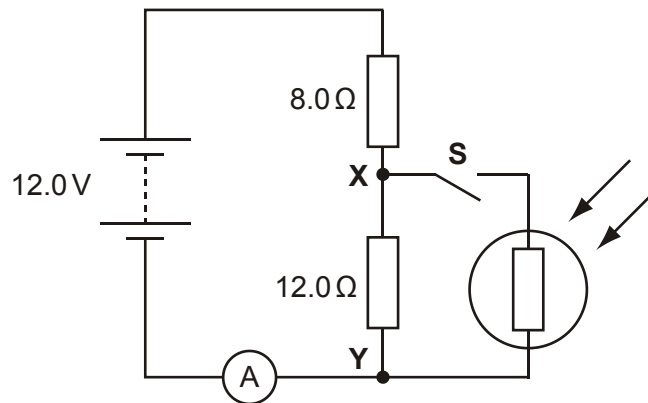


1. The figure below shows a circuit containing a battery of e.m.f. 12 V, two resistors, a light-dependent resistor (LDR), an ammeter and a switch **S**. The battery has negligible internal resistance.



- (a) When the switch **S** is open, show that the potential difference between the points **X** and **Y** is 7.2 V.

[2]

- (b) The switch **S** is now closed. Describe and explain the change to each of the following when the intensity of light falling on the LDR is increased:

- (i) the ammeter reading

.....

.....

.....

[2]

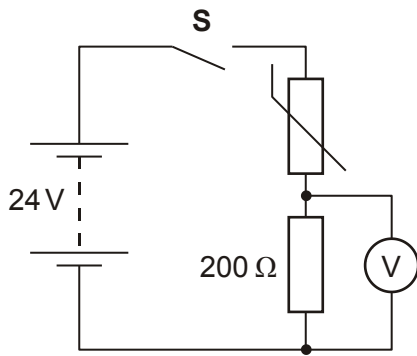
(ii) the potential difference across **XY**.

.....  
.....  
.....

[2]

[Total 6 marks]

2. Fig. 1 shows a thermistor and fixed resistor of  $200\ \Omega$  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. 1**

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

Calculate

- (i) the current  $I$  in the circuit

$I = \dots\dots\dots$  A

[2]

(ii) the potential difference  $V_T$  across the thermistor

$$V_T = \dots\dots\dots V$$

[1]

(iii) the resistance  $R_T$  of the thermistor

$$R_T = \dots\dots\dots \Omega$$

[2]

(iv) the power  $P_T$  dissipated in the thermistor.

$$P_T = \dots\dots\dots W$$

[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  $\Omega$ .

Explain why

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

.....  
.....  
.....  
.....

[3]

- (ii) the resistance of the thermistor must now be 200  $\Omega$ .

.....  
.....

[1]

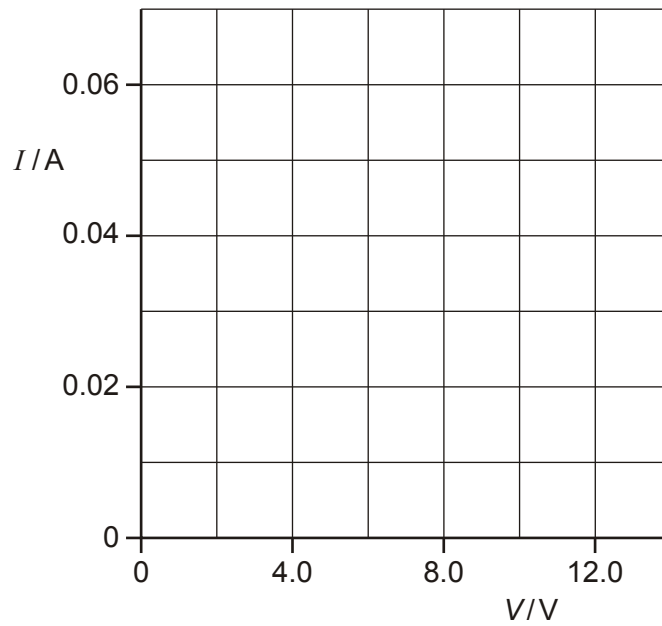
(c) Sketch, on the labelled axes of Fig. 2 below, a possible  $I$ - $V$  characteristic for:

(i) the fixed resistor. Label it **R**.

[2]

(ii) the thermistor. Label it **T**.

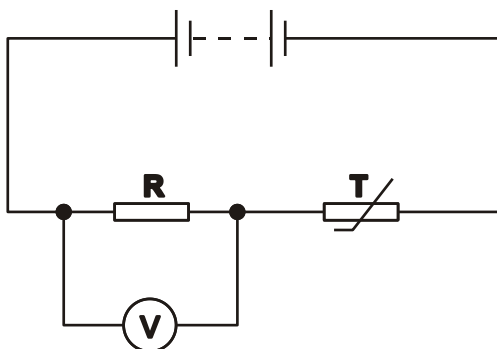
[2]



**Fig. 2**

[Total 15 marks]

3. The figure below shows a potential divider circuit used to monitor the temperature of a greenhouse.



The thermistor **T** is a negative temperature coefficient type. The voltmeter is placed across the resistor **R**. Describe and explain how the voltmeter reading changes as the temperature of the greenhouse **increases**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[Total 4 marks]

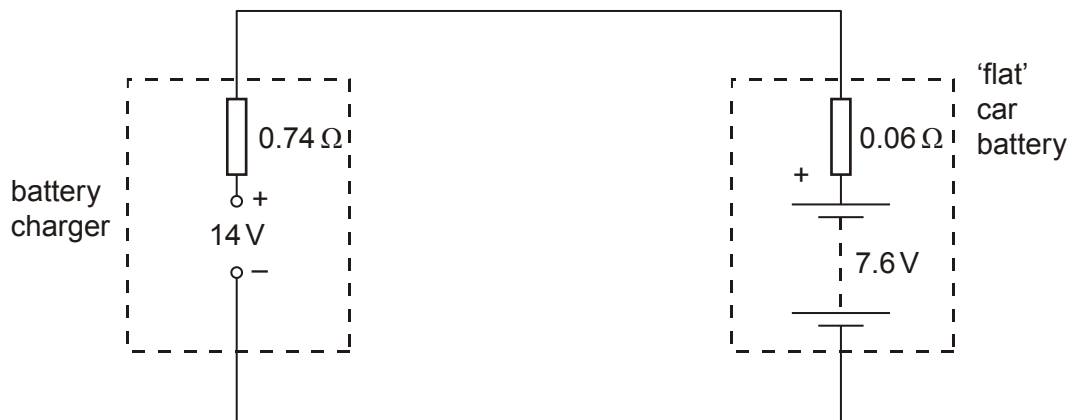
4. (a) A battery of e.m.f.  $E$  and internal resistance  $r$  delivers a current  $I$  to a circuit of resistance  $R$ .

Write down an equation for  $E$  in terms of  $r$ ,  $I$  and  $R$ .

.....

[1]

- (b) A 'flat' car battery of internal resistance  $0.06 \Omega$  is to be charged using a battery charger having an e.m.f. of  $14 \text{ V}$  and internal resistance of  $0.74 \Omega$ , as shown in the figure below.



You can see that the battery to be charged has its positive terminal connected to the positive terminal of the battery charger.

At the beginning of the charging process, the e.m.f. of the 'flat' car battery is  $7.6 \text{ V}$ .

- (i) For the circuit of the figure above, determine

1 the total resistance

resistance = .....  $\Omega$

[1]

2 the sum of the e.m.f.s in the circuit.

e.m.f. = .....  $\text{V}$

[1]

- (ii) State Kirchhoff's second law.

.....  
 .....

[1]

(iii) Apply the law to this circuit to calculate the initial charging current.

current = ..... A

[2]

(c) For the majority of the charging time of the car battery in the circuit of the figure above, the e.m.f. of the car battery is 12 V and the charging current is 2.5 A. The battery is charged at this current for 6.0 hours. Calculate, for this charging time,

(i) the charge that passes through the battery

charge = ..... C

[2]

(ii) the energy supplied by the battery charger of e.m.f. 14 V

energy = ..... J

[2]



- (iii) the percentage of the energy supplied by the charger which is dissipated in the internal resistances of the battery charger and the car battery.

percentage of energy = ..... %

[2]

[Total 12 marks]

5. 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

$V = \dots\dots\dots V$

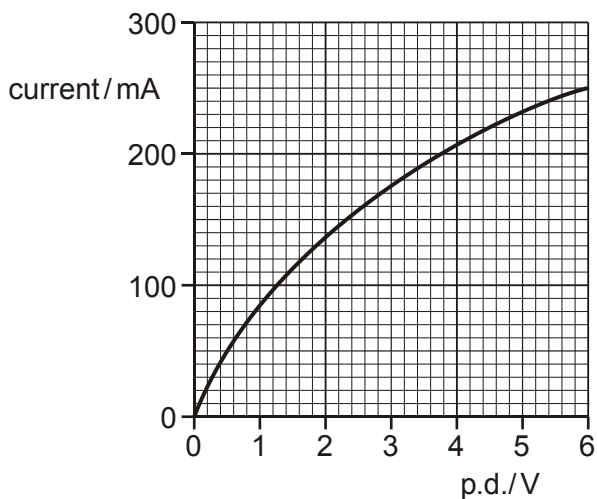
[1]

(ii) the resistance  $R$  of a lamp.

$$R = \dots\dots\dots \Omega$$

[2]

(c) Fig. 1 shows the results of an experiment to find how the current in one of the lamps varies with the potential difference across it.

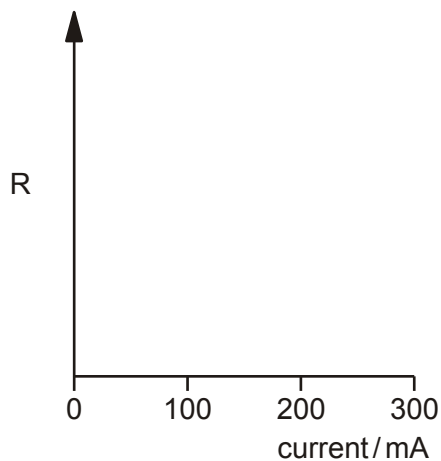


**Fig. 1**

(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  $10\ \Omega$ . Using Fig. 1.1 sketch a graph on the axes of Fig. 2 of the variation of resistance  $R$  with current for the lamp.



**Fig. 2**

[2]

- (iii) Explain why the resistance of the lamp varies as shown by the graph you have drawn on Fig. 2.

.....

.....

.....

.....

[2]

- (d) In an alternative design for the set of Christmas tree lights, a  $100\ \Omega$  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]

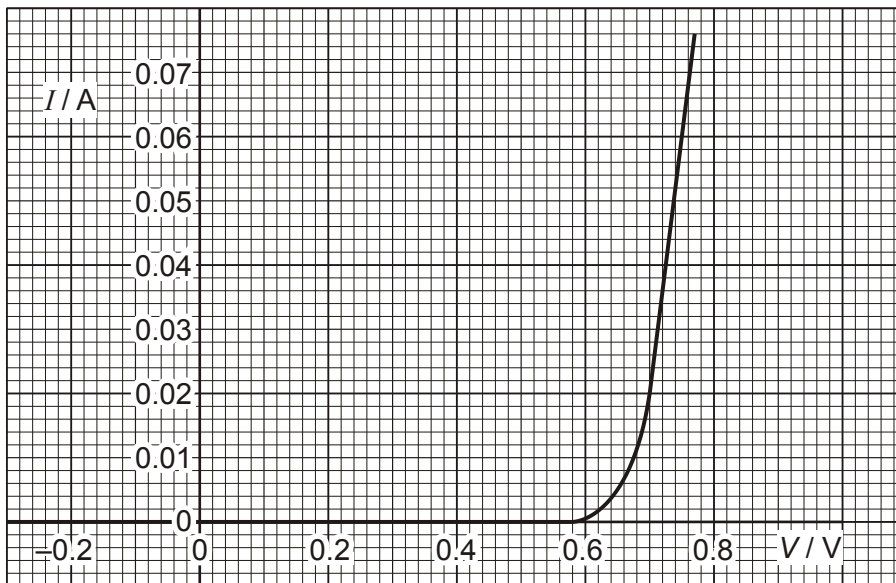
[Total 16 marks]

6. Kirchhoff's second law is based on the conservation of a quantity. State the law and the quantity that is conserved.

.....  
.....  
.....

[Total 2 marks]

7. Fig. 1 shows the  $I$ - $V$  characteristic of a particular electrical component.



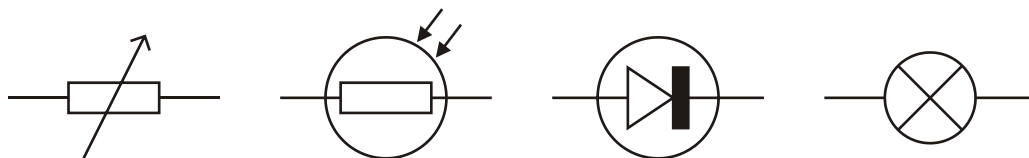
**Fig. 1**

(a) Name the component.

.....

[1]

(b) Circle the correct circuit symbol for the component.



[1]

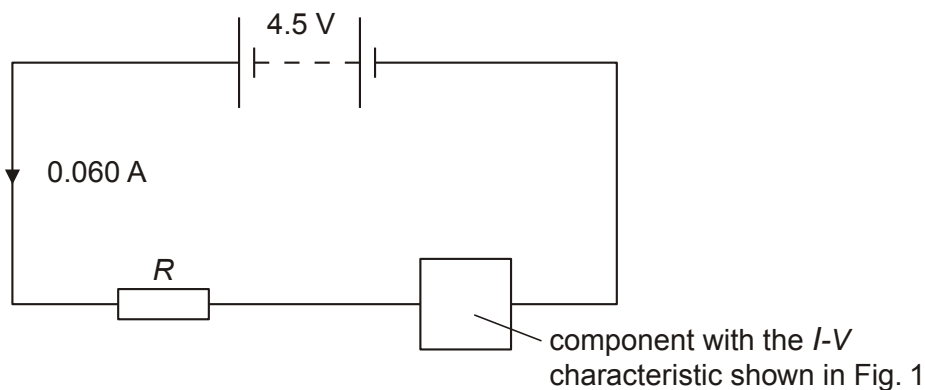
(c) Use Fig. 1 to calculate the resistance of the component at 0.20 V and 0.70 V.

resistance at 0.20 V = .....  $\Omega$

resistance at 0.70 V = .....  $\Omega$

[3]

- (d) Fig. 2 shows the component with the  $I$ - $V$  characteristic shown in Fig. 1 connected in series with a resistor of resistance  $R$  and a supply of e.m.f. 4.5 V.



**Fig. 2**

The supply has negligible internal resistance. The current in the resistor is 0.060 A.

Use Fig. 1 to determine the resistance  $R$  of the resistor.

$R = \dots\dots\dots \Omega$

[3]

- (e) On the axes of Fig. 1, draw the  $I$ - $V$  characteristic of a metallic conductor kept at a constant temperature and having the same resistance as your answer to (d). Label your line **M**.

[2]

[Total 10 marks]