Name:	Target Grade:	Actual Grade:

BRIGHT CULTURE

CURRENT OF ELECTRICITY
MCQ and STRUCTURED QUESTIONS

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

1. Find a quiet, comfortable spot free place from distractions.

2. Spend one minute on each mark.

3. Time yourself for every single question.

4. Every chapter has their own question types. Ensure that you know the different question type for each chapter.

5. Make a conscientious effort to remember your mistakes, especially in terms of answering techniques. E.g Take a picture for the mistakes that you made, keep it in a photo album, and revise it over and over again.

6. Highlight question types that you tend to keep making mistakes and review them nearing exams.

7. Always review the common questions and question type that you tend to make mistakes nearing exams.

8. During exams, classify the question type and recall what you have learnt, how you need to analvse the questions for the different question type, what you need to take note of and answer with the correct answering techniques!

✨ **Wishing you all the best for this test!**

You’ve got this!

💡 **With lots of love,**
Bright Culture 💛

GOOD LUCK
FOR YOUR EXAM!

MARKS

CURRENT OF ELECTRICITY MCQ

1 A metal wire of length l and diameter d has a resistance of 10 Ω. If another wire of the same metal is 2l in length and 0.5d in diameter, what is its resistance?

A 5 Ω **B** 10 Ω

C 40 Ω **D** 80 Ω

2 A potential difference of 10 V applied across a resistor produces a current of 4.0 A. Given that the time of current flow is 20 s, which of the following correctly gives the value of the resistance R of the resistor and the quantity of charge Q passing through the resistor?

R / Q / C

A 2.5 80

B 2.5 40

C 0.40 80

D 0.50 200

3 A metal wire of length l and diameter d has resistance of 10 . If another wire of the same metal is 2l in length and 0.5d in diameter, what is its resistance?

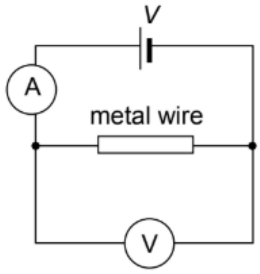
A 5

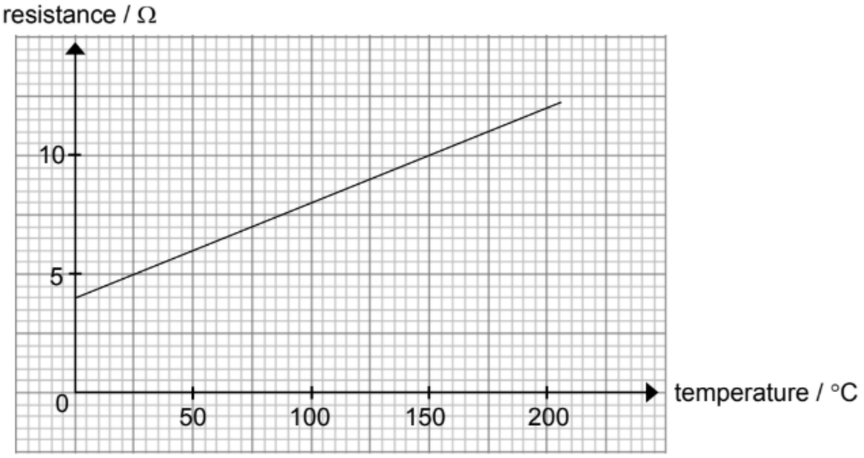
B 10

C 40

D 80

4 Jolyn connects the following circuit and obtains a resistance-temperature graph of the wire as shown below.





When the ammeter reading is 1.0 A, the temperature of the wire is 25 °C.

What is the reading of the ammeter when the temperature of the wire is 200 °C?

A 0.42 A

B 0.60 A

C 1.0 A

D 1.5 A

5 A metal wire of length land diameter d has a resistance of 20 n.

If another wire of the same metal is 2/ in length and 0.5d in diameter, what is its resistance?

A 10 Ω

B 20 Ω

C 80 Ω

D 160 Ω

6 In a lightning strike, 20 C of charge is transferred from a cloud to the ground in 0.020 s where the p.d. between the cloud and the ground is 1.5×10^6 V.

What is the current produced by this lightning strike?

A 0.4 A **B** 1000 A

C 3.0×10^4 A **D** 3.8×10^6 A

7 A wire W of length 0.50 m has a cross-sectional area of 1.0 mm^2. Which of the following wires of the same material has the same resistance as wire W?

	length/m	cross-sectional area / mm^2
A	0.50	2.0
B	0.50	0.50
C	0.25	2.0
D	0.25	0.50

8 Which of the following describes the electromotive force of a cell?

A The energy used to drive a unit charge through the resistance of the cell.

B The energy used to drive a unit charge round the complete circuit.

C The force exerted to drive a unit charge through the resistance of the cell.

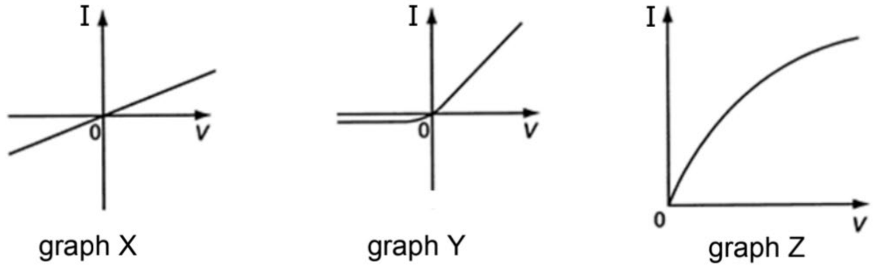
D The force exerted by the cell to drive a unit charge round the complete Circuit.

9 An electrical signal is transmitted through a thick copper wire. The radius of the wire is 3.0 cm and the resistivity of copper is 1.72×10^{-8} Ω m. For a clear transfer of signal, the maximum resistance across the wire is 2.0 Ω. What is the maximum transmission distance through the wire?

A 574 m **B** 329 km

C 21900 km **D** 4.11×10^7 km

10 The three graphs X, Y and Z show the I-V characteristics for three different circuit components.



Which of the following shows the possible circuit components displaying the I-V characteristics of the graphs?

A filament lamp metallic conductor semiconductor diode

B metallic conductor filament lamp semiconductor diode

C semiconductor diode filament lamp metallic conductor

D metallic conductor semiconductor diode filament lamp

11 A conductor carries a current of 2.5 A.

How long does it take for 20 C of charge to pass a point in the conductor?

A 2.5 s **B** 8.0 s

C 20 s **D** 50 s

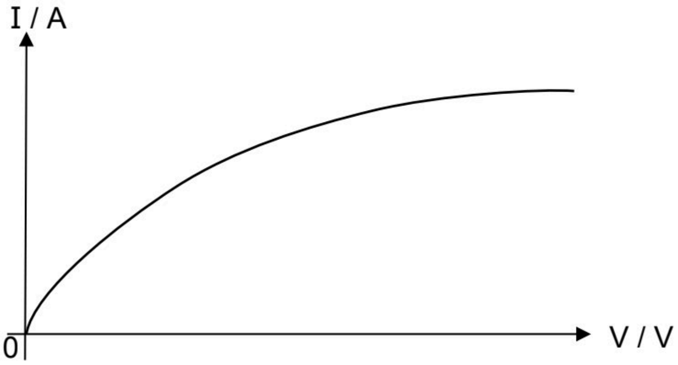
12 Wire E has a resistance of 10 Ω. Wire F, made of the same material, is twice the length but has half the cross sectional area of wire E.

What is the resistance of wire F?

A 2.5 Ω **B** 5.0 Ω

C 20 Ω **D** 40 Ω

13 The graph shows the variation of current, I in a lamp with potential difference, V across it.



From the graph, which statement about the resistance of the lamp is correct as the potential difference increases?

A Resistance of the lamp increases at first then decreases.

B Resistance of the lamp decreases at first then increases.

C Resistance of the lamp increases.

D Resistance of the lamp decreases.

14 What is an electromotive force?

A It is the work done by a voltage source to drive a unit charge through a component.

B It is the work done by an appliance in driving a unit charge around a circuit.

C It is the work done by a voltage source in driving a unit charge around a circuit.

D It is the product of current through a component and the resistance of the component.

15 A metal wire of length l and diameter d has resistance of 10 Ω.

If another wire of the same metal is 2l in length and 0.5d in diameter, what is its resistance?

A 5 Ω **B** 10 Ω **C** 40 Ω **D** 80 Ω

16 What is electric current?

A Rate of work done.

B Rate of flow of charge.

C Rate of change of resistance.

D Rate of change of potential.

17 A 6.00 m long cable with a radius of 1.0 mm has a resistance of 80 Ω. What is the corresponding length and radius of the cable that is made of the same material, which has a resistance of 15 Ω?

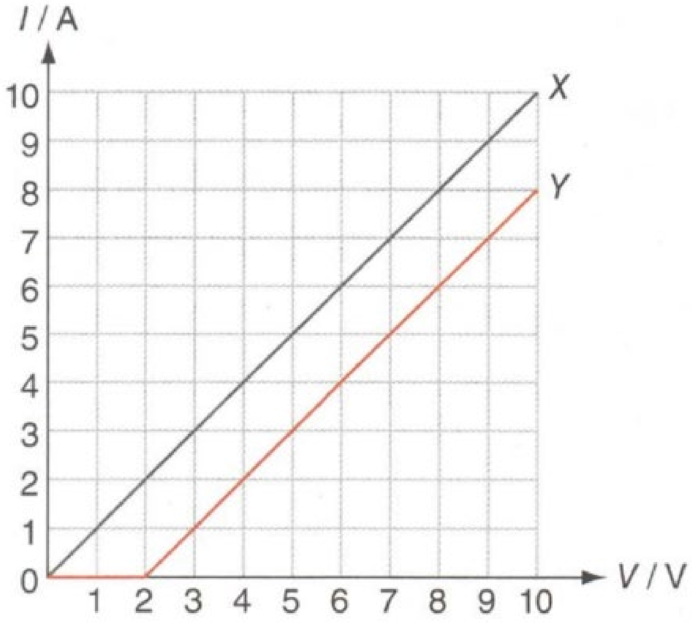
	length / m	radius / mm
A	2.00	2.0
B	2.00	4.0
C	18.00	2.0
D	18.00	4.0

18 A conductor carries a current of 4.0 A. How long does it take for 20 C of charge to pass a point in the conductor?

A 0.20 s **B** 5.0 s

C 24 s **D** 80 s

19 The diagram below shows the current-voltage (I-V) graph of electric components X and Y.



Which of the following statement is correct?

A X and Y have constant resistance.

B The resistance of X is larger than the resistance of Y.

C When X and Y are connected in series to a 6.0 V battery, the current drawn from the battery is 10 A.

D When X and Y are connected in parallel to a 6.0 V battery, the current drawn from the battery is 10 A.

20 Two wires P and Q of the same length 1.0 m and made of the same material are connected in parallel to a battery. The cross-section area of P is half of that of Q.

What is the ratio of the current through P to that in Q?

A 0.50

B 2.0

C 0.25

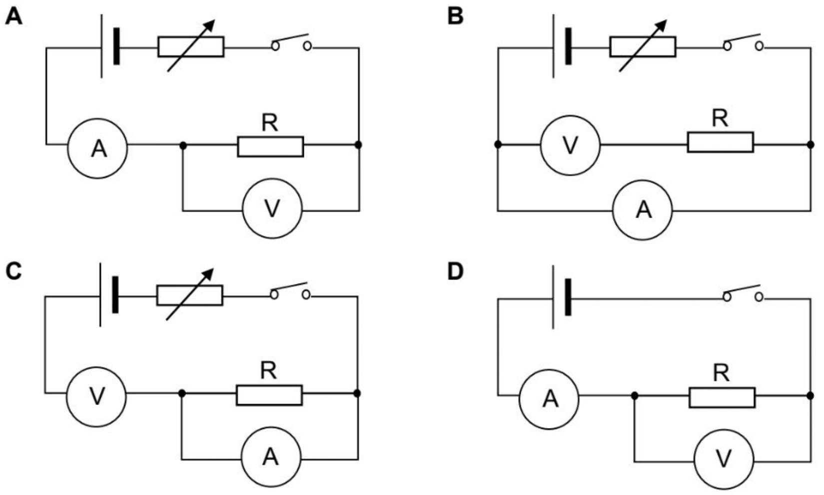
D 4.0

21 An electric toaster has 900 C flowing through it to toast two slices of bread in 1.5 minutes. What is the current through the electric toaster?

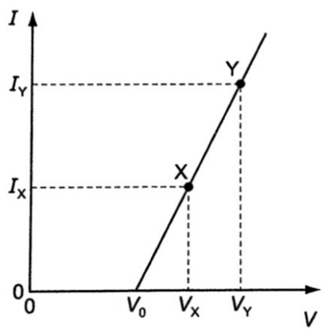
A 0.10 A **B** 10 A

C 600 A **D** 1400 A

22 Which circuit could be used to test whether a resistor R obeys Ohm's Law?



23 The graph shows the variation with potential difference (p.d.) V of the current I in an electrical component.



The resistance of the component is measured to have the values:

R_X, when the current is I_X and

R_Y, when the current is I_Y.

What is the difference between the resistance values of R_X and R_Y?

A zero

B $\dfrac{V_Y - V_X}{I_Y - I_X}$

C $\dfrac{V_X}{I_X} - \dfrac{V_Y}{I_Y}$

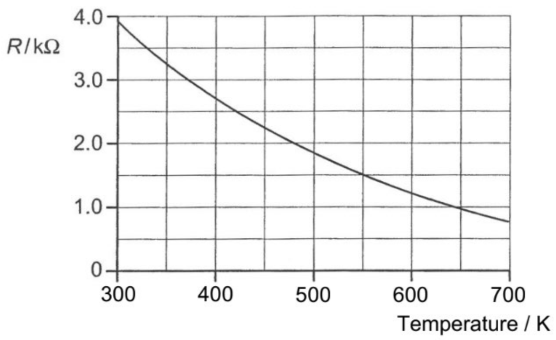
D $\dfrac{V_Y - V_0}{I_Y} - \dfrac{V_X - V_0}{I_X}$

24 A wire made of a material with resistivity ρ has length l and cross-section A. It is connected to a d.c. supply and has a potential difference V across it.

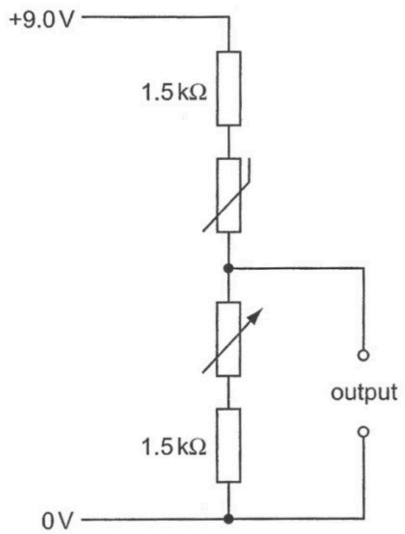
What is the energy supplied to the wire in time t?

A $\frac{V^2tA}{\rho l}$ **B** $\frac{VtA}{\rho l}$ **C** $\frac{V\rho lt}{A^2}$ **D** $\frac{V^2t\rho l}{A}$

25 The graph shows how the resistance of a thermistor changes with temperature.



The thermistor is connected in the potential divider circuit shown.



In order to obtain an output of 6.0 V at 550 K, to which value should the variable resistor be set?

A 1.5 k Ω **B** 3.0 k Ω **C** 4.5 k Ω **D** 6.0 k Ω

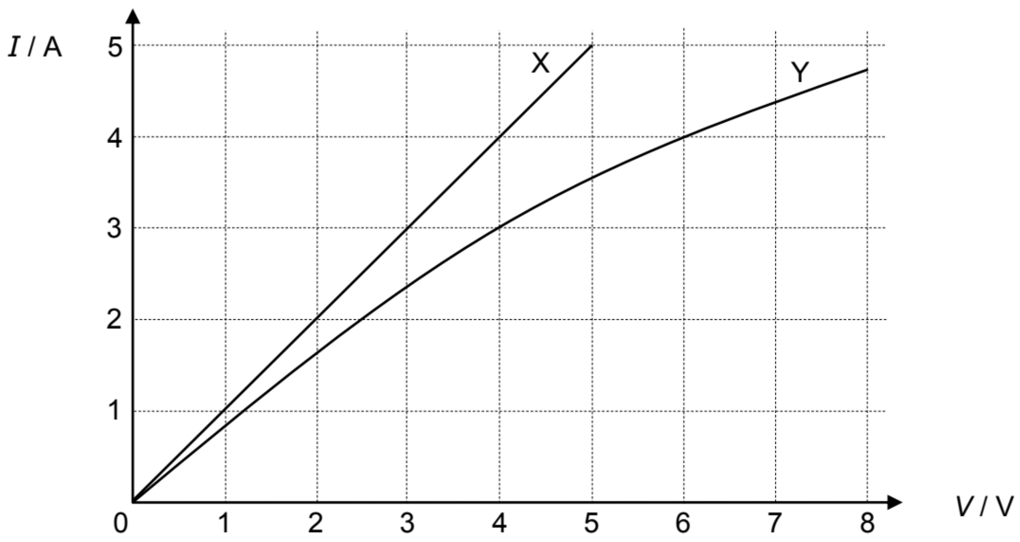
26 A light bulb is rated 12 V, 200 mW.

What quantity of charge flows through this light bulb in 30 minutes when it is operating normally?

A 2 mC **B** 30 mC

C 2 C **D** 30 C

27 The diagram below shows the current-voltage *(I-V)* graph of electric components X and Y.



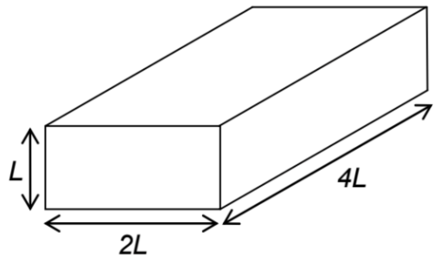
A When X and Y are connected in series, the current drawn from the battery is 3.5 A.

B When X and Y are connected in parallel, the current drawn from the battery is 3.5 A.

C When X and Y are connected in series, the current drawn from the battery is 7.0 A.

D When X and Y are connected in parallel, the current drawn from the battery is 7.0 A.

28 The diagram below shows a rectangular copper block with dimensions L, $2L$, and $4L$.



Electrical contact can be made to the block between opposite faces.

Assuming that the resistivity of the block is ρ, what is the smallest possible value of electrical resistance that can be obtained?

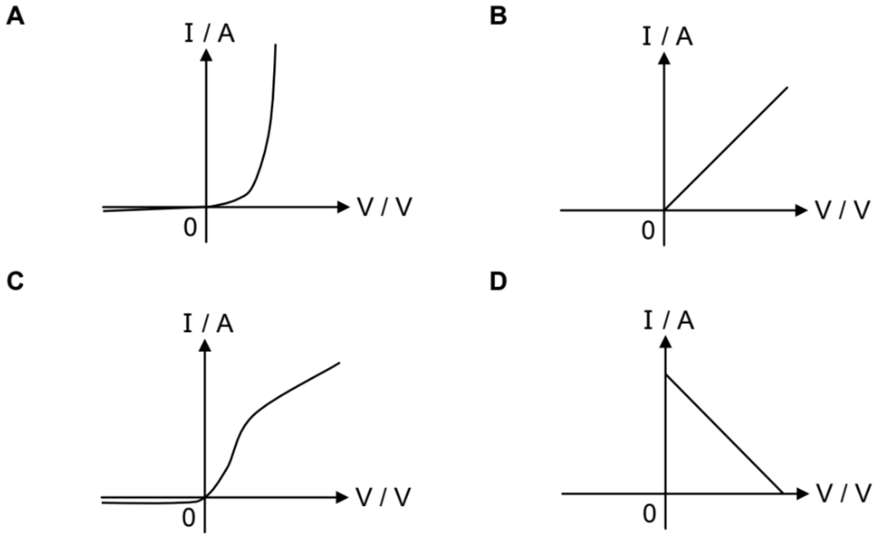
A $\rho / 9L$

B $\rho / 8L$

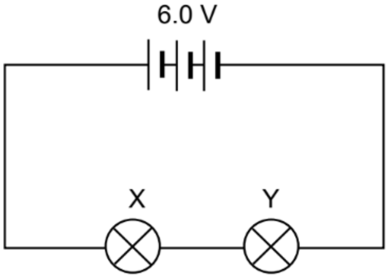
C $\rho / 2L$

D $2\rho / L$

29 Which is the I-V characteristic graph of a diode?



30 Two bulbs X and Y are connected to a 6.0 V battery as shown. If the potential difference (p.d.) across bulb X is 2.0 V, which of the following statements is NOT correct?



A When 2.0 C of charge pass through bulb X, 4.0 J of energy is transferred to this bulb.

B When 1.0 C of charge pass through bulb Y, 2.0 J of energy is transferred to this bulb.

C The charge passing through bulb X in 1.0 s is equal to the charge passing through bulb Y in 1.0 s.

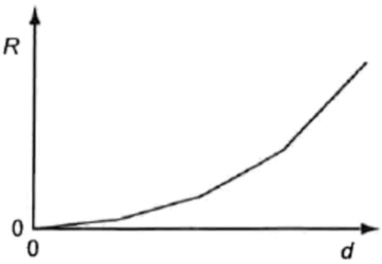
D The work done to move 1.0 C of charge across bulb Y is 4.0 J.

31 A composite wire is made by connecting in series four uniform wires made of the same material but having different diameters.

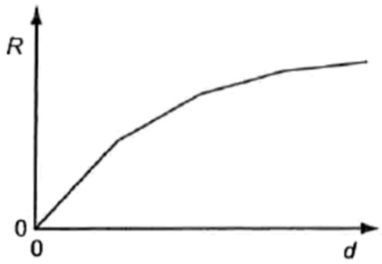
The resistance R of this composite wire is measured between X and other points on the wire at distances d from X.

Which graph best represents the relationship between R and d?

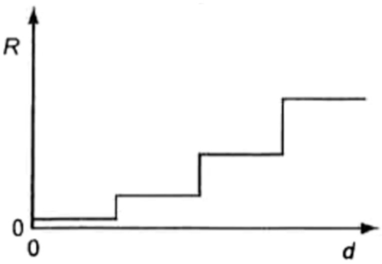
A



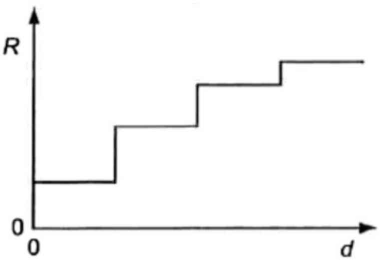
B



C



D



32 In a lightning strike, 20 C of charge is transferred from a cloud (at a high voltage of 1.5 × 106 V) to the ground in 0.020 s.

What is the average current produced by this strike?

A 0.40 A

B 1 000 A

C 30 000 A

D 3.8 × 106 A

33 Which of the following is the correct unit for work done to move a charge through an electrical component in a circuit?

A V C

B V s

C A Ω

D C s-1

34 A copper wire is stretched so that its length increases and its diameter decreases.

What happens to the wire's resistivity and resistance?

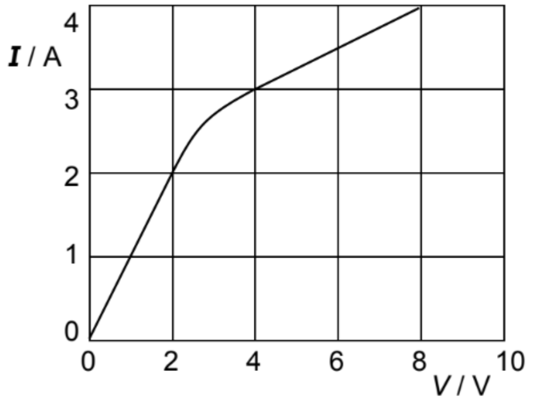
	resistivity	resistance
A	stays the same	decreases
B	decreases	stays the same
C	stays the same	increases
D	increases	stays the same

35 A wire of length 0.60 m has a cross-sectional area of 1.2 mm2.

Which row shows another wire of the same material with the same resistance?

	cross-sectional area / mm^2	length / m
A	2.0	0.50
B	0.5	0.50
C	2.0	0.25
D	0.5	0.25

36 The diagram shows a graph of current I against potential difference V for a filament lamp.



What is the resistance when the potential difference across the lamp is 6.0 V?

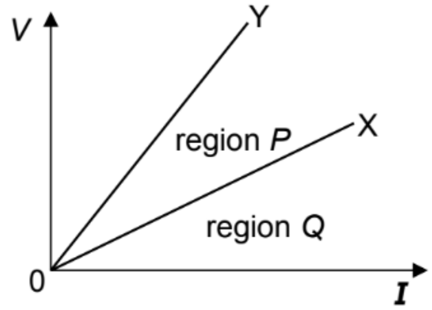
A 0.25 Ω

B 0.58 Ω

C 1.7 Ω

D 4.0 Ω

37 The diagram shows the voltage-current (V-I) graphs of two resistors X and Y.



Which statements is/are correct?

(1) The resistance of X is higher than that of Y.
(2) If X and Y are connected in series, the V-I graph of the combined resistor will lie in region P.
(3) If X and Y are connected in parallel, the V-I graph of the combined resistor will lie in region Q.

A (2) only.

B (3) only.

C (1) and (2) only.

D (1) and (3) only.

CURRENT OF ELECTRICITY STRUCTURED QUESTIONS

1 **(a)** Define **potential difference.**

....

....

....[1]

(b) A circuit was set up to enable a variable potential difference to be applied across a wire, and for the current and the potential difference to be measured.

Two insulated wires **A** and **B** of the same material and length, but different thicknesses were connected into the circuit one at a time.

Readings of current and potential difference were recorded for each of the wire.

The graphs below represent the results of the experiment.

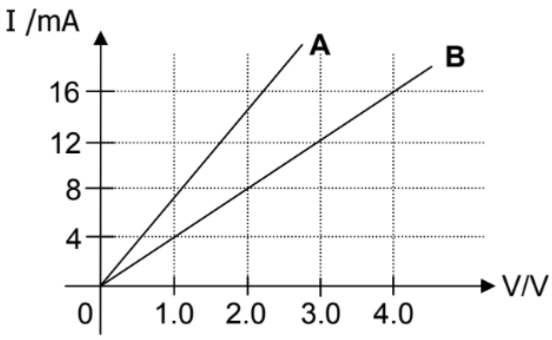


Fig. 20

(i) Draw the circuit diagram of a circuit which would enable the necessary current and potential difference measurements to be made to plot the above graph for each of the wires **A** and **B**. Include all the necessary measuring instruments. [3]

(ii) From the graph, calculate the resistance of wire **B.** Show all your working clearly.

Resistance = ... [2]

(iii) Which wire has a smaller cross-sectional area?

Explain how you arrived at your answer.

....

....

....

....[2]

(iv) Both wires **A** and **B** are coiled and made into heating elements. They are then connected in turn across a voltage supply.

State and explain which wire gives a larger power output.

....

....

....

....[2]

2 The variation with current of the potential difference (p.d.) across a component X is shown in Fig. 9.1.

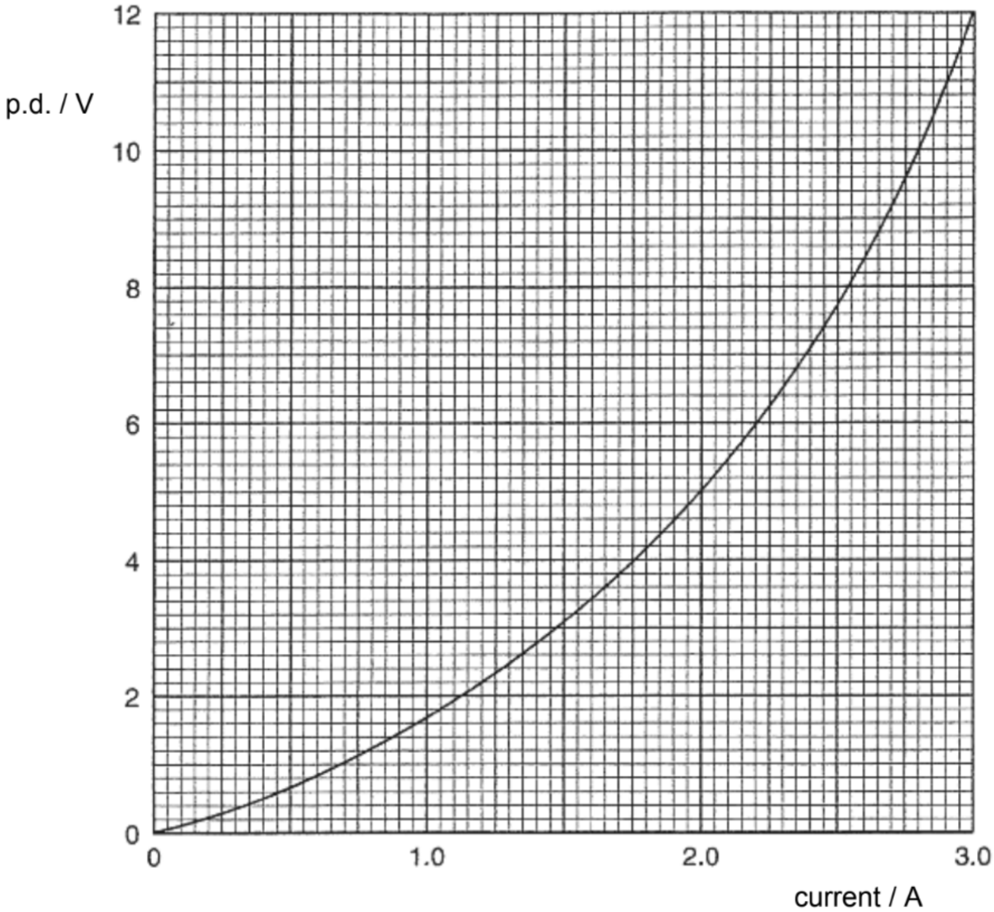


Fig. 9.1

(a) **(i)** State how the resistance of component X varies, if at all, with increase of current.

....[1]

(ii) On Fig. 9.1 (using the same axes), draw a line to show the variation with current of the p.d. across a resistor R of constant resistance 3.0 Ω.

[1]

(b) The component X and a resistor R of resistance 3.0 Ω are connected in series with a battery as shown in Fig. 9.2.

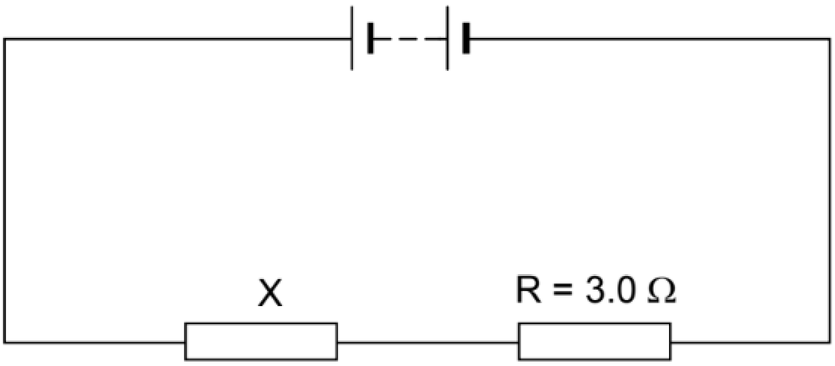


Fig. 9.2

The current in the circuit is found to be 2.0 A.

(i) Use Fig. 9.1 to determine the p.d. across component X.

p.d. across X = ... [1]

(ii) Determine the p.d. across R.

p.d. across R = ... [1]

(c) The resistor R and the component X are now connected in parallel with the same battery, as shown in Fig. 9.3.

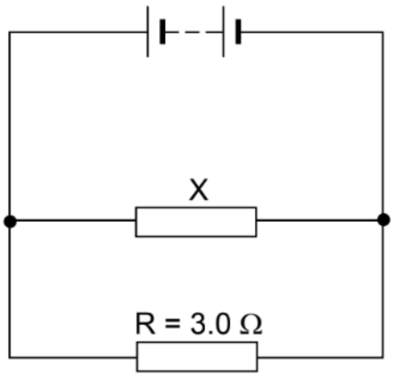


Fig. 9.3

Using your answer to (b)(iii) and the graph of Fig.9.1, determine the current supplied by the battery in Fig. 9.3.

current = ... [2]

3 Fig. 10.1 below shows how the readings of current through a metal wire changes when different potential differences are applied across it.

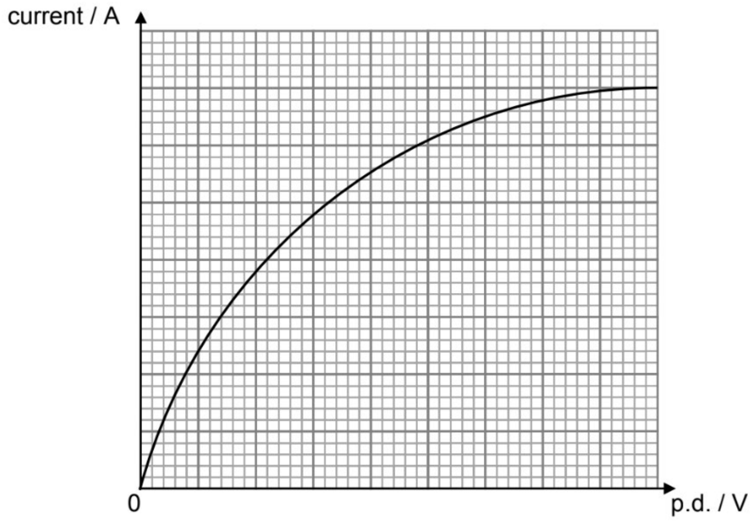


Fig. 10.1

(a) Describe how the resistance of the wire changes as the potential difference applied across it increases. Explain your reasoning clearly.

....

....

....

.... [2]

(b) The change in resistance of a piece of metal wire can be used to monitor the growth of cracks in a wall. Fig. 10.2 shows a piece of such wire being stretched tightly and fixed firmly on two points X and Y across the gap on a wall to be monitored.

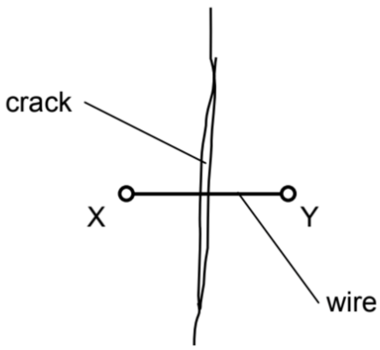


Fig. 10.2

X and Y are connected to an external circuit that measures the change in resistance of the wire.

(i) If the crack opened slightly, state how the length, thickness and resistance of the wire would be affected (if any).

....

....

....

....

....

....

....[3]

(ii) State one other physical factor that affects the resistance of a metal wire.

Explain how it introduces an error in determining the size of the crack in (i).

....

....

....

....[2]

(c) Fig. 10.3 shows an electric circuit connected to a battery with an e.m.f. of 12 V and negligible internal resistance.

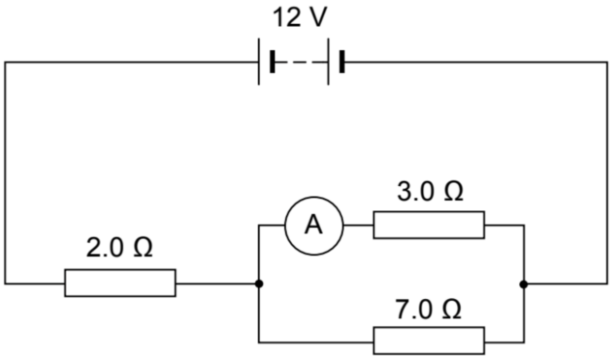


Fig. 10.3

The reading on the ammeter is 2.05 A.

Calculate

(i) the combined resistance of the 3 resistors in the circuit,

resistance = ... [2]

(ii) the current through the 7.0 Ω resistor.

current = ... [1]

4 Fig. 7.1 shows a lamp L and a resistor R connected in series to a cell with an electromotive force (e.m.f.) of 5.0 V.

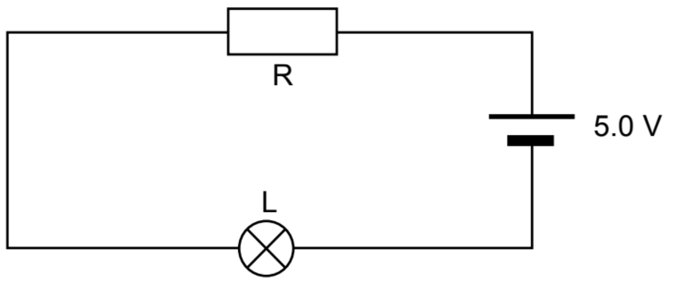


Fig. 7.1

(a) Explain what is meant by the term "electromotive force (e.m.f.) of 5.0 V".

....

....

....[1]

Fig. 7.2 shows how the current in lamp L varies with the potential difference (p.d.) applied across it.

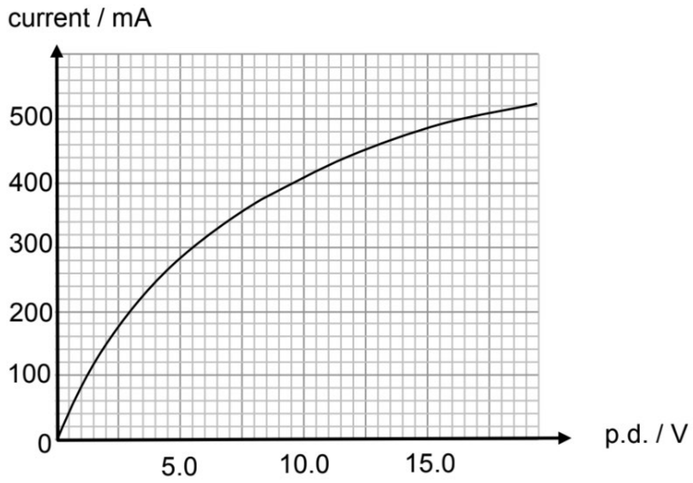


Fig. 7.2

(b) Describe how the resistance of the lamp L varies as the p.d. applied increases.

....

....

....[1]

(c) The current in the circuit is 200 mA.

(i) Use the graph to determine the resistance of the lamp L in the circuit shown in Fig. 7.1.

resistance of lamp L = ...[2]

(ii) Calculate the resistance of the resistor R.

resistance of resistor R = ...[2]

(d) Sketch on the graph in Fig. 7.2, a line that shows the variation of current with the p.d. for the resistor R. [2]

5 XY is a variable resistor made from a long bare resistance wire and a sliding contact C is connected to a 12.0 V supply in a circuit as shown in Fig. 8.1. A thermistor with resistance that decreases with increase in temperature, is connected between the terminals A and B.

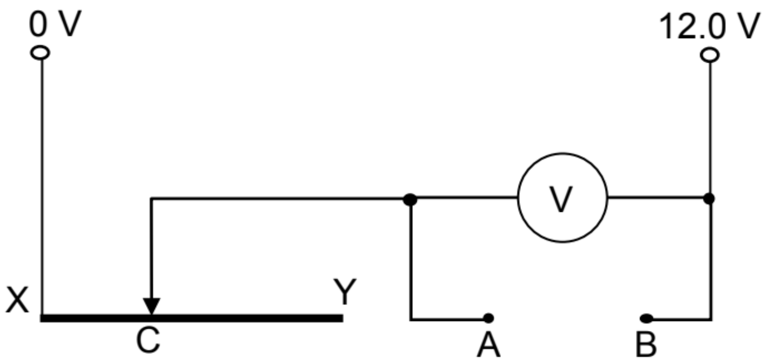


Fig. 8.1

(a) Draw the symbol of the thermistor in the circuit in Fig. 8.1. [1]

(b) Describe and explain how the voltmeter reading changes when the sliding contact C is moved from X towards Y.

....

....

....

....

....

....

....[3]

(c) At a constant surrounding temperature of 70 °C, the resistance of the thermistor is 200 Ω and the maximum resistance of the variable resistor is 400 Ω. The sliding contact C in the circuit is set at a position midway between X and Y. Calculate:

(i) the effective resistance of the circuit at 70 °C.

effective resistance = ……………..…..[1]

(ii) the current in the thermistor at 70 °C.

current = ……………..….[2]

(d) Sketch on Fig. 8.2 a graph showing how the resistance of the thermistor varies with temperature. [1]

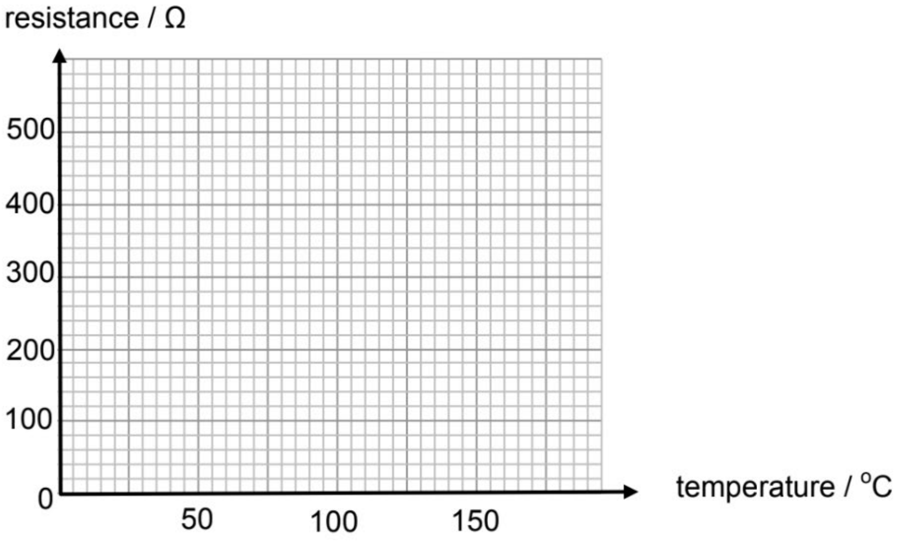


Fig. 8.2

(e) State and explain clearly how the voltmeter reading changes as the surrounding temperature increases.

....

....

....

....

....[2]

6 Fig. 7.1 show a circuit that Jeanette uses to find the resistance of a resistor X. The e.m.f. of the cell E is 2.0 V and the voltmeter has a resistance of 2.5 × 103 Ω.

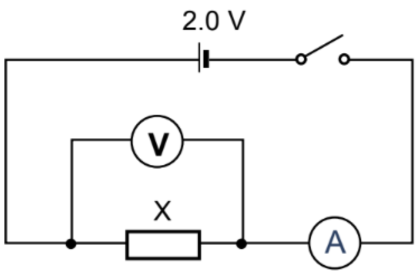


Fig. 7.1

(a) If the actual resistance of X is 2.0 × 103 Ω, and the resistance of the ammeter is much smaller than that of X, calculate

(i) the reading of the ammeter, and

ammeter reading = ...[2]

(ii) the value of the resistance of X that Jeanette gets.

value of resistance of X obtained = ...[1]

(b) Explain why the value of X obtained by Jeanette is different from the actual value.

....

....

....

....

....

.... [2]

(c) In the space below, draw the correct circuit that she should connect to determine the value of X. [1]

7 Wire P is made from the same material and of the same length as wire Q.

However, the radius of P is twice that of Q.

Determine the ratio of the resistance of wire P to the resistance of wire Q.

ratio = ... [2]

8 **(a)** An electrical component C has an I-V characteristic as shown in Fig. 10.1, where I is the current passing through C and V is the potential difference (p.d.) across it.

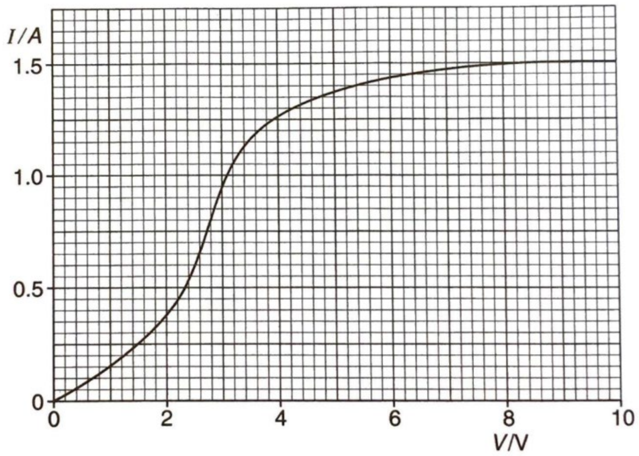


Fig. 10.1

(i) Explain what is meant by potential difference across a component.

....

....[1]

(ii) Calculate the resistance of component C when a p.d. of 6.0 V is applied across it.

resistance = ... [2]

(iii) Deduce the minimum value of the resistance of component C over the range 0 to 10 V. Show your reasoning clearly.

minimum resistance = ... [2]

(b) Component C is then connected into a circuit as shown in Fig. 10.2.

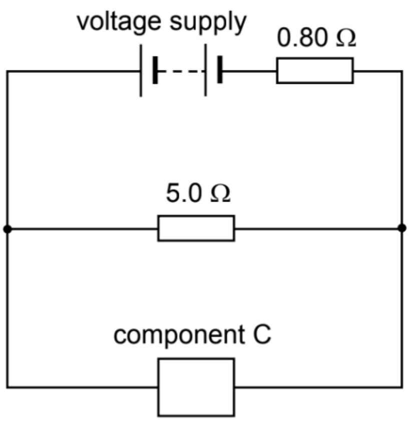


Fig. 10.2

The current through the 5.0 resistor is found to be 0.85 A.

Calculate

(i) the p.d. across component C,

p.d. = ... [1]

(ii) the total current from the voltage supply,

total current = ... [2]

(iii) the e.m.f. of the voltage supply.

e.m.f. = ... [2]

9 Fig. 6.1 shows a uniform metal wire P of length 2.4 cm with a cross-sectional area 5.0 x 10^{-6} m^2. The resistivity of the metal is 1.2 Ω m.

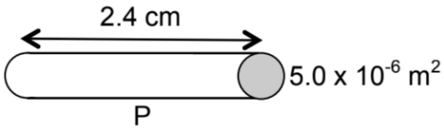


Fig. 6.1

(a) Define electrical resistance of a wire.

....

....

.... [1]

(b) Calculate the resistance of wire P.

resistance = ... [2]

(c) Another wire Q is constructed from the same material but has twice the length and half the diameter of wire P.

Determine the ratio of the resistance of wire P to the resistance of wire Q.

ratio = ... [2]

10 The I-V characteristics of a car headlamp are investigated using the circuit shown in Fig. 7.1.

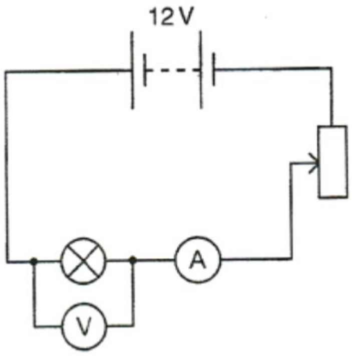


Fig. 7.1

The variable resistor can be adjusted to have resistance between 0 and 10 W .

Readings of potential difference (p.d.) V across the lamp and current I in the circuit are taken. The results obtained are shown in Fig. 7.2.

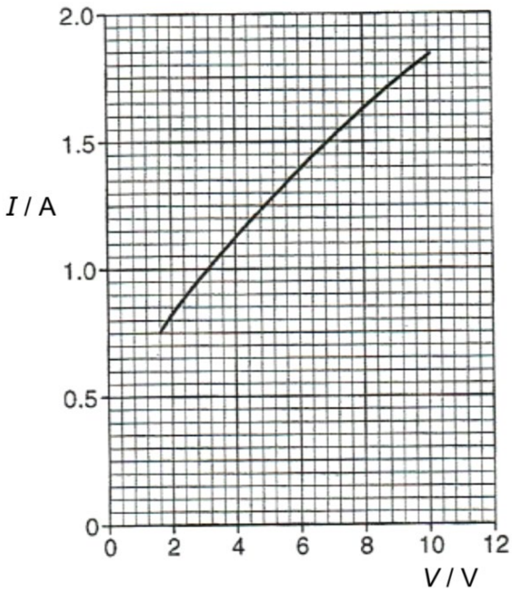


Fig. 7.2

(a) Describe how the resistance of the lamp can be obtained from Fig. 7.2.

....

.... [1]

(b) On Fig. 7.3, sketch the variation in resistance of the lamp when the p.d. across it is varied over the range of 2.0 V to 10.0 V. (Indicate the numerical values for the extreme ends of your graph). [2]

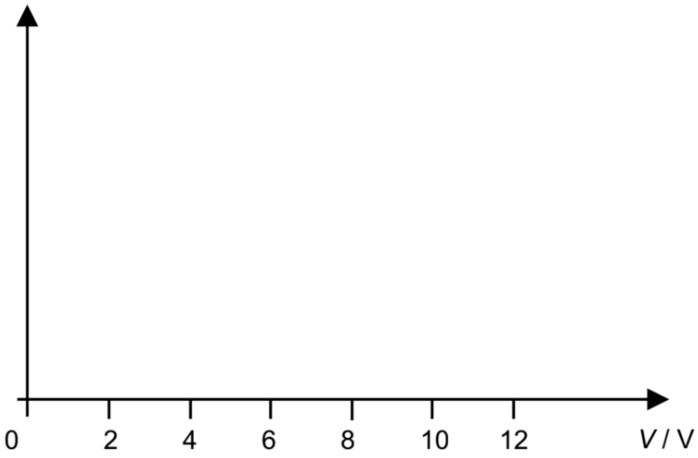


Fig. 7.3

11 Fig. 5.1 shows the I/V characteristic graph for a filament lamp and a resistor.

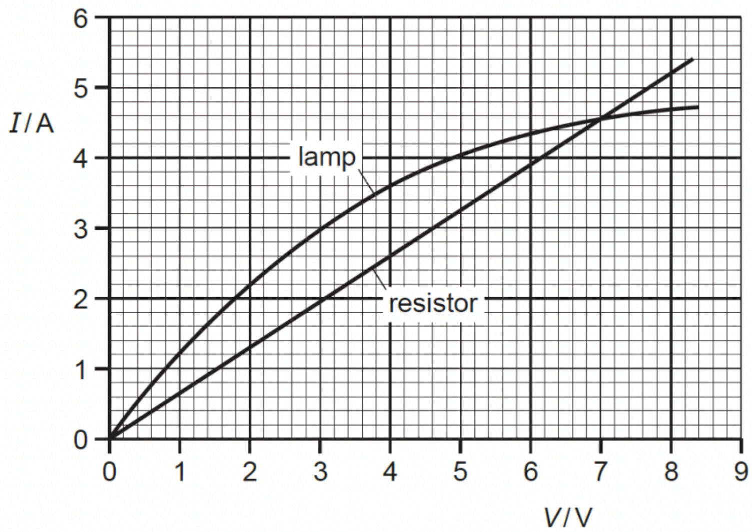


Fig. 5.1

(a) Describe how Fig. 5.1 shows that the resistor obeys Ohm's Law.

....

....

.... [1]

(b) State the value of the potential difference where the lamp and the resistor have the same resistance.

potential difference = ... [1]

(c) Another resistor X is made of the same material as the original resistor but is twice as long and has a diameter three times larger.

Calculate the resistance of resistor X.

resistance = ... [2]

(d) Another lamp labelled 6 V, 12 W is connected to a 6 V fully charged battery and it shines at normal brightness for 12 hours.

Calculate the charge that passes through the lamp during this time.

charge = ... [2]

[Total: 6]

12 Fig. 6.1 shows a circuit with a light-dependent resistor (LDR) and a resistor with fixed resistance of 8.0 kΩ.

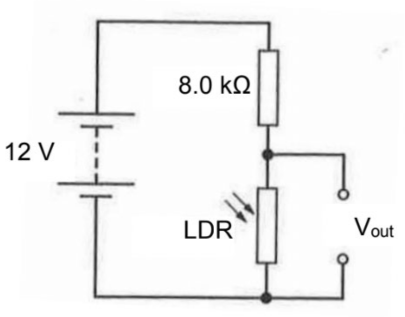


Fig. 6.1

The LDR has a resistance of 600 Ω in bright light.

(a) Calculate the output voltage Vout when the LDR is in bright light.

Vout = ……………….. [2]

(b) In dim light, Vout is 8.0 V. For this level of brightness, determine

(i) the voltage across the fixed resistor,

V = …………………. [1]

(ii) the resistance of the LDR.

resistance = ……………………… [1]

(c) The output is now connected across the resistor. A lamp is connected across the output, and this lamp only switches on when Vout is larger than 8.0 V.

Describe and explain the operation of this new device as the level of light changes.

…………………………………………………………………………………......

…………………………………………………………………………………

…………………………………………………………………………………..

………………………………………………………………………………….. [2]

[Total: 6]

ANSWERS FOR CURRENT OF ELECTRICITY MCQ

Q1: D	Q11: B	Q21: B	Q31: A
Q2: A	Q12: D	Q22: A	Q32: B
Q3: D	Q13: C	Q23: C	Q33: A
Q4: A	Q14: C	Q24: A	Q34: C
Q5: D	Q15: D	Q25: C	Q35: D
Q6: B	Q16: B	Q26: D	Q36: C
Q7: D	Q17: D	Q27: D	Q37: B
Q8: B	Q18: B	Q28: B	
Q9: B	Q19: D	Q29: A	
Q10: D	Q20: A	Q30: B	

ANSWERS FOR CURRENT OF ELECTRICITY STRUCTURED QUESTIONS

1 **(a)** Define **potential difference.**

Potential difference is the work done* to drive a unit / coulomb) of charge through a component / between 2 points in the circuit. [1m]

* ‘energy converted from electrical to other forms’ accepted since it is given in textbook but not encouraged. There can be instances when a charge is moved but energy conversion does not take place. [1]

(b) A circuit was set up to enable a variable potential difference to be applied across a wire, and for the current and the potential difference to be measured.

Two insulated wires **A** and **B** of the same material and length, but different thicknesses were connected into the circuit one at a time.

Readings of current and potential difference were recorded for each of the wire.

The graphs below represent the results of the experiment.

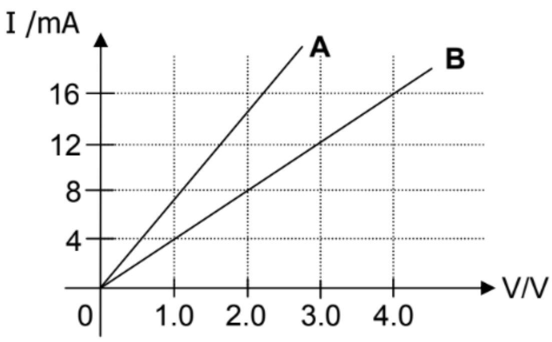
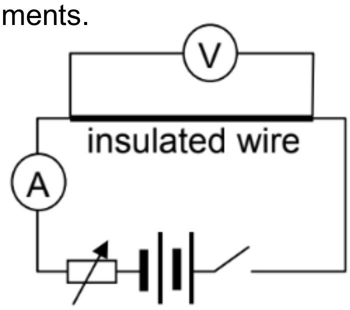


Fig. 20

(i) Draw the circuit diagram of a circuit which would enable the necessary current and potential difference measurements to be made to plot the above graph for each of the wires **A** and **B**. Include all the necessary measuring instruments. [3]



- Voltmeter in parallel with insulated wire
- Ammeter in series with insulated wire
- Correct symbols used for circuit diagram
- Circuit allows for current and p.d. to be correctly measured for the insulated wire

[1m to be deducted for each of the above not fulfilled. If insulated wire is represented by resistor symbol, student shd label it as the wire]

(ii) From the graph, calculate the resistance of wire **B.** Show all your working clearly.

R = V/I = 4.0 / (16×10^{-3})

[1m; other correct sets of values from the graph can be accepted]

= 250 Ω [1m] [2]

(iii) Which wire has a smaller cross-sectional area?

Explain how you arrived at your answer.

A wire with a smaller cross-sectional area will have a higher resistance since the resistance of a wire is inversely proportional to its cross-sectional area. [1m]

Since R = V/I, it is the inverse of the gradient of the graph. The smaller gradient will indicate the larger resistance. [1m]

Wire B has a smaller cross-sectional area. [deduct one mark if not stated, but no mark for this if the explanation is wrong.] [2]

(iv) Both wires **A** and **B** are coiled and made into heating elements. They are then connected in turn across a voltage supply.

State and explain which wire gives a larger power output.

Power output $P = V^2/R$. [1m]

Since V is a constant for both wires, wire A with the lower resistance will give a larger power output. [1m] [2]

2 The variation with current of the potential difference (p.d.) across a component X is shown in Fig. 9.1.

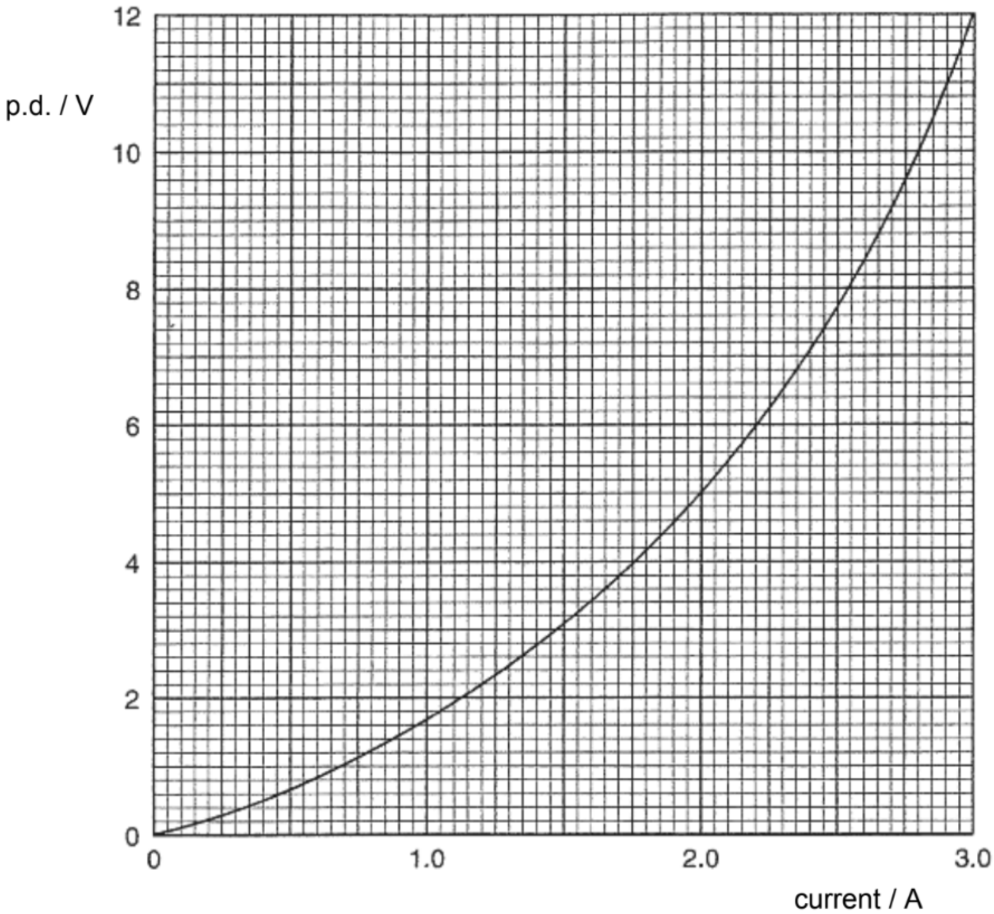


Fig. 9.1

(a) **(i)** State how the resistance of component X varies, if at all, with increase of current.

R is the ratio of p.d. to current. As the current increases, the ratio increases.

<u>Resistance of X increases with the current</u> [1]

(ii) On Fig. 9.1 (using the same axes), draw a line to show the variation with current of the p.d. across a resistor R of constant resistance 3.0 Ω.

straight line with "slope" = R = 3 Ω, passing through (0, 0) and (3, 9)

[1]

(b) The component X and a resistor R of resistance 3.0 Ω are connected in series with a battery as shown in Fig. 9.2.

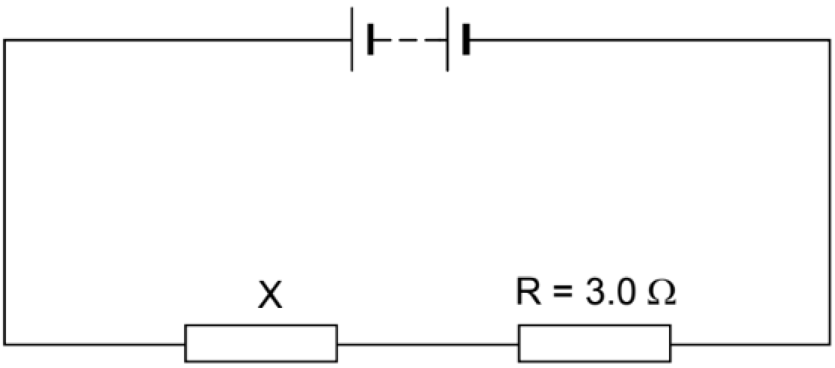


Fig. 9.2

The current in the circuit is found to be 2.0 A.

(i) Use Fig. 9.1 to determine the p.d. across component X.

From graph, when current = 2.0 A, p.d. across X is 5.0 V. [1]

(ii) Determine the p.d. across R.

From straight line graph drawn, p.d. of R = 6.0 V

OR V = IR = 2.0 x 3.0 = 6.0 V [1]

e.m.f. = sum of p.d.s = 5.0 + 6.0

= 11.0 V

(c) The resistor R and the component X are now connected in parallel with the same battery, as shown in Fig. 9.3.

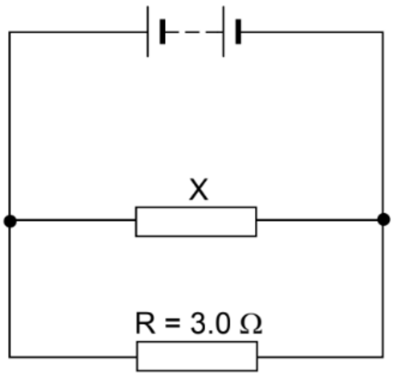


Fig. 9.3

Using your answer to (b)(iii) and the graph of Fig.9.1, determine the current supplied by the battery in Fig. 9.3.

e.m.f. = p.d. across both X and R is 11.0 V

Current from battery = current through X + current through R

= 2.9 A (from graph) + (11.0 V / 3.0 Ω)

= 6.567 ≈ 6.6 A (2 s.f.)

[2]

3 Fig. 10.1 below shows how the readings of current through a metal wire changes when different potential differences are applied across it.

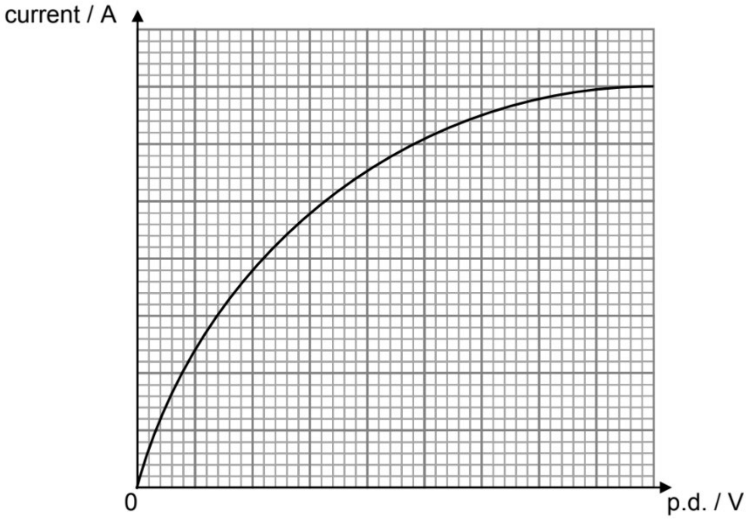


Fig. 10.1

(a) Describe how the resistance of the wire changes as the potential difference applied across it increases. Explain your reasoning clearly.

The **resistance** of the wire is the **ratio of the potential difference applied to the current** flowing through it.

From the graph, this **ratio increases as the potential difference applied increases, (or the current increases at a slower rate than the increase in p.d.)** hence, the **resistance of the wire increases** with the increase in potential difference. [2]

(b) The change in resistance of a piece of metal wire can be used to monitor the growth of cracks in a wall. Fig. 10.2 shows a piece of such wire being stretched tightly and fixed firmly on two points X and Y across the gap on a wall to be monitored.

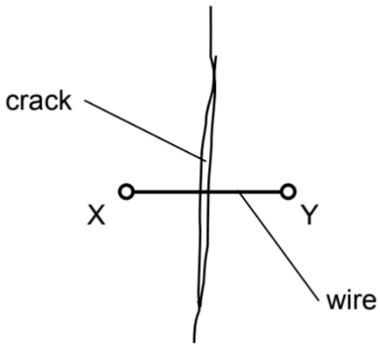


Fig. 10.2

X and Y are connected to an external circuit that measures the change in resistance of the wire.

(i) If the crack opened slightly, state how the length, thickness and resistance of the wire would be affected (if any).

The **length** will **increase**.

The **thickness** will **decrease** (hence cross-section area will decrease).
The **resistance** of the wire will **increase**. [3]

(ii) State one other physical factor that affects the resistance of a metal wire.

Explain how it introduces an error in determining the size of the crack in (i).

Temperature of the environment.

If the **temperature** of the environment **increases**, (the **resistivity** of the wire increases), the **resistance** of the wire will **increase**. This will result in a **wrong indication to the user that the crack has widened**. [2]

(c) Fig. 10.3 shows an electric circuit connected to a battery with an e.m.f. of 12 V and negligible internal resistance.

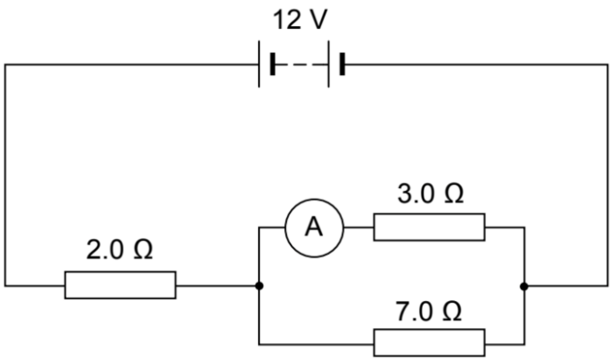


Fig. 10.3

The reading on the ammeter is 2.05 A.

Calculate

(i) the combined resistance of the 3 resistors in the circuit,

Effective resistance (in parallel) of 3.0 Ω & 7.0 Ω = 2.1 Ω

Hence, combined resistance = 2.0 Ω + 2.1 Ω = 4.1 Ω [2]

(ii) the current through the 7.0 Ω resistor.

I_{main} = e.m.f. / R_{eff} = 12 / 4.1 = 2.927 A

I (through 7.0 Ω resistor) = V/R = (e.m.f. – p.d.(across 2.0 Ω)) / R

= (12 – (2.927 × 2)) / 7.0 = <u>0.88 A</u> [1]

4 Fig. 7.1 shows a lamp L and a resistor R connected in series to a cell with an electromotive force (e.m.f.) of 5.0 V.

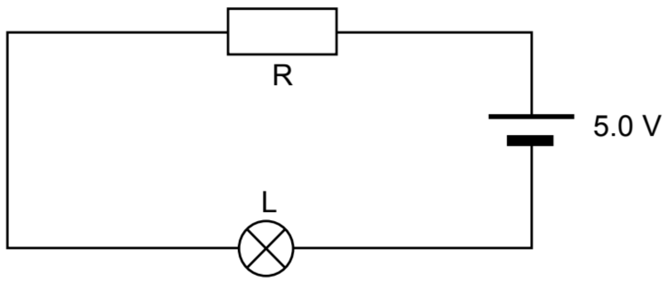


Fig. 7.1

(a) Explain what is meant by the term "electromotive force (e.m.f.) of 5.0 V".

An e.m.f of 5.0V means that the cell will convert 5.0 J of chemical potential energy to electrical energy to drive 1.0 C of charge round the circuit.[1]

Fig. 7.2 shows how the current in lamp L varies with the potential difference (p.d.) applied across it.

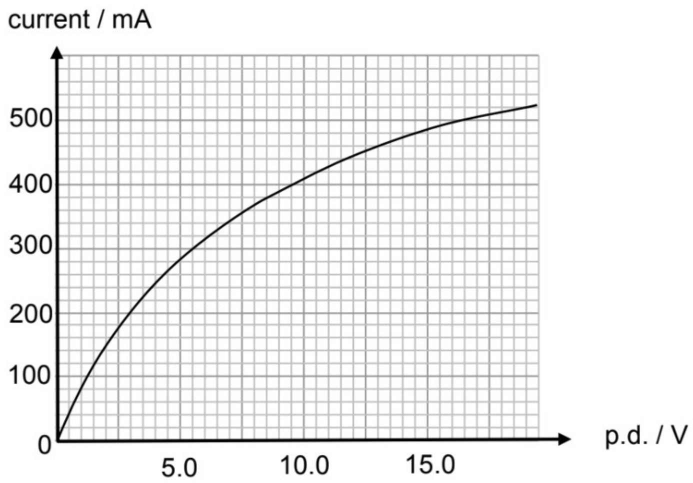


Fig. 7.2

(b) Describe how the resistance of the lamp L varies as the p.d. applied increases.

The resistance of the lamp **increases** as the p.d. increases. [1]

(c) The current in the circuit is 200 mA.

(i) Use the graph to determine the resistance of the lamp L in the circuit shown in Fig. 7.1.

p.d. of the lamp when current is 200 mA = 3.0 V

RL = V÷ I = 3.0 V ÷ 0.200 A = <u>15 Ω</u> [2]

(ii) Calculate the resistance of the resistor R.

P.d. across the resistor = 5.0 V – 3.0 V = 2.0 V

RR = V÷ I = 2.0 V ÷ 0.200 A = <u>10 Ω</u> [2]

(d) Sketch on the graph in Fig. 7.2, a line that shows the variation of current with the p.d. for the resistor R. [2]

Straight line from the origin.

Line to cut V = 5.0 V,

Current = 500 mA

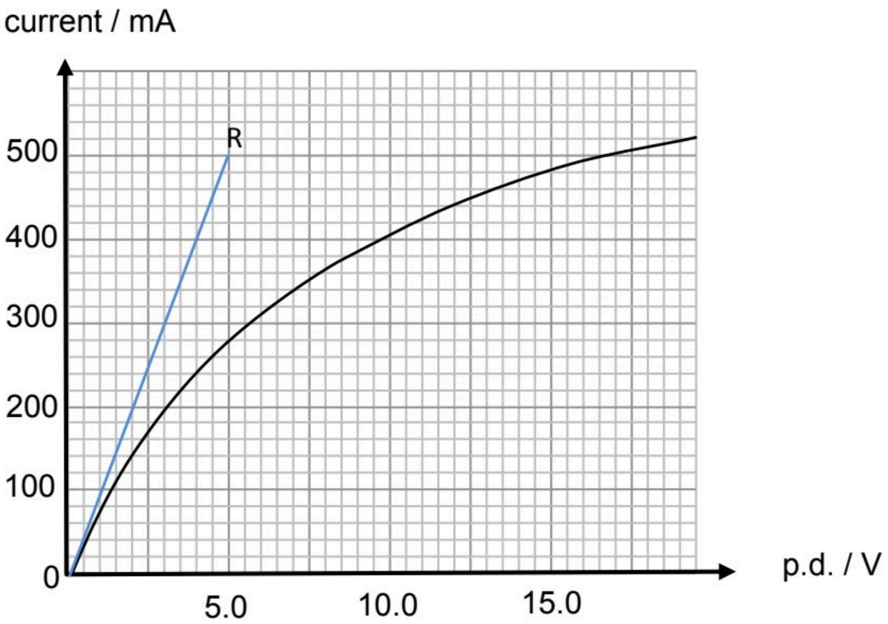


Fig. 8.2

5 XY is a variable resistor made from a long bare resistance wire and a sliding contact C is connected to a 12.0 V supply in a circuit as shown in Fig. 8.1. A thermistor with resistance that decreases with increase in temperature, is connected between the terminals A and B.

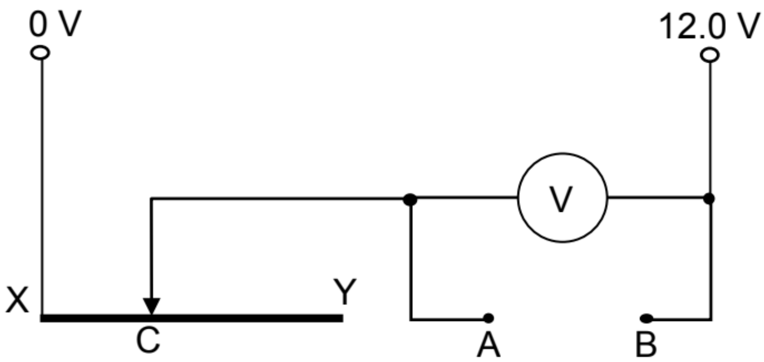
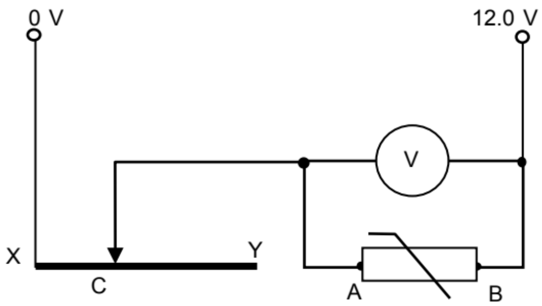


Fig. 8.1

(a) Draw the symbol of the thermistor in the circuit in Fig. 8.1. [1]

Symbol of thermistor drawn with correct orientation in the circuit.



(b) Describe and explain how the voltmeter reading changes when the sliding contact C is moved from X towards Y.

Since XC section of the resistance wire and the thermistor are connected in **series**, the **same current** flows through them. Hence, the p.d. is directly proportional to the resistance (potential divider concept).

When C is at X, the resistance across CX is 0 Ω. Applying the potential divider concept, the p.d. across CX is 0 V and the p.d. across the thermistor is 12 V.

As C slid towards Y, the resistance across CX will gradually increases to a maximum. Applying the potential divider concept, the p.d. across CX increases and the p.d. across the thermistor decreases. [3]

(c) At a constant surrounding temperature of 70 °C, the resistance of the thermistor is 200 Ω and the maximum resistance of the variable resistor is 400 Ω. The sliding contact C in the circuit is set at a position midway between X and Y. Calculate:

(i) the effective resistance of the circuit at 70 °C.

Effective resistance $R_E = R_T + R_{CX}$ = 200 Ω + 200 Ω = 400 Ω [1]

(ii) the current in the thermistor at 70 °C.

$I_T = V \div R_E$ = 12 V ÷ 400 Ω = 0.030 A [2]

(d) Sketch on Fig. 8.2 a graph showing how the resistance of the thermistor varies with temperature. [1]

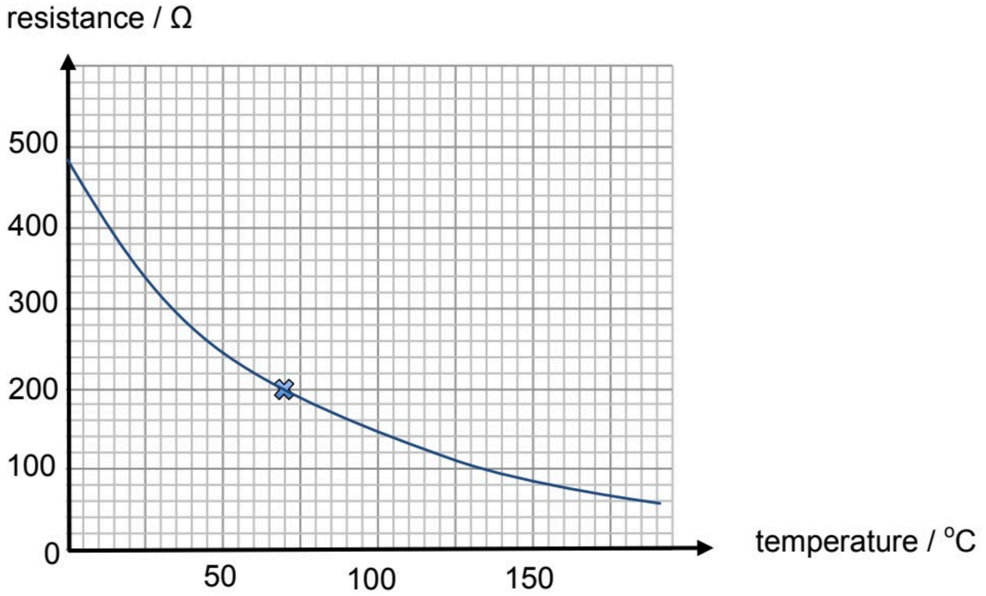


Fig. 8.2

Curve line drawn that shows decreasing resistance with increased in temperature that pass through point when temp = 70 °C and resistance = 200 Ω

(e) State and explain clearly how the voltmeter reading changes as the surrounding temperature increases.

As room temperature increases, the resistance of the thermistor decreases **and the resistance of the resistance wire increases**. (both changes must be mentioned) As room temperature increases, the ratio of the resistance of the thermistor to that of the resistance wire decreases. Hence, based on potential divider concept, the p.d. across the thermistor decreases. [2]

6 Fig. 7.1 show a circuit that Jeanette uses to find the resistance of a resistor X. The e.m.f. of the cell E is 2.0 V and the voltmeter has a resistance of 2.5 × 103 Ω.

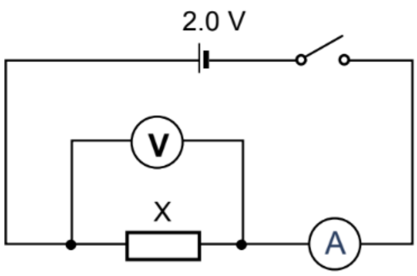


Fig. 7.1

(a) If the actual resistance of X is 2.0 × 103 Ω, and the resistance of the ammeter is much smaller than that of X, calculate

(i) the reading of the ammeter, and

Effective resistance of the voltmeter and X connected in parallel:

$$\frac{1}{R_e} = \frac{1}{2500\Omega} + \frac{1}{2000\Omega}$$

$R_e = 1111\Omega$

Reading of ammeter = $\frac{2.0\ V}{1111\Omega}$ $= 1.8 \times 10^{-3}$ A [2]

(ii) the value of the resistance of X that Jeanette gets.

value of X obtained = $\frac{2.0\ V}{0.0018\ A}$ = 1100 Ω (2 s.f) [1]

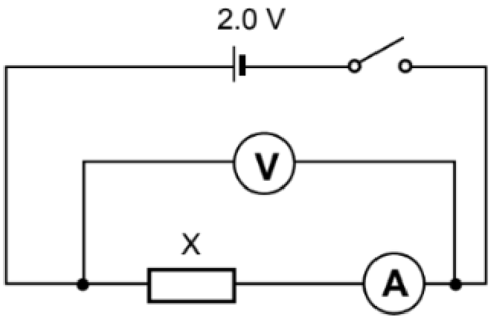
(b) Explain why the value of X obtained by Jeanette is different from the actual value.

As the resistance of X is close to the resistance of the voltmeter, the current that flows through the voltmeter is not negligible.

The ammeter measures the total current flowing through X and the voltmeter.

[2]

(c) In the space below, draw the correct circuit that she should connect to determine the value of X. [1]



7 Wire P is made from the same material and of the same length as wire Q.

However, the radius of P is twice that of Q.

Determine the ratio of the resistance of wire P to the resistance of wire Q.

$R = \frac{\rho L}{A} = \frac{\rho L}{\pi r^2}$ → $R \propto 1/r^2$ (same ρ and L)

$\frac{R_P}{R_Q} = \left(\frac{r_Q}{r_P}\right)^2 = \left(\frac{1}{2}\right)^2$

$= 0.5^2 = 0.25$

[2]

8 **(a)** An electrical component C has an I-V characteristic as shown in Fig. 10.1, where I is the current passing through C and V is the potential difference (p.d.) across it.

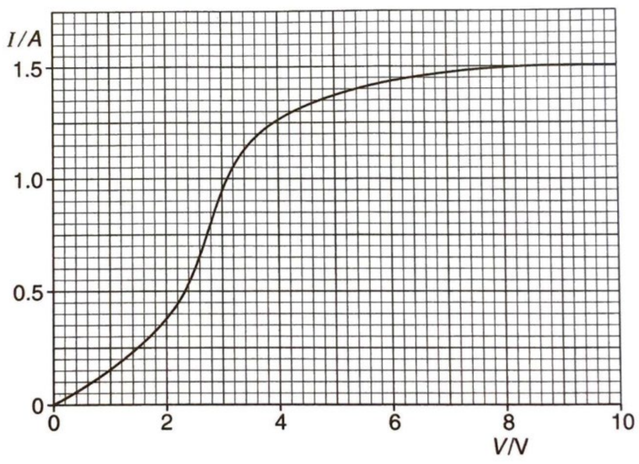


Fig. 10.1

(i) Explain what is meant by potential difference across a component.

p.d. across a component is the work done in driving a unit charge through the component. [1]

(ii) Calculate the resistance of component C when a p.d. of 6.0 V is applied across it.

From the graph, when V = 6.0 V, I = 1.45 A

Resistance R = V / I = 6.0 V / 1.45 A = 4.138 ≈ 4.1 Ω [2]

(iii) Deduce the minimum value of the resistance of component C over the range 0 to 10 V. Show your reasoning clearly.

From the graph, the steepest line from origin (0, 0) and touching the curve gives the smallest resistance.

This line touches the point: I = 1.1 A & V = 3.3 V

Minimum R = V / I = 3.3 V / 1.1 A = 3.0 Ω [2]

(b) Component C is then connected into a circuit as shown in Fig. 10.2.

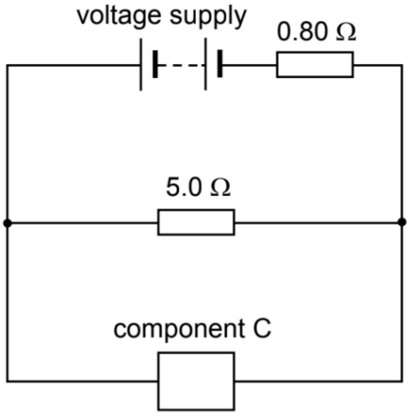


Fig. 10.2

The current through the 5.0 resistor is found to be 0.85 A.

Calculate

(i) the p.d. across component C,

p.d. $V_1 = I R = 0.85\text{ A} \cdot 5.0\ \Omega = 4.25 \approx 4.3\text{ V}$ [1]

(ii) the total current from the voltage supply,

From the graph, when $V_1 = 4.3$ V, I = 1.3

A passing through component C

Total current from voltage supply = 0.85 A + 1.3 A = 2.15 A ≈ 2.2 A [2]

(iii) the e.m.f. of the voltage supply.

p.d. across 0.80 Ω

resistor, $V_2 = I R = 2.15\text{ A} \cdot 0.80\ \Omega = 1.72\text{ V}$

Hence, e.m.f. = $V_1 + V_2 = 4.25 + 1.72 = 5.97 \approx 6.0\text{ V}$

OR

Resistance of C = V / I = 4.25/1.3 = 3.27 Ω

Effective resistance R = $\left(\frac{1}{5.0}\right) + \left(\frac{1}{3.27}\right)^{-1} + 0.80 = 2.78\ \Omega$

e.m.f. = I R = 2.15 · 2.78 = 5.977 ≈ 6.0 A

[2]

9 Fig. 6.1 shows a uniform metal wire P of length 2.4 cm with a cross-sectional area 5.0 x 10^{-6} m^2. The resistivity of the metal is 1.2 Ω m.

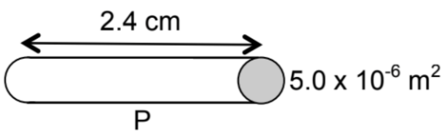


Fig. 6.1

(a) Define electrical resistance of a wire.

Resistance is defined as the ratio of the potential difference across the wire to the current flowing through it. [1]

(b) Calculate the resistance of wire P.

R $= \frac{\rho l}{A} = \frac{1.2\ \Omega\ \text{m x}\ 0.024\ \text{m}}{5.0\ x\ 10^{-6} m^2}$ [1]

$= 5760\ \Omega \sim 5800\ \Omega$ [1] [2]

(c) Another wire Q is constructed from the same material but has twice the length and half the diameter of wire P.

Determine the ratio of the resistance of wire P to the resistance of wire Q.

$R_P : R_Q = \frac{\rho l}{\pi\left(\frac{d}{2}\right)2} : \frac{\rho\ x\ 2l}{\pi\left(\frac{d}{4}\right)2}$

$= \frac{1}{\left(\frac{1}{2}\right)2} : \frac{\rho l}{\pi\left(\frac{1}{4}\right)2}$

= 4: 32

= 1: 8 [1] OR 1/8 OR = 0.125 ~ 0.13

[2]

10 The I-V characteristics of a car headlamp are investigated using the circuit shown in Fig. 7.1.

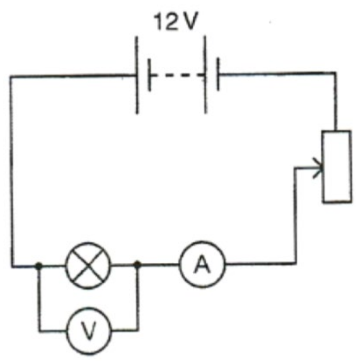


Fig. 7.1

The variable resistor can be adjusted to have resistance between 0 and 10 W .

Readings of potential difference (p.d.) V across the lamp and current I in the circuit are taken. The results obtained are shown in Fig. 7.2.

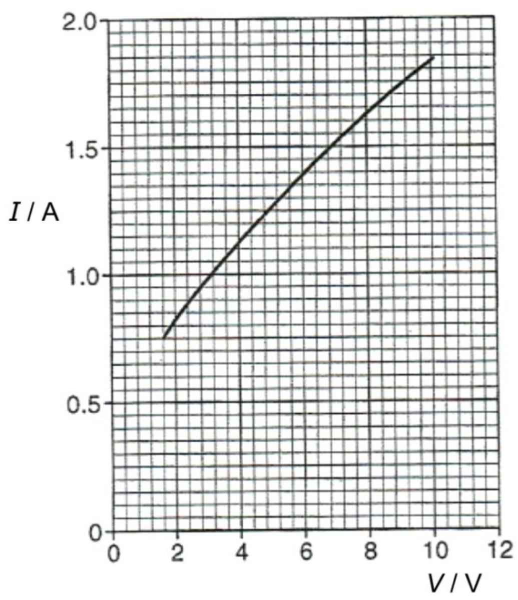
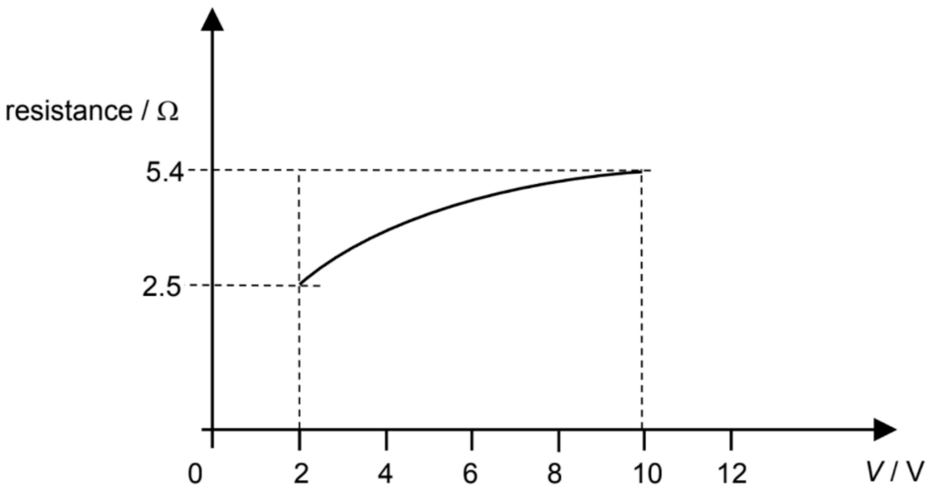


Fig. 7.2

(a) Describe how the resistance of the lamp can be obtained from Fig. 7.2.

The resistance R can be obtained by calculating ratio V / I , (using (I, V) values from the graph) [1]

(b) On Fig. 7.3, sketch the variation in resistance of the lamp when the p.d. across it is varied over the range of 2.0 V to 10.0 V. (Indicate the numerical values for the extreme ends of your graph). [2]



Smallest R = 2V / 0.8A = 2.5 Ω

Largest R = 10V / 1.85A = 5.4Ω

Middle value of R = 6V / 1.4A = 4.3Ω (> 3.95Ω , average of 2.5 and 5.4 Ω)

11 Fig. 5.1 shows the I/V characteristic graph for a filament lamp and a resistor.

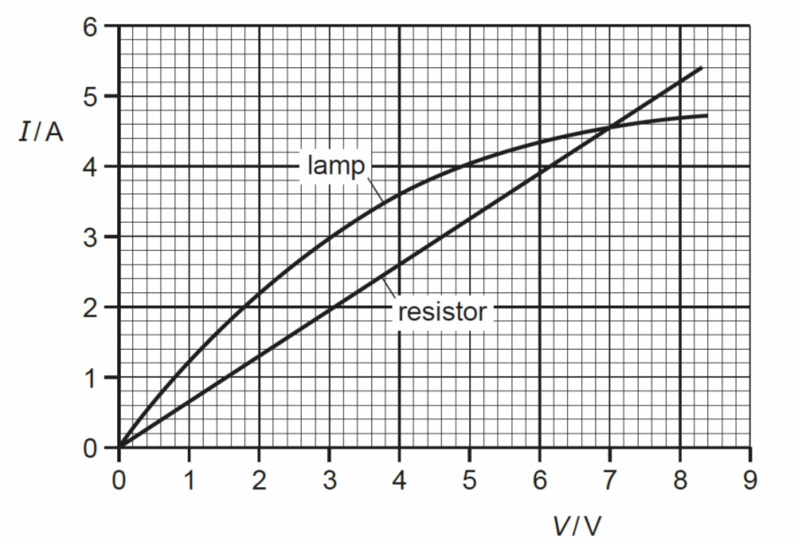


Fig. 5.1

(a) Describe how Fig. 5.1 shows that the resistor obeys Ohm's Law.

I varies linearly with V (resistance is constant) and passes through origin for the resistor.

[Do not accept: *I* is directly proportional to V (only)] describe the features of the graph [1]

(b) State the value of the potential difference where the lamp and the resistor have the same resistance.

potential difference = 7.0 V.

do not accept 7 V must have unit [1]

(c) Another resistor X is made of the same material as the original resistor but is twice as long and has a diameter three times larger.

Calculate the resistance of resistor X.

R = V/I = 8/5.2 =1.5 Ω

(choose a point that can be read accurately from the grid provided) (accept if V = 4 V and I = 2.6 A)

Rx = 1.5 x 2 /9 = 0.33 Ω (2 sf) [2]

(d) Another lamp labelled 6 V, 12 W is connected to a 6 V fully charged battery and it shines at normal brightness for 12 hours.

Calculate the charge that passes through the lamp during this time.

Q = I x t

= P/V x t

= 12/6 x 12 x 3600

(C1 is for either correct sub for P/V or correct conversion)

= 86 000 C

Accept if student use *I* = 4.4 A (from graph).

Q = 190 000 C. [2]

[Total: 6]

12 Fig. 6.1 shows a circuit with a light-dependent resistor (LDR) and a resistor with fixed resistance of 8.0 kΩ.

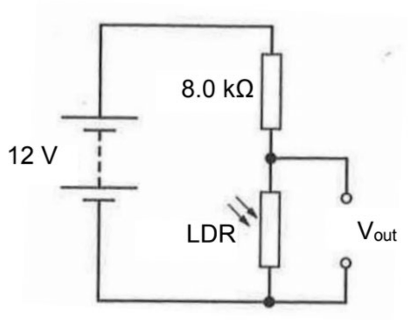


Fig. 6.1

The LDR has a resistance of 600 Ω in bright light.

(a) Calculate the output voltage Vout when the LDR is in bright light.

V_{out} = 600/(600 + 8000) x 12

= 0.84 V [2]

(b) In dim light, Vout is 8.0 V. For this level of brightness, determine

(i) the voltage across the fixed resistor,

V = 12 V – 8.0 V = 4.0 V [1]

(ii) the resistance of the LDR.

4/12 = 8000/ (R + 8000)

R = 16000Ω [1]

(c) The output is now connected across the resistor. A lamp is connected across the output, and this lamp only switches on when Vout is larger than 8.0 V.

Describe and explain the operation of this new device as the level of light changes.

When light is dim, Vout is low and when light is bright, V_{out} is high. The light will switch on when the light is bright. [2]

[Total: 6]