1 This question is about the rigid copper bars which carry the very large currents generated in a power station to the transformers. Fig. 1.1 shows such a copper bar.

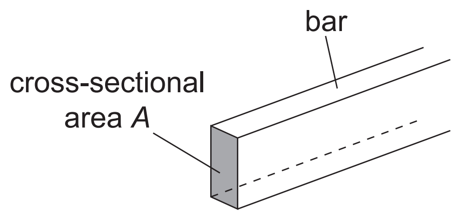

Fig. 1.1

(a) Write down a suitable word equation to define the *resistivity* of a material.

....

....

.... **[1]**

(b) **(i)** The cross-sectional area *A* of the bar is $6.4 \times 10^{-3}\,m^2$. Calculate the resistance of a 1.0 m length of the bar. The resistivity of copper is $1.7 \times 10^{-8}\,\Omega\,m$.

resistance = ... Ω **[2]**

(ii) The bar carries a constant current of 8000 A. Calculate the power dissipated as heat along a 1.0 m length of it.

power = ... W **[3]**

(iii) The bar is 9.0 m long. Estimate the total energy in kW h lost from the bar in one day.

energy = ... kW h **[2]**

(iv) Calculate the cost per day of operating the copper bar. The cost of 1kW h is 15p.

cost = ... p **[1]**

(c) Calculate the mean drift velocity *v* of the free electrons in the copper bar. The number of free electrons per unit volume in copper is $8.4 \times 10^{28}\,m^{-3}$.

v = ... $m\,s^{-1}$ **[3]**

[Total: 12]

2 A cell is a source of e.m.f. When the cell is connected into a circuit the potential difference measured between its terminals, called the *terminal p.d.*, is less than its e.m.f.

(a) (i) Define the term *e.m.f.*

....

....

.... **[2]**

(ii) Explain why the terminal p.d. is less than the e.m.f.

....

....

.... **[2]**

(b) In the circuit of Fig. 3.1 the cell of e.m.f. 1.6 V and internal resistance r is delivering a current of 0.20 A to a resistor of resistance R. The voltmeter reads the terminal p.d. It is 1.2 V.

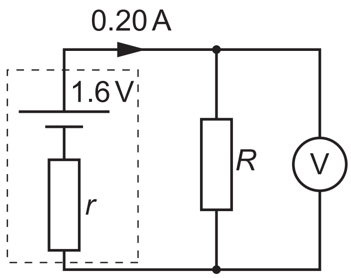

Fig. 3.1

Calculate the values of

(i) the resistance R

R = ... Ω **[2]**

(ii) the internal resistance r.

r = ... Ω **[2]**

(c) (i) The current in the resistor of Fig. 3.1 remains constant at 0.20 A for several hours. Calculate

1 the charge which passes through the resistor in 1.5 hours

charge = ... unit .... **[3]**

2 the energy dissipated by the resistor in 1.5 hours.

energy = ... J **[2]**

(ii) The cell is left connected to the resistor for 12 hours. The graph of Fig. 3.2 shows the variation of current I with time t.

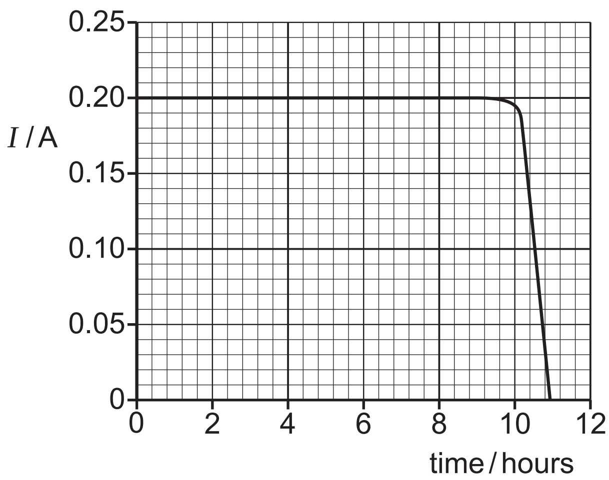

Fig. 3.2

Describe how the current varies with time. Suggest reasons why it varies in this way.

In your answer you should link each feature of the graph to the reason for it.

....

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....

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.... **[4]**

[Total: 17]

3 A resistor **X** is constructed from a rod of cross-sectional area $9.0 \times 10^{-6}\,m^2$ and length 0.012 m as shown in Fig. 1.1. The resistivity of the material of the rod is $2.4\,\Omega\,m$.

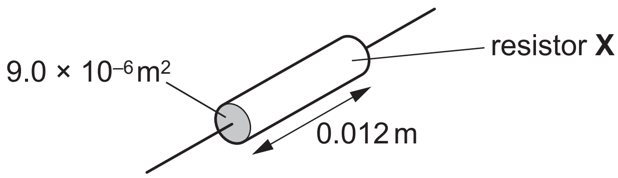

Fig. 1.1

(a) Show that the resistance of the resistor **X** is $3.2\,k\Omega$.

[2]

(b) The power rating of resistor **X** is 0.125 W. Show that the maximum potential difference which should be applied safely across the resistor is 20 V.

[2]

(c) A student needs a resistor of the same resistance as **X** but with a power rating of 0.50 W. The only resistors available are identical to **X**. It is suggested that four of these resistors could be connected as shown in Fig. 1.2 to solve the problem. The potential difference across the combination of resistors is 40 V.

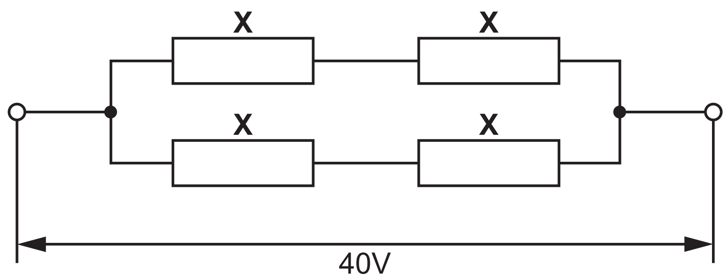

Fig. 1.2

(i) Show that the total resistance of the combination in Fig. 1.2 is 3.2 kΩ.

[2]

(ii) Show that the power dissipation in each resistor is 0.125 W.

....

....

....

.... **[2]**

(d) Another resistor **Y** is constructed from the same material but has twice the length and twice the diameter of resistor **X**.

(i) Show that the resistance R_Y of **Y** is half the resistance R_X of resistor **X**.

[2]

(ii) The two resistors **X** and **Y**, where $R_Y = R_X/2$, are connected in series to a d.c. power supply as shown in Fig. 1.3.

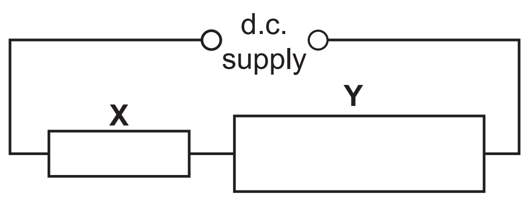

Fig. 1.3

State and explain which resistor dissipates greater power.

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....

.... **[3]**

[Total: 13]