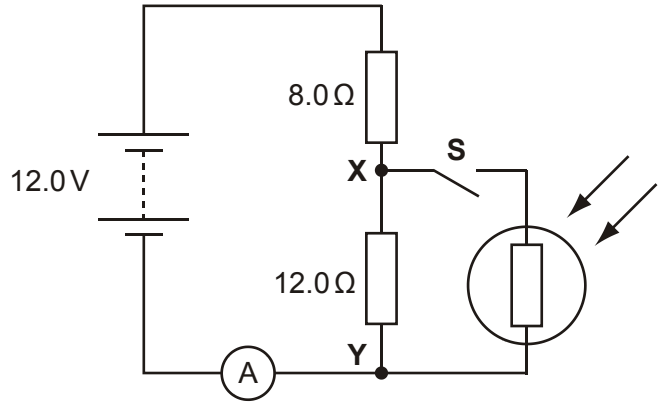
1. The figure below shows a circuit containing a battery of e.m.f. 12 V, two resistors, a light-dependent resistor (LDR), an ammeter and a switch **S**. The battery has negligible internal resistance.



(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 cell of e.m.f. *E* and internal resistance *r* connected to a variable resistor.

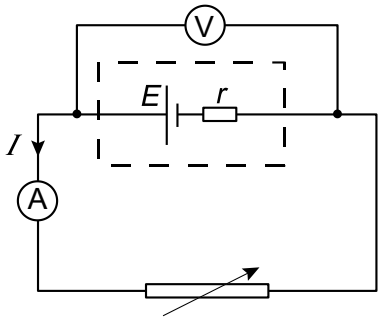


Fig. 1

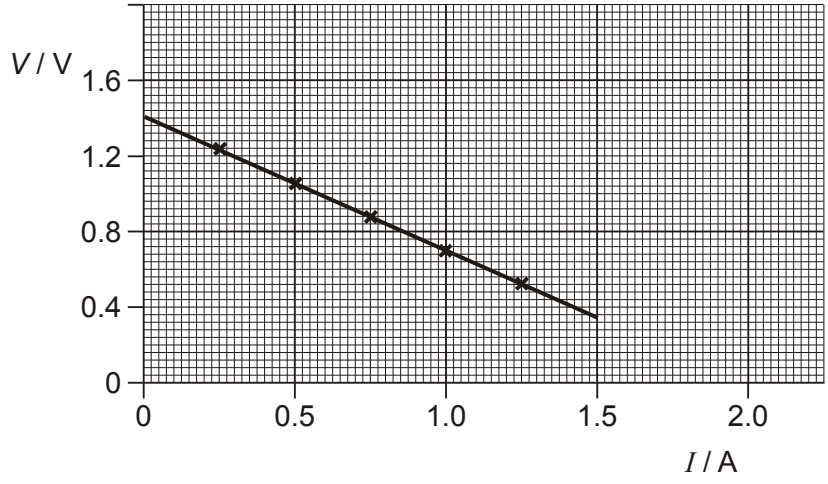


Fig. 2

Fig. 2 shows the variation of the p.d. *V* across the terminals of the cell with the current *I* drawn from the cell.

(a) Explain how Fig. 2 shows that the e.m.f. *E* is 1.4 V.

.....

.....

[1]

(b) (i) Use Fig. 2 to determine the maximum possible current that can be drawn from the cell.

current = ... A

[1]

(ii) Calculate the internal resistance *r* of the cell.

r = ... Ω

[2]

(iii) Suggest why it may not be advisable to maintain the current determined in (b)(i) for a long time.

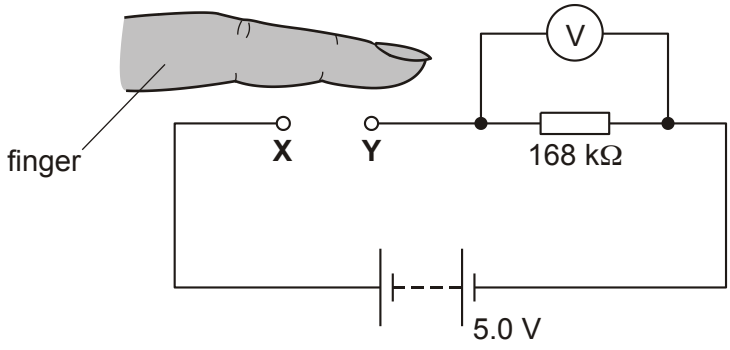
.....

.....

[1]

[Total 5 marks]

3. The following figure shows a potential divider circuit designed as a touch-sensor.



The battery has negligible internal resistance and the voltmeter has infinite resistance.

(a) Explain why the voltmeter reading is zero when there is nothing connected between the contacts **X** and **Y**.

.....

.....

[1]

(b) When the finger makes contact between **X** and **Y**, the voltmeter reading changes from 0 V to 3.4 V because of the electrical resistance of the skin. Use this information to calculate the electrical resistance of the skin between the two contacts.

resistance = ... kΩ

[3]

[Total 4 marks]

4. A convenient unit of energy is the kilowatt hour (kW h).

(a) Define the *kilowatt hour*.

.....

.....

[1]

(b) A 120 W filament lamp transforms 5.8 kW h. Calculate the time in seconds for which the lamp is operated.

time = ... s

[2]

[Total 3 marks]

5. (a) (i) Define electrical *resistivity*.

.....

.....

.....

.....

[2]

(ii) Explain why the *resistivity* rather than the *resistance* of a material is given in tables of properties of materials.

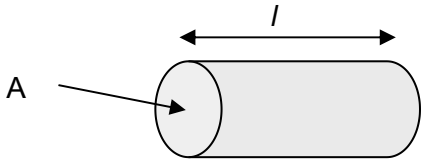
.....

.....

.....

[1]

(b)



The diagram above shows a copper rod of length l = 0.080m, having a cross-sectional area $A = 3.0 \times 10^{-4}$ m^2.

The resistivity of copper is 1.7×10^{-8} Ω m.

Calculate the resistance between the ends of the copper rod.

resistance = ... Ω

[2]

[Total 5 marks]

6. (a) A rechargeable battery is put on charge for 4.0 hours with a constant current of 50 mA from a 6.0 V supply. Calculate

(i) the charge which flows through the battery in this time

charge = ... C

[3]

(ii) the energy which has been provided from the supply.

energy = ... J

[2]

(b) In what form does a battery store energy?

..... energy

[1]

(c) The charged battery has an e.m.f of 4.5 V and is connected to a 48 Ω resistor. The potential difference across the resistor is found to be 4.0 V. The current is constant during the 45 minutes the battery discharges. Calculate

(i) the internal resistance of the battery when in use

internal resistance = ... Ω

[2]

(ii) the energy supplied to the 48 Ω resistor in this time

energy = ... J

[3]

(iii) the fraction of the initial energy (a)(ii) which the energy in (c)(ii) represents.

fraction = ...

[1]

(d) Explain why the value of the internal resistance calculated in (c)(i) is only reliable to 1 significant figure.

.....

[1]

[Total 13 marks]

7. The *I*/*V* characteristic of a filament lamp is shown in Fig. 1.

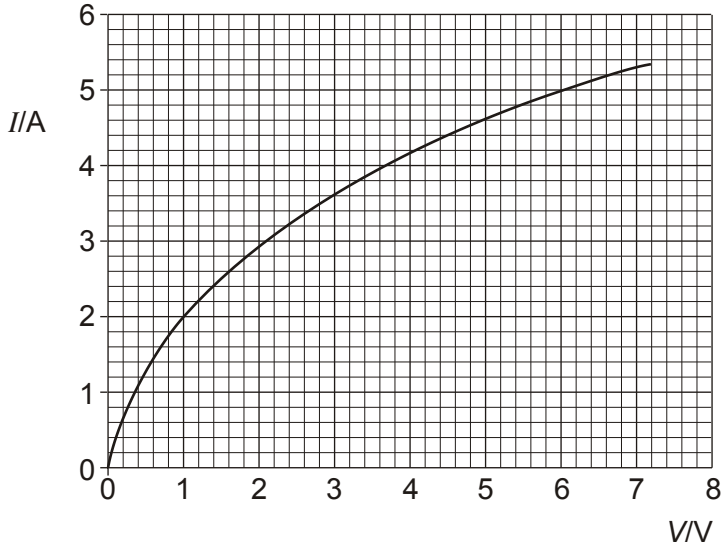


Fig. 1

(i) On Fig. 1, mark a point on the graph, and label it with the letter **M**, where the resistance of the filament lamp is **maximum**.

[1]

(ii) Calculate the power dissipated by the lamp when operating at 6.0 V.

power = ... W

[3]

(iii) Fig. 2 shows the same filament lamp and a resistor of resistance 1.2 Ω connected in series with a battery.

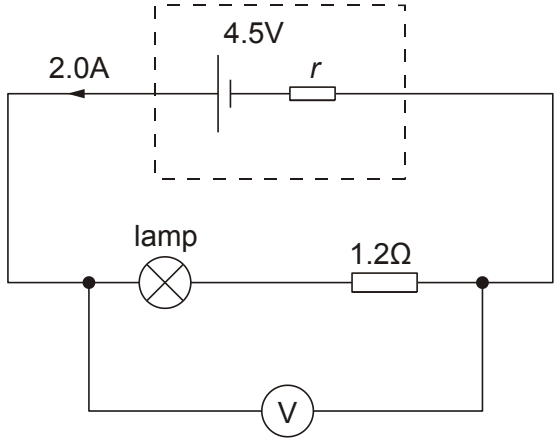


Fig. 2

The battery has e.m.f. 4.5 V and internal resistance *r*. The voltmeter has very high resistance. The current in the circuit is 2.0 A.

1 Show, with the help of Fig. 1, that the voltmeter reading is 3.4 V.

[3]

2 Calculate the internal resistance *r* of the battery.

resistance = ... Ω

[2]

[Total 9 marks]

8. (i) Use energy considerations to distinguish between potential difference (p.d.) and electromotive force (e.m.f.).

.....

.....

.....

.....

[2]

(ii) Here is a list of possible units for e.m.f. or p.d.

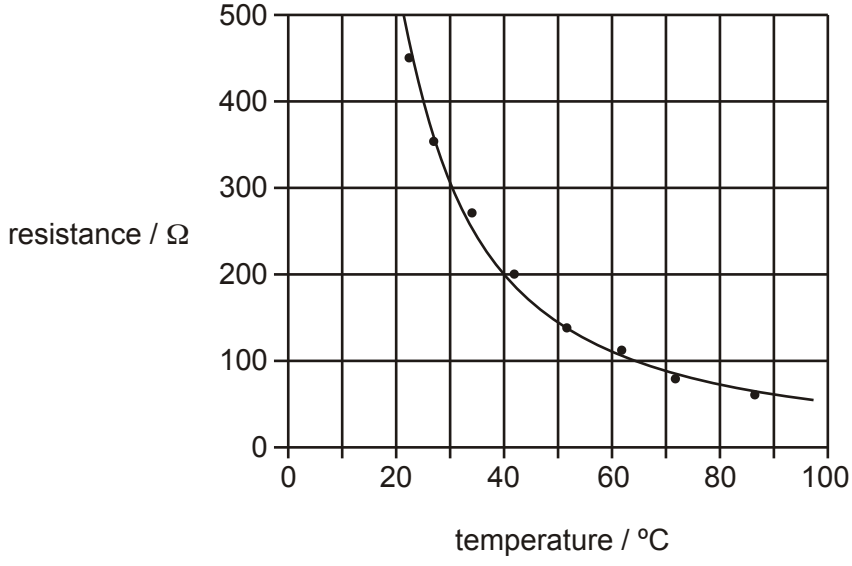
$J\ s^{-1}$ $J\ A^{-1}$ $J\ C^{-1}$

State which one is a correct unit: .....

[1]

[Total 3 marks]

9. (a) The diagram below shows how the resistance of a thermistor varies with temperature.



(i) Describe qualitatively how the resistance of the thermistor changes as the temperature rises.

.....

[1]

(ii) The change in resistance between 80 °C and 90 °C is about 15 Ω.

State the change in resistance between 30 °C and 40 °C.

.....

[1]

(iii) Describe, giving a reason, how the sensitivity of temperature measurement using this circuit changes over the range of temperatures shown on the diagram.

.....

.....

.....

[2]

(b) Fig. 1 shows how the resistance of a thermistor varies with temperature.

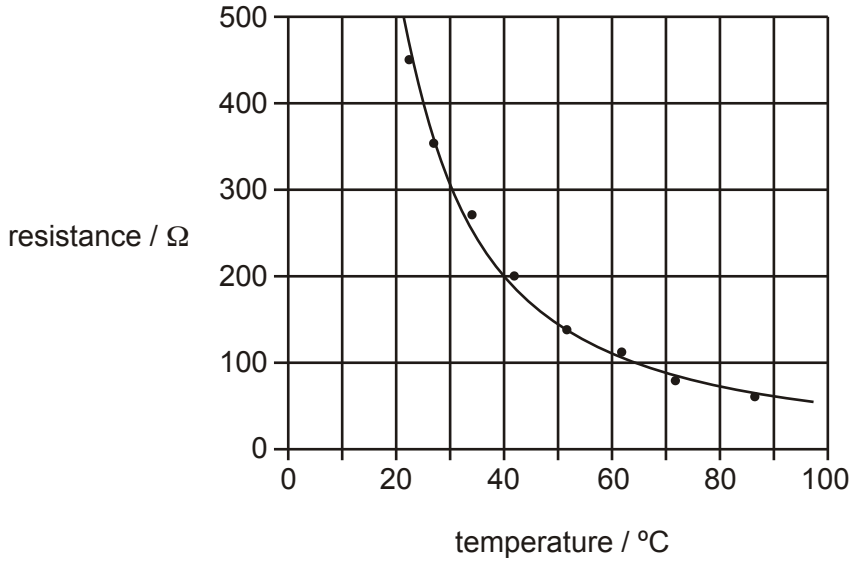


Fig. 1

Fig. 2 below shows a temperature sensing potential divider circuit where this thermistor may be connected, between terminals A and B, in series with a resistor.

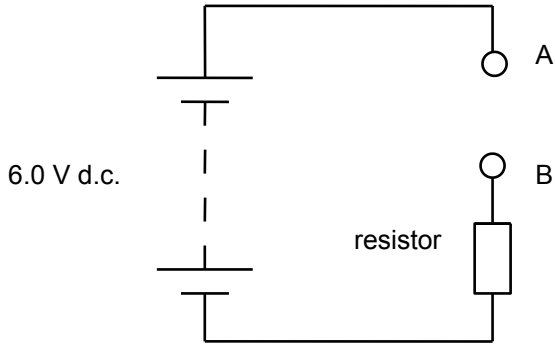


Fig. 2

(i) Draw the circuit symbol for a thermistor on Fig. 2 in the space between terminals **A** and **B**.

[1]

(ii) A voltmeter is to be connected to the circuit to indicate an increasing p.d. when the thermistor detects an increasing temperature. On Fig. 2, draw the circuit connections for a voltmeter to measure a p.d. that rises with increasing temperature.

[1]

(iii) The value of the resistor in Fig. 2 is 200 Ω. The thermistor is at 65 °C. Use data from Fig. 1 to show that the current in the circuit is about 0.02 A.

[3]

(iv) Calculate the p.d. across the 200 Ω resistor at 65 °C.

p.d. across resistor = ... V

[1]

[Total 10 marks]

10. State Ohm's law in words.

.....

.....

.....

[Total 2 marks]