6 A straight wire of unstretched length L has an electrical resistance R. When it is stretched by a force F, the wire extends by an amount ΔL and the resistance increases by ΔR. The area of cross-section A of the wire may be assumed to remain constant.

For Examiner's Use

(a) (i) State the relation between R, L, A and the resistivity ρ of the material of the wire.

.....

..... [1]

(ii) Show that the fractional change in resistance $\frac{\Delta R}{R}$ is equal to the strain in the wire.

[2]

(b) A steel wire has area of cross-section $1.20 \times 10^{-7}\,\text{m}^2$ and a resistance of $4.17\,\Omega$.

The Young modulus of steel is $2.10 \times 10^{11}\,\text{Pa}$.

The tension in the wire is increased from zero to 72.0 N. The wire obeys Hooke's law at these values of tension.

Determine the strain in the wire and hence its change in resistance. Express your answer to an appropriate number of significant figures.

change = ... Ω [5]

7 **(a)** Distinguish between the electromotive force (e.m.f.) of a cell and the potential difference (p.d.) across a resistor.

.....

.....

.....

..... [3]

(b) Fig. 7.1. is an electrical circuit containing two cells of e.m.f. E_1 and E_2.

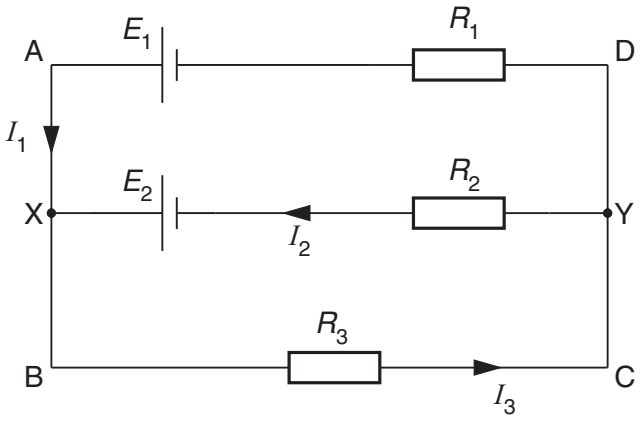

Fig. 7.1

The cells are connected to resistors of resistance R_1, R_2 and R_3 and the currents in the branches of the circuit are I_1, I_2 and I_3, as shown.

(i) Use Kirchhoff's first law to write down an expression relating I_1, I_2 and I_3.

..... [1]

(ii) Use Kirchhoff's second law to write down an expression relating

1. E_2, R_2, R_3, I_2 and I_3 in the loop XBCYX,

..... [1]

2. E_1, E_2, R_1, R_2, I_1 and I_2 in the loop AXYDA.

..... [1]

7 A circuit contains three similar lamps A, B and C. The circuit also contains three switches, S_1, S_2 and S_3, as shown in Fig. 7.1.

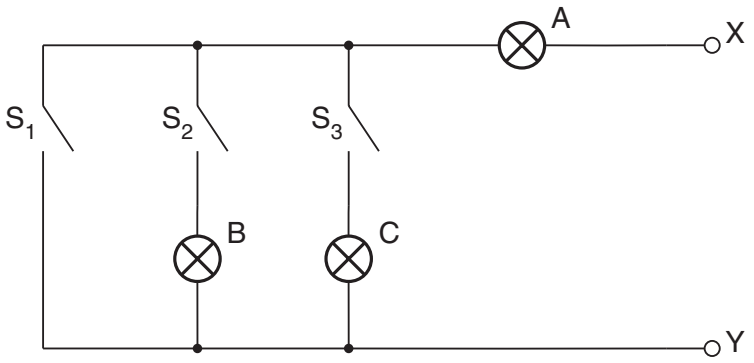

Fig. 7.1

One of the lamps is faulty. In order to detect the fault, an ohm-meter (a meter that measures resistance) is connected between terminals X and Y. When measuring resistance, the ohm-meter causes negligible current in the circuit.

Fig. 7.2 shows the readings of the ohm-meter for different switch positions.

switch			meter reading
S_1	S_2	S_3	/ Ω
open	open	open	∞
closed	open	open	15 Ω
open	closed	open	30 Ω
open	closed	closed	15 Ω

Fig. 7.2

(a) Identify the faulty lamp, and the nature of the fault.

faulty lamp: .....

nature of fault: ..... [2]

(b) Suggest why it is advisable to test the circuit using an ohm-meter that causes negligible current rather than with a power supply.

.....

..... [1]

(c) Determine the resistance of one of the non-faulty lamps, as measured using the ohm-meter.

resistance = ... Ω [1]

(d) Each lamp is marked 6.0 V, 0.20 A.

Calculate, for one of the lamps operating at normal brightness,

(i) its resistance,

resistance = ... Ω [2]

(ii) its power dissipation.

power = ... W [2]

(e) Comment on your answers to **(c)** and **(d)(i)**.

.....

.....

.....[2]

7 A battery of e.m.f. 4.50 V and negligible internal resistance is connected in series with a fixed resistor of resistance 1200 Ω and a thermistor, as shown in Fig. 7.1.

For Examiner's Use

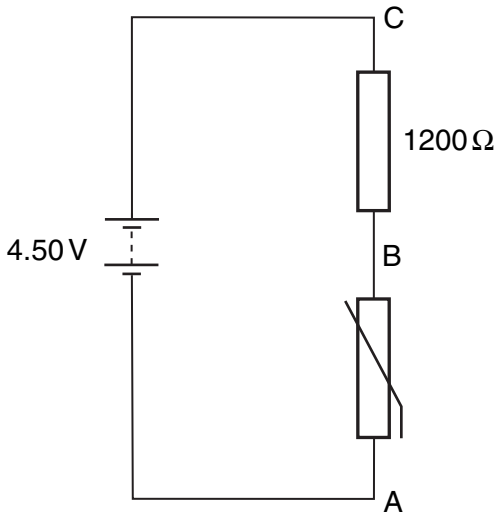

Fig. 7.1

(a) At room temperature, the thermistor has a resistance of 1800 Ω. Deduce that the potential difference across the thermistor (across AB) is 2.70 V.

[2]

(b) A uniform resistance wire PQ of length 1.00 m is now connected in parallel with the resistor and the thermistor, as shown in Fig. 7.2.

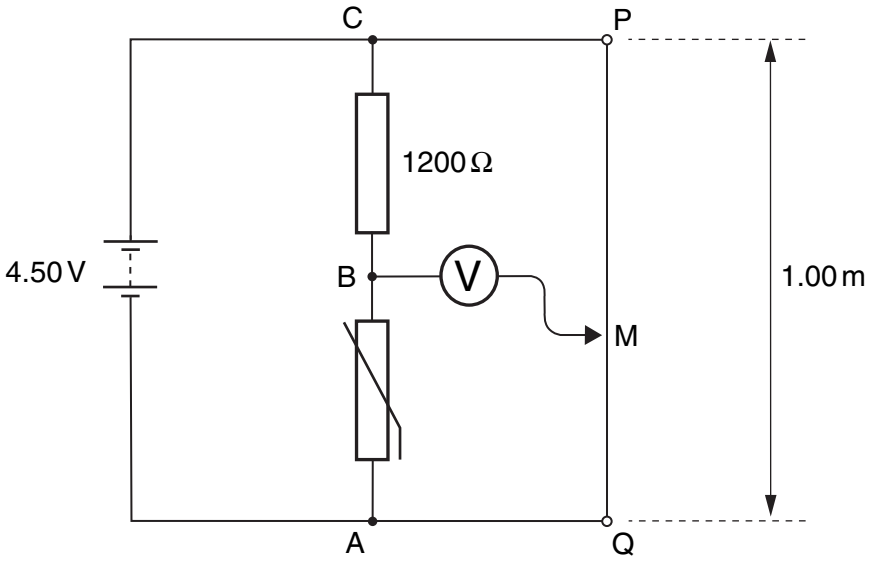

Fig. 7.2

A sensitive voltmeter is connected between point B and a moveable contact M on the wire.

For Examiner's Use

(i) Explain why, for constant current in the wire, the potential difference between any two points on the wire is proportional to the distance between the points.

.....

.....

.....[2]

(ii) The contact M is moved along PQ until the voltmeter shows zero reading.

1. State the potential difference between the contact at M and the point Q.

potential difference = ……. V [1]

2. Calculate the length of wire between M and Q.

length = …….. cm [2]

(iii) The thermistor is warmed slightly. State and explain the effect on the length of wire between M and Q for the voltmeter to remain at zero deflection.

.....

.....

.....[2]

[Turn over

7 **(a)** Define the *resistance* of a resistor.

For Examiner's Use

.....

.....[1]

(b) In the circuit of Fig. 7.1, the battery has an e.m.f. of 3.00 V and an internal resistance *r*. R is a variable resistor. The resistance of the ammeter is negligible and the voltmeter has an infinite resistance.

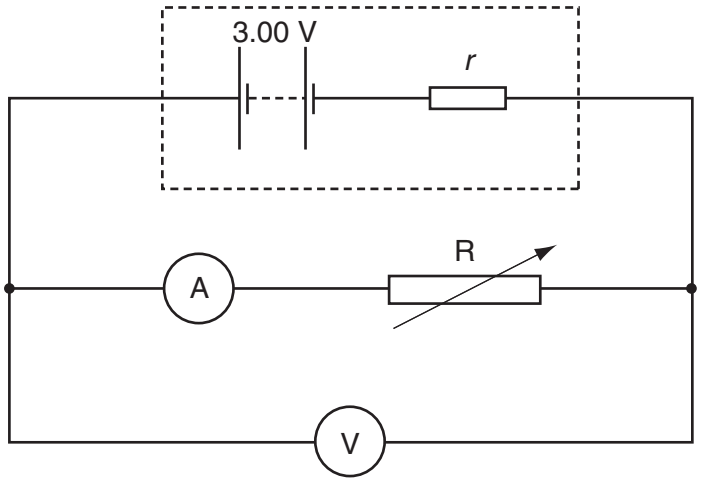

Fig. 7.1

The resistance of R is varied. Fig. 7.2 shows the variation of the power *P* dissipated in R with the potential difference *V* across R.

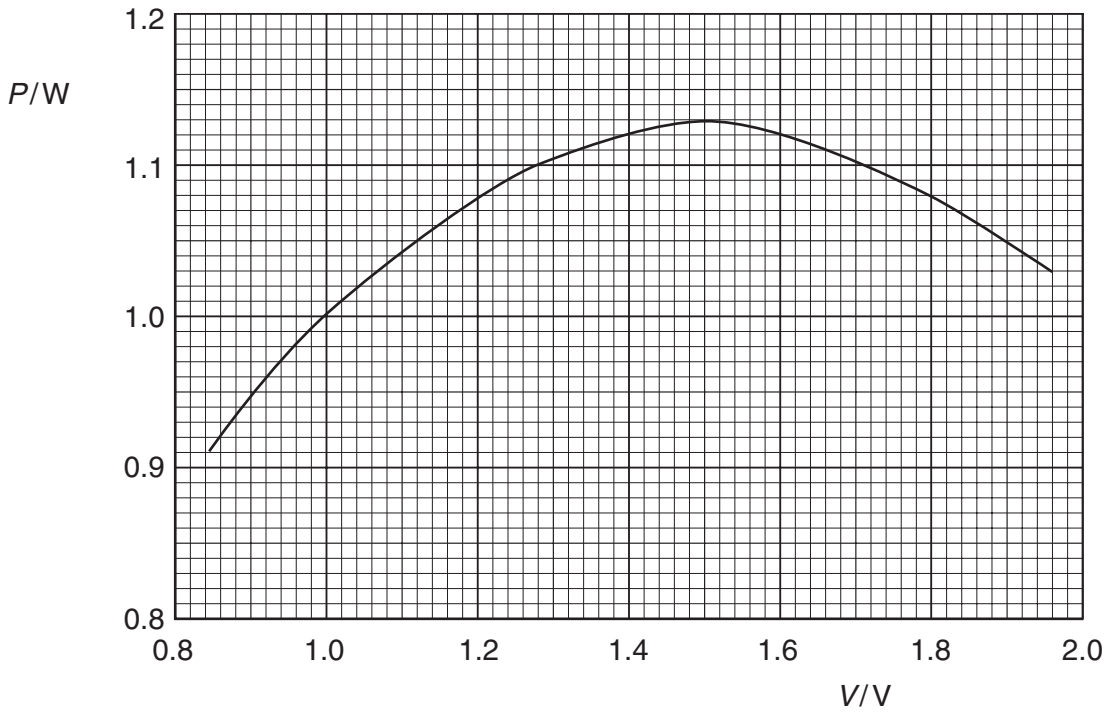

Fig. 7.2

(i) Use Fig. 7.2 to determine

1. the maximum power dissipation in R,

maximum power = ... W

2. the potential difference across R when the maximum power is dissipated.

potential difference = ... V
[1]

(ii) Hence calculate the resistance of R when the maximum power is dissipated.

resistance = ... Ω [2]

(iii) Use your answers in **(i)** and **(ii)** to determine the internal resistance *r* of the battery.

r = ... Ω [3]

(c) By reference to Fig. 7.2, it can be seen that there are two values of potential difference *V* for which the power dissipation is 1.05 W.
State, with a reason, which value of *V* will result in less power being dissipated in the internal resistance.

.....

.....

.....

.....[3]

6 Fig. 6.1 shows the variation with applied potential difference V of the current I in an electrical component C.

For Examiner's Use

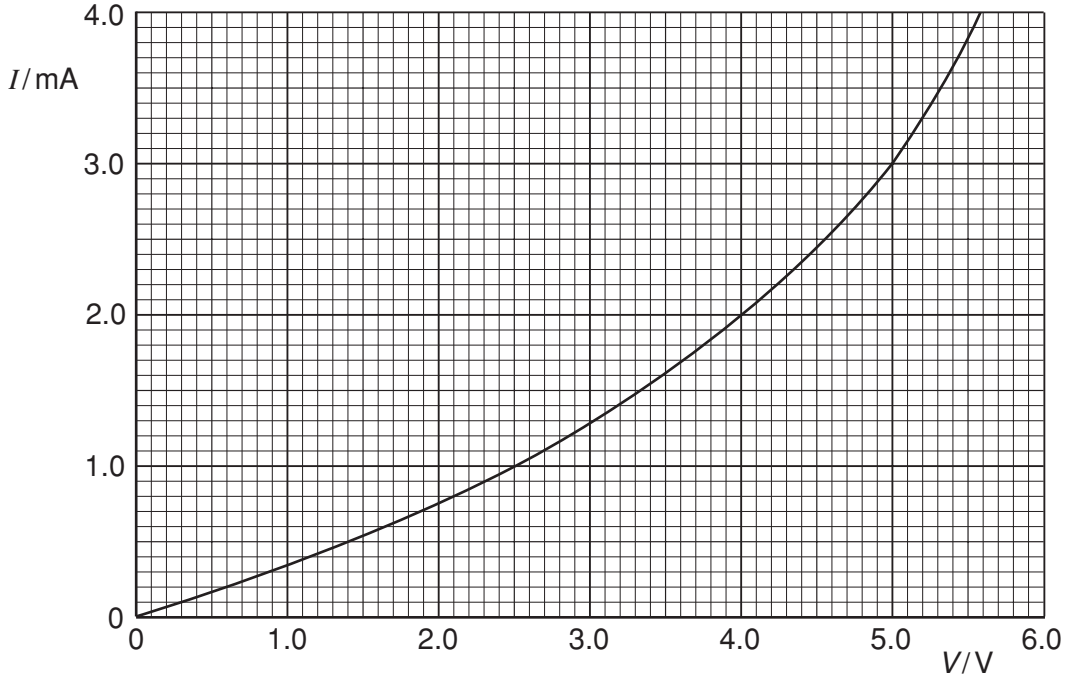

Fig. 6.1

(a) (i) State, with a reason, whether the resistance of component C increases or decreases with increasing potential difference.

.....

..... [2]

(ii) Determine the resistance of component C at a potential difference of 4.0 V.

resistance = …….. Ω [2]

(b) Component C is connected in parallel with a resistor R of resistance 1500 Ω and a battery of e.m.f. *E* and negligible internal resistance, as shown in Fig. 6.2.

For Examiner's Use

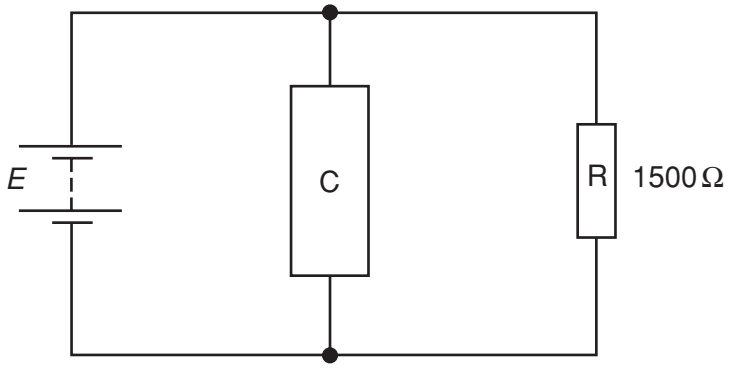

Fig. 6.2

(i) On Fig. 6.1, draw a line to show the variation with potential difference *V* of the current *I* in resistor R. [2]

(ii) Hence, or otherwise, use Fig. 6.1 to determine the current in the battery for an e.m.f. of 2.0 V.

current = ... A [2]

(c) The resistor R of resistance 1500 Ω and the component C are now connected in series across a supply of e.m.f. 7.0 V and negligible internal resistance.

Using information from Fig. 6.1, state and explain which component, R or C, will dissipate thermal energy at a greater rate.

.....

.....

.....

..... [3]

7 A household electric lamp is rated as 240 V, 60 W. The filament of the lamp is made from tungsten and is a wire of constant radius 6.0×10^{-6} m. The resistivity of tungsten at the normal operating temperature of the lamp is $7.9 \times 10^{-7}\ \Omega$ m.

(a) For the lamp at its normal operating temperature,

(i) calculate the current in the lamp,

current = ... A

(ii) show that the resistance of the filament is 960 Ω.

[3]

(b) Calculate the length of the filament.

length = ... m [3]

(c) Comment on your answer to **(b)**.

.....

..... [1]

[Turn over