1 A set of Christmas tree lights consists of 40 identical filament lamps connected in series across a supply of 240 V.

(a) Define *resistance.*

.....

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

(b) Each lamp when lit normally carries a current of 250 mA.

Calculate

(i) the potential difference V across a lamp

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

(ii) the resistance R of a lamp.

R = ... Ω **[2]**

(c) Fig. 1.1 shows the results of an experiment to find how the current in one of the lamps varies with the potential difference across it.

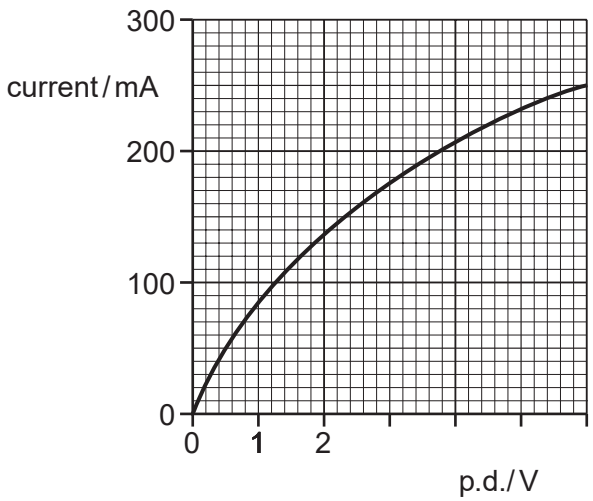

Fig. 1.1

(i) Draw a diagram of the circuit that you would use to perform this experiment.

[3]

(ii) The resistance of the lamp when at room temperature is 10 Ω. Using Fig. 1.1 sketch a graph on the axes of Fig. 1.2 of the variation of resistance *R* with current for the lamp.

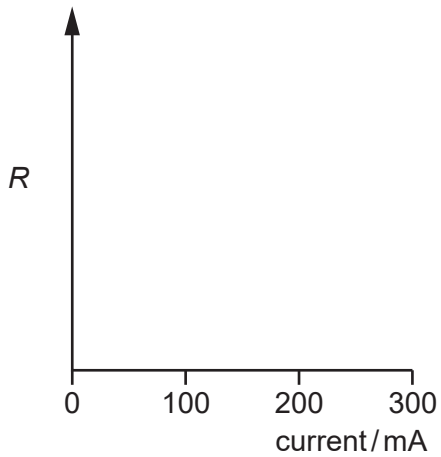

Fig. 1.2

[2]

(iii) Explain why the resistance of the lamp varies as shown by the graph you have drawn on Fig. 1.2.

.....

.....

.....

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

(d) In an alternative design for the set of Christmas tree lights, a 100 Ω resistor is connected in parallel with each lamp.

(i) Describe what happens to the brightness in each set of lamps when one lamp filament burns out.

1 *original set* .....

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

2 *alternative set* .....

.....

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

(ii) Calculate the current drawn from the supply for the alternative set of lamps with all lamps working.

current = ... A **[3]**

[Total: 16]

2 Fig. 1.1 shows the $I-V$ characteristic of a filament lamp.

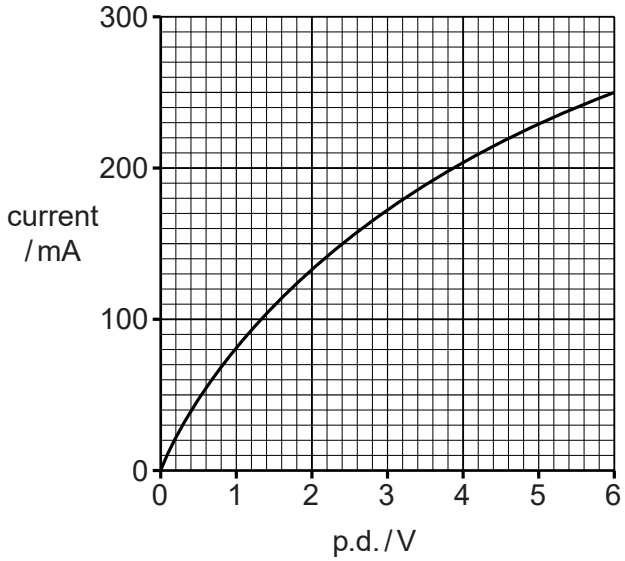

Fig. 1.1

(a) Explain how the graph of Fig. 1.1 shows that the filament lamp does not obey Ohm's law.

.....

.....

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

(b) You are to carry out an experiment to obtain the $I-V$ characteristic shown in Fig. 1.1.

(i) Draw a suitable circuit diagram for your experiment in the space below. **[2]**

(ii) Describe how you would carry out the experiment.

In your answer you should make clear how you make the measurements to obtain the data for the characteristic.

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.....

..... **[3]**

(c) The lamp is connected in **parallel** with a resistor of resistance 20 Ω to a 6.0 V d.c. supply of negligible internal resistance. Use Fig. 1.1 to calculate the current I_P drawn from the supply.

I_P = ... A **[3]**

(d) The circuit is rearranged with the lamp connected in **series** with the 20 Ω resistor to the same 6.0 V supply.

(i) On Fig. 1.1 draw the $I-V$ characteristic of the resistor. **[1]**

(ii) Use your answer to **(i)** and Fig. 1.1 to determine the current I_S drawn from the supply. Explain your method.

I_S = ... A **[3]**

[Total: 14]

3 An electric heater has a constant resistance of 42.5 Ω. It is connected to the 230 V mains supply by wires of total resistance 2.50 Ω. See Fig. 2.1.

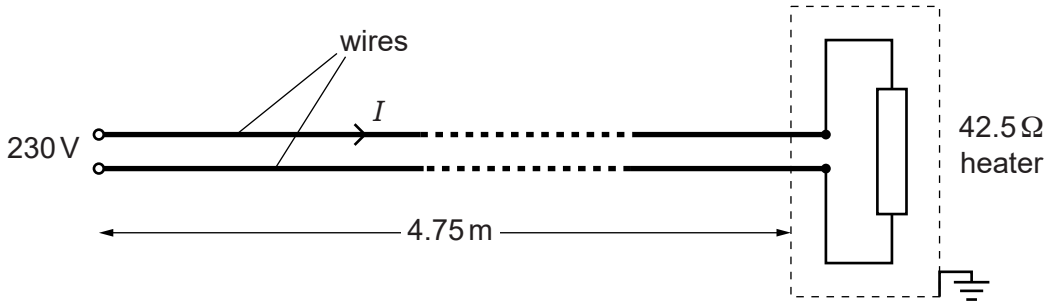

Fig. 2.1

(a) (i) Show that the current I in the wires is about 5 A.

[2]

(ii) Calculate the total power P dissipated in the heater and wires. Give your answer to three significant figures.

P = ... W **[3]**

(iii) Suggest a suitable value for the fuse in the plug connecting the cable to the mains supply.

fuse value = ... A **[1]**

(b) Calculate the cost, to the nearest penny, of using this heater for 4.0 hours, when 1 kW h costs 21p.

cost = ... p **[2]**

(c) The wires used to connect the heater to the supply have a total length of 9.50 m. The wires are made of copper. The resistivity of copper is $1.70 \times 10^{-8}\,\Omega\,m$.

Calculate the cross-sectional area *A* of the wire.

A = ... m^2 **[3]**

(d) Suggest and explain **one** disadvantage of connecting the heater to the mains supply using thinner copper wires.

.....

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.....

.....

..... **[3]**

[Total: 14]