1 This question is about possible heating circuits used to demist the rear window of a car. The heater is made of 8 thin strips of a metal conductor fused onto the glass surface. Fig. 2.1 shows the 8 strips connected in parallel to the car battery of e.m.f. E and internal resistance r.

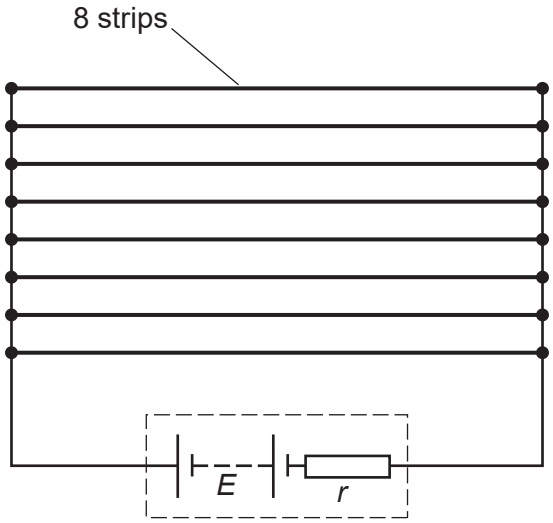

Fig. 2.1

(a) The potential difference across each strip is 12 V when a current of 2.0 A passes through it.

(i) Calculate the resistance r_p of one strip of the heater.

r_p = ... Ω **[1]**

(ii) Calculate the total resistance R_p of the heater.

R_p = ... Ω **[3]**

(iii) Show that the power P dissipated by the heater is about 200 W.

[2]

(b) Each strip is 0.90 m long, 2.4×10^{-4} m thick and 2.0×10^{-3} m wide.

Calculate the resistivity ρ of the metal of the strip. Give the unit with your answer.

ρ = ...unit ..... **[4]**

(c) An alternative way of making the heater is to connect eight metal strips in **series**. The heater is to dissipate the same power as the parallel combination of **(a)** when the p.d. across it is 12V.

(i) Explain why the total resistance of the series heater must equal R_p calculated in **(a)(ii)**.

.....

..... **[1]**

(ii) Calculate the resistance r_s of one strip of this series heater.

r_s = ... Ω **[1]**

(iii) Suggest, with a reason, whether you would choose the series or parallel circuit arrangement of the strips for a demister heater.

.....

..... **[1]**

(d) Fig. 2.2 is a graph showing how the potential difference across the terminals of the battery varies with the current drawn from it.

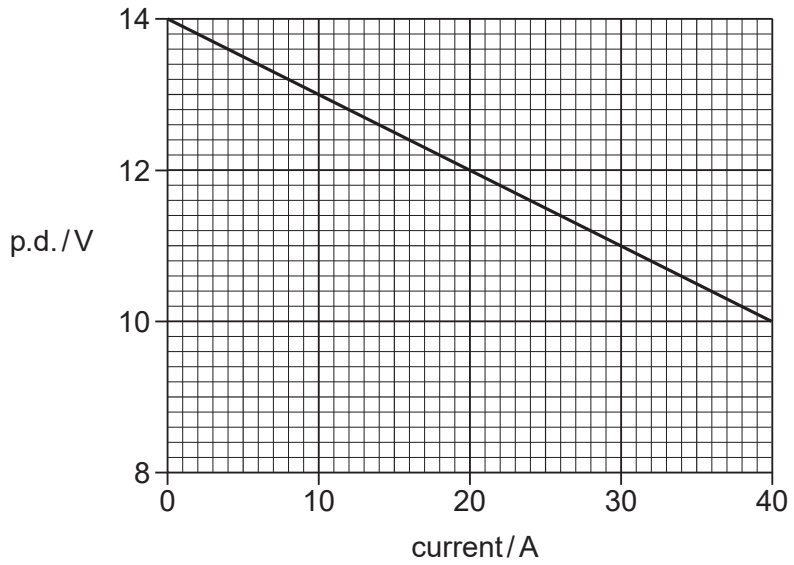

Fig. 2.2

(i) From the graph find the e.m.f. E of the battery.

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

(ii) Use data from the graph to calculate the internal resistance r of the battery.

r = ... Ω **[3]**

[Total: 17]

2 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.

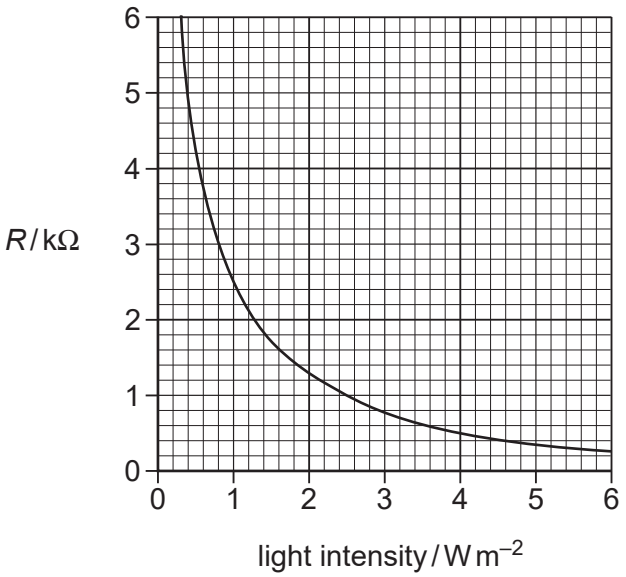

Fig. 3.1

(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.

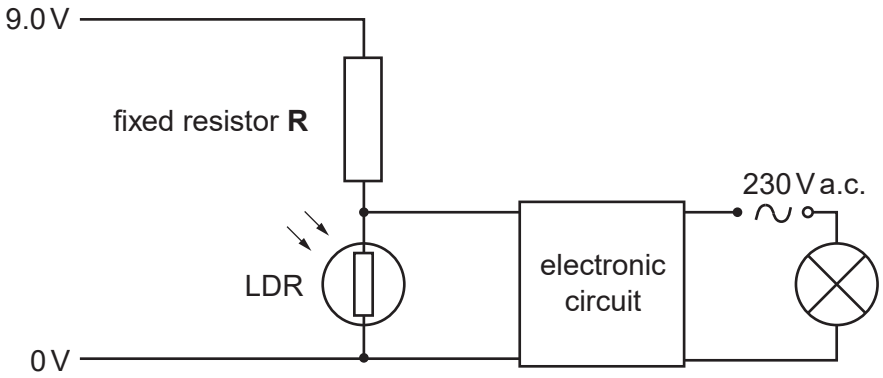

Fig. 3.2

The electronic circuit draws a negligible current. The potential difference across the LDR must be at least 5.0 V 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 5.0 V.

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]

3 **(a)** Two filament lamps are described as being 230V, 25W and 230V, 60W.

(i) Describe what is meant by '230V, 25W' for a lamp.

.....

.....

.....

..... **[2]**

(ii) Calculate the resistance of the 25W lamp when connected to a 230V supply.

resistance = ... Ω **[2]**

(iii) Each of the two lamps is connected across a 230V supply. Explain which lamp has the greater current.

.....

.....

.....

..... **[2]**

(iv) Both lamps are connected in parallel across the 230V supply. The resistance of the 60W lamp in the circuit is 880Ω. Calculate

1 the total resistance *R* across the supply

R = ... Ω

2 the current I drawn from the supply.

I = ... A **[4]**

(b) The 60W filament lamp is connected to a 6.0V battery. The resistance of the lamp in this circuit is 70Ω. Explain why this value differs from the value given in **(a)(iv)** when the lamp is connected to the 230V supply.

In your answer, you should make clear how your explanation links with the observations.

.....

.....

.....

.....

..... **[2]**

(c) By mistake a householder leaves a 60W filament lamp switched on overnight for a period of 8.0 hours.

The cost of 1.0 kilowatt-hour of electricity is 21 pence.

(i) Define the *kilowatt-hour* (kWh).

.....

.....

..... **[1]**

(ii) Calculate the cost of this mistake to the householder.

cost = ... pence **[2]**

[Total: 15]