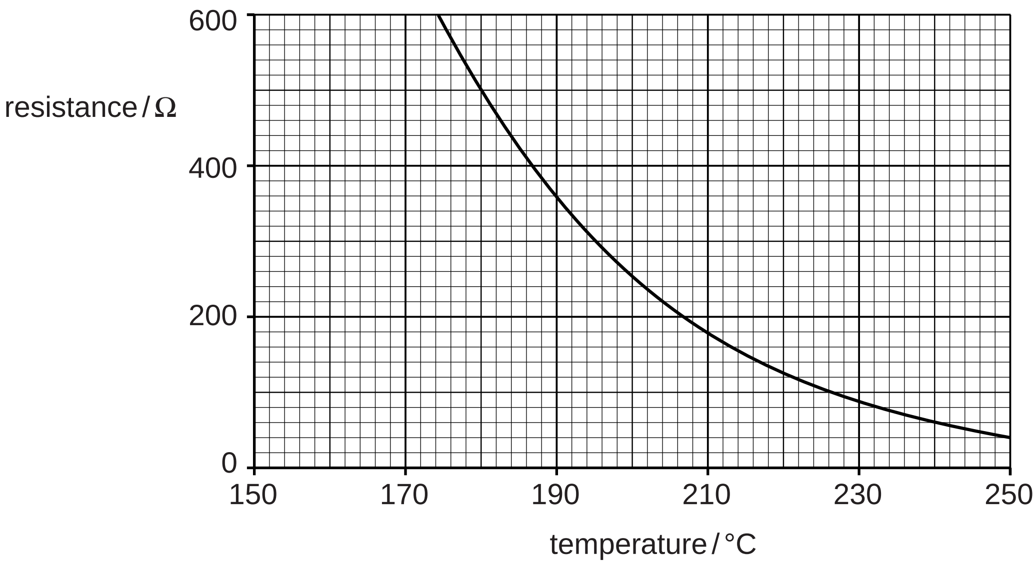

Fig. 2.2

(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]**