1 Fig. 3.1 shows a thermistor and fixed resistor of 200 Ω connected through a switch **S** to a 24 V d.c. supply of negligible internal resistance. The voltmeter across the fixed resistor has a very high resistance.

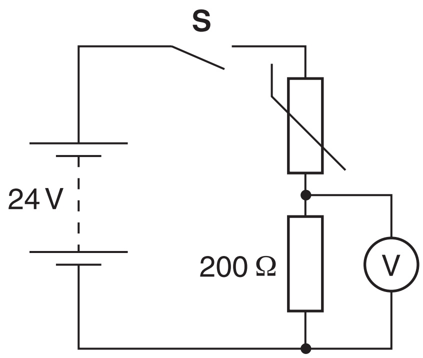

Fig. 3.1

(a) When the switch **S** is closed the voltmeter initially measures 8.0 V.

Calculate

(i) the current I in the circuit

I = ... A **[2]**

(ii) the potential difference V_T across the thermistor

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

(iii) the resistance R_T of the thermistor

R_T = ... Ω **[2]**

(iv) the power P_T dissipated in the thermistor.

P_T = ... W **[2]**

(b) A few minutes after closing the switch **S** the voltmeter reading has risen to a steady value of 12 V. The value of the fixed resistor remains at 200 Ω.

Explain why

(i) the potential difference across the fixed resistor has increased

....

....

....

.... **[3]**

(ii) the resistance of the thermistor must now be 200 Ω.

....

.... **[1]**

(c) Sketch, on the labelled axes of Fig. 3.2 below, a possible *I-V* characteristic for:

(i) the fixed resistor. Label it **R**. **[2]**

(ii) the thermistor. Label it **T**. **[2]**

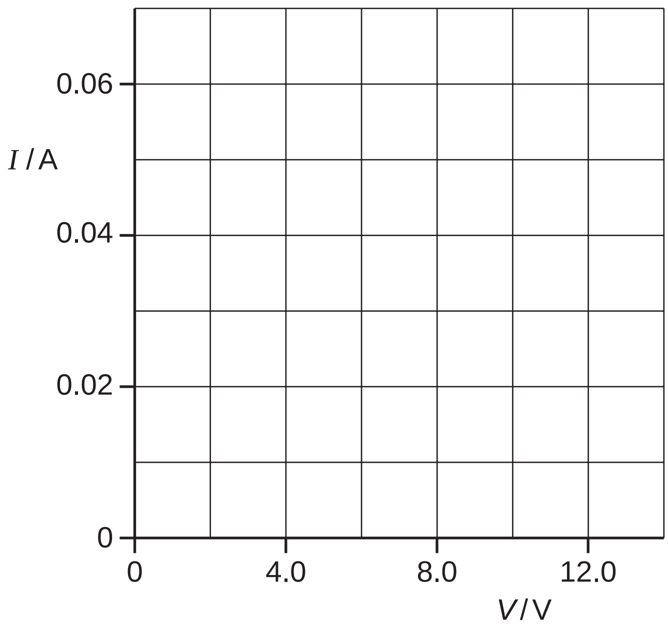

Fig. 3.2

[Total: 15]

2 Fig. 3.1 shows a circuit consisting of a battery of electromotive force 16.0V and negligible internal resistance, two resistors and a thermistor.

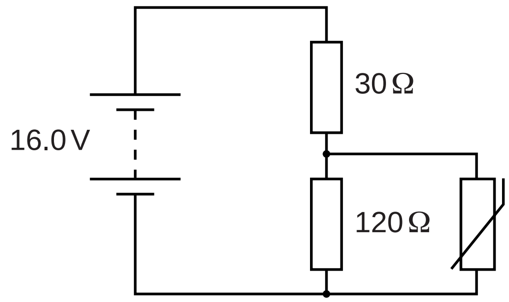

Fig. 3.1

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

....

....

.... **[2]**

(ii) Explain the meaning of the term *internal resistance*.

....

....

.... **[1]**

(b) The thermistor has a resistance of 360Ω at 20°C. Calculate

(i) the total resistance *R* of the thermistor and the resistor of resistance 120Ω at 20°C

R = ... Ω **[2]**

(ii) the potential difference *V* across the thermistor.

V = ... V **[3]**

(iii) It is suggested that the thermistor in the circuit of Fig. 3.1 is used to monitor temperatures between 20 °C and 200 °C. Describe how the potential difference across the thermistor and the current in it will vary as the temperature increases above 20 °C.

In your answer you should explain why the potential difference and current vary as the temperature increases.

....

....

....

....

....

....

.... **[4]**

(c) The battery in Fig. 3.1 is rechargeable.

(i) Calculate the charge stored in the battery when it is charged for 8.0 hours at a constant current of 1.2 A.

charge = …………………… unit ……….. **[3]**

(ii) After charging, the battery loses energy at a constant rate of 1.4 J s^{-1}. The e.m.f. of the battery remains constant at 16.0 V. Calculate how many hours it takes for the battery to discharge.

discharge time = ... h **[3]**

[Total: 18]

3 **(a)** Fig. 2.1 shows combinations of resistors connected to a power supply of e.m.f. *E*.

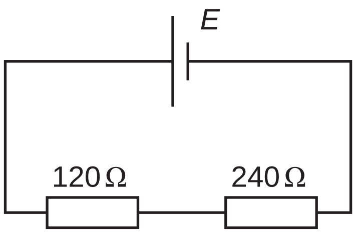

Fig. 2.1a

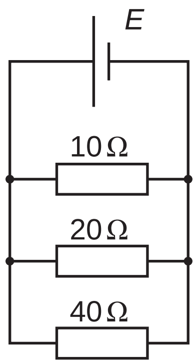

Fig. 2.1b

(i) For the circuit of Fig. 2.1a

1 calculate the total resistance R_s

R_s = ... Ω **[1]**

2 state one electrical quantity which is the same for both resistors.

.... **[1]**

(ii) For the circuit of Fig. 2.1b

1 calculate the total resistance R_p

R_p = ... Ω **[2]**

2 state one electrical quantity which is the same for all the resistors.

.... **[1]**

(b) Fig. 2.2 shows the I–V characteristics of two electrical components, a resistor, line **R** and a thermistor, line **T**.

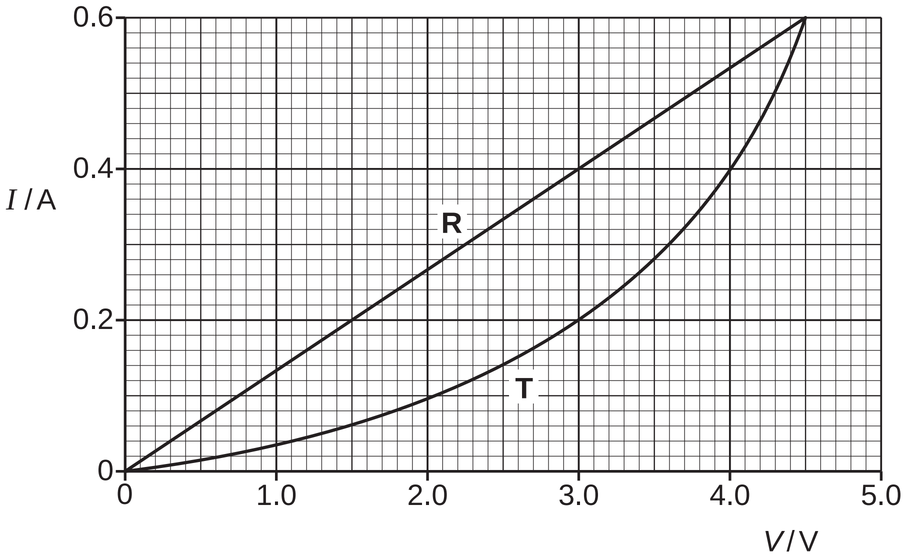

Fig. 2.2

(i) State Ohm's law. Use Fig. 2.2 to explain why component **R** obeys Ohm's law.

....

....

....

....

.... **[3]**

(ii) The resistor and the thermistor can be connected to a variable voltage supply of negligible internal resistance in two ways as shown in Fig. 2.3a and Fig. 2.3b.

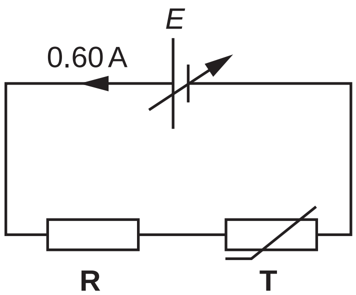

Fig. 2.3a

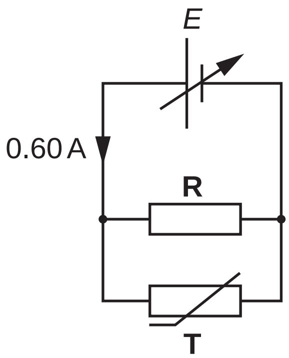

Fig. 2.3b

The voltage of the supply is varied in each circuit until the current drawn from it is 0.60 A. Use data from Fig. 2.2 to explain why the e.m.f. *E* of the supply is

1 9.0 V in Fig. 2.3a

....

....

.... **[2]**

2 3.0 V in Fig. 2.3b.

....

....

....

.... **[2]**

(iii) The thermistor is now connected on its own across the terminals of the supply set at 4.5 V. Fig. 2.4 shows the variation of current I with time t from the moment the thermistor is connected to the supply.

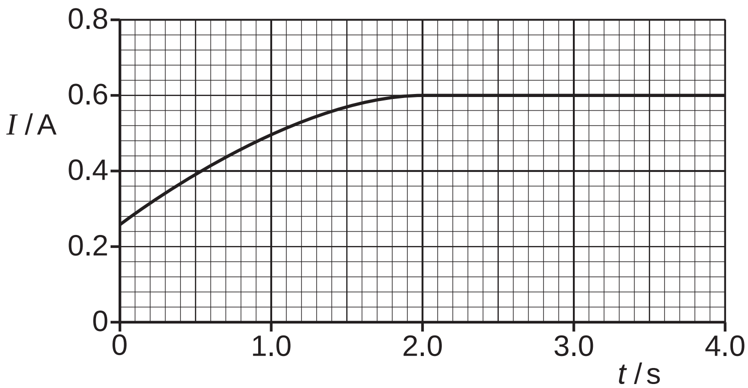

Fig. 2.4

Explain the shape of the graph in Fig. 2.4.

....

....

....

....

....

....

....

....

.... **[3]**

 [Total: 15]