Name:	Target Grade:	Actual Grade:

BRIGHT CULTURE

D. C. CIRCUIT
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!

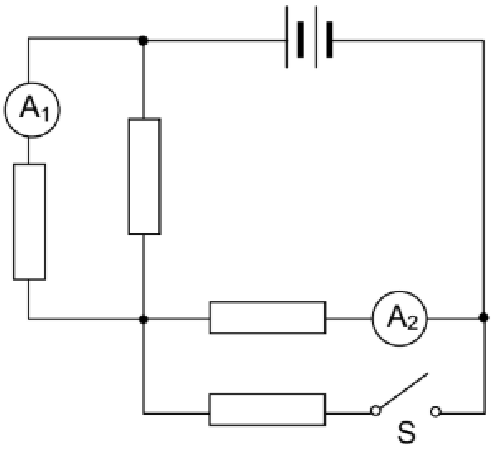
💡 With lots of love,
Bright Culture 💛

GOOD LUCK FOR YOUR EXAM!

MARKS

D.C. CIRCUIT MCQ

1 All resistors in the following circuit are identical.



When the switch S of the circuit is closed, how do the readings of ammeters A1 and A2 change?

Reading of A1 Reading of A2

A Increases Decreases

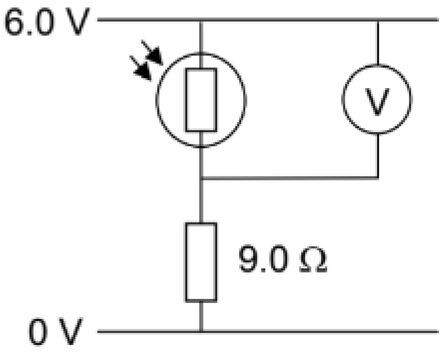
B Decreases Increases

C Increases Increases

D Decreases Decreases

2 The voltmeter in the circuit on the right gives a reading of 1.5 V.

What is the resistance of the LDR?



A 1.0 Ω

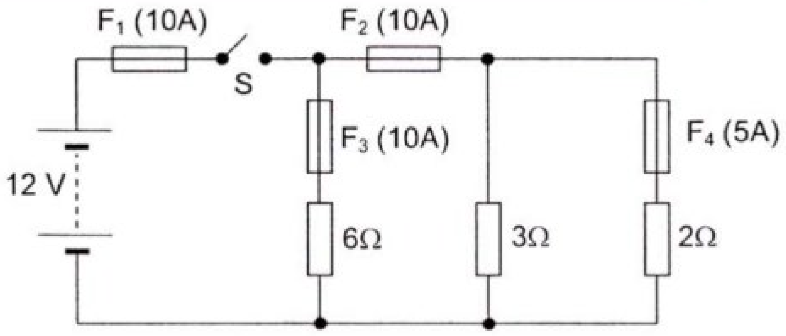
B 1.5 Ω

C 3.0 Ω

D 4.5 Ω

3 In the circuit below, there are four fuses F1 to F4 with their ratings labelled in brackets.

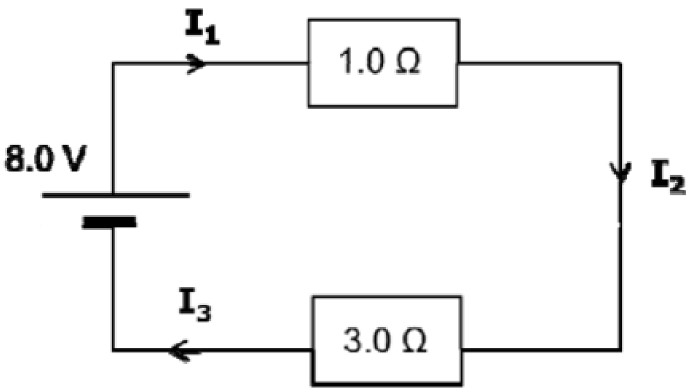
When switch S is closed, which two fuses are likely to blow?



A F1 and F2 only **B** F2 and F3 only

C F3 and F4 only **D** F1 and F4 only

4 The diagram below shows a closed circuit and the currents, I1, I2, and I3, at different points of the circuit.



Which of the following statements about the currents is true?

A $I_1 = I_2 = I_3$

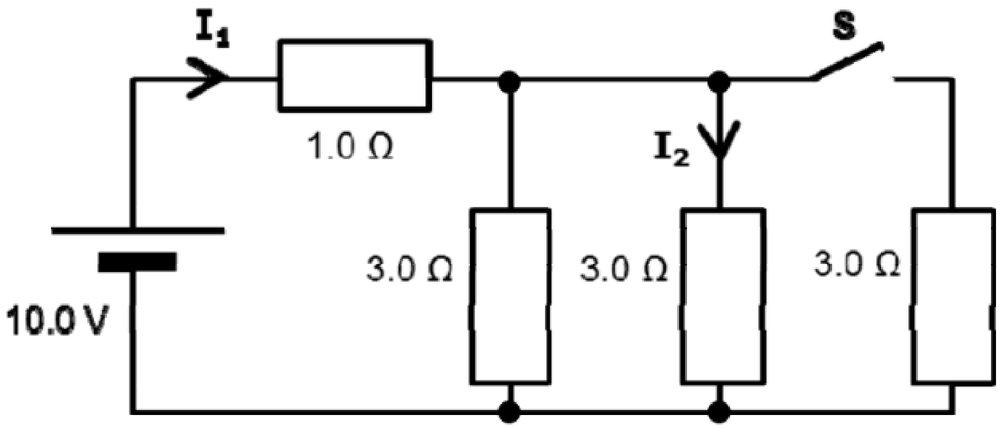
B $I_1 > I_2 > I_3$

C $I_1 = I_2 + I_3$

D $I_2 = I_1 + I_3$

5 The circuit below consists of a 10.0 V cell, 4 resistors and a switch, S.

The 1.0 Ω resistor is in series with the three 3.0 Ω resistors, where the three 3.0 Ω resistors are in parallel with each other.



When switch **S** is open, $\mathbf{I_1}$ = 4.0 A and $\mathbf{I_2}$ = 2.0 A.

What are the currents, $\mathbf{I_1}$ and $\mathbf{I_2}$, when switch **S** is closed?

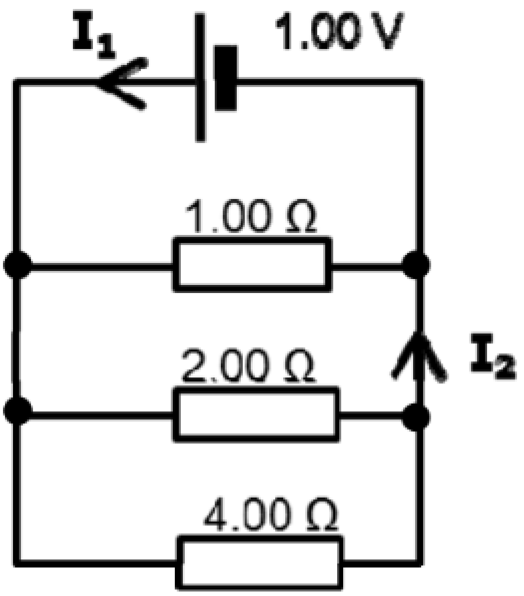
A $\mathbf{I_1}$ = 6.0 A $\mathbf{I_2}$ = 2.0 A

B $\mathbf{I_1}$ = 5.0 A $\mathbf{I_2}$ = 1.7 A

C $\mathbf{I_1}$ = 4.0 A $\mathbf{I_2}$ = 1.3 A

D $\mathbf{I_1}$ = 4.0 A $\mathbf{I_2}$ = 1.0 A

6 The diagram below shows a cell connected to three different resistors.



What are the currents, $\mathbf{I_1}$ and $\mathbf{I_2}$?

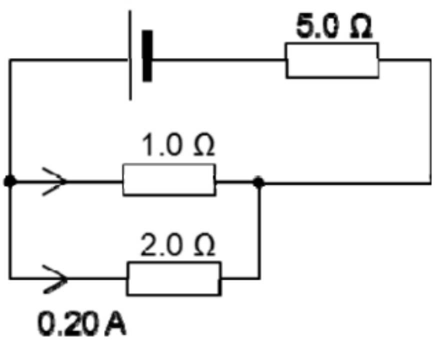
A $\mathbf{I_1}$ = 1.00 A and $\mathbf{I_2}$ = 0.50 A

B $\mathbf{I_1}$ = 1.75 A and $\mathbf{I_2}$ = 0.75 A

C $\mathbf{I_1}$ = 1.75 A and $\mathbf{I_2}$= 1.00 A

D $\mathbf{I_1}$ = 1.75 A and $\mathbf{I_2}$ = 1.75 A

7 Three resistors are connected to a cell of unknown e.m.f. as given in the diagram below. The current flowing through the 2.0 Ω resistor is 0.20 A.



What is the potential difference across the 5.0 Ω resistor?

A 0.40 V

B 1.5 V

C 3.0 V

D 3.4 V

8 A variable resistor, a light bulb, and a cell are connected as shown below.

What will happen to the power dissipated by the bulb as the resistance of the variable resistor is doubled?

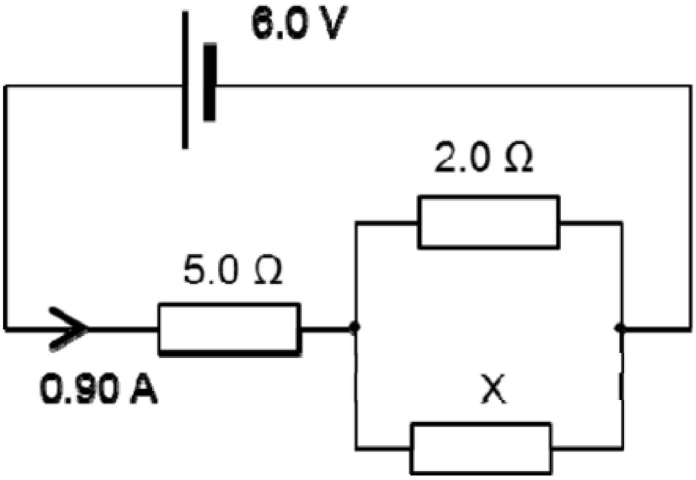
A Power dissipated by the bulb will be halved.

B Power dissipated by the bulb will remain the same.

C Power dissipated by the bulb will be doubled.

D Power dissipated by the bulb will increase by four times.

9 The total current through the circuit below is 0.90 A.

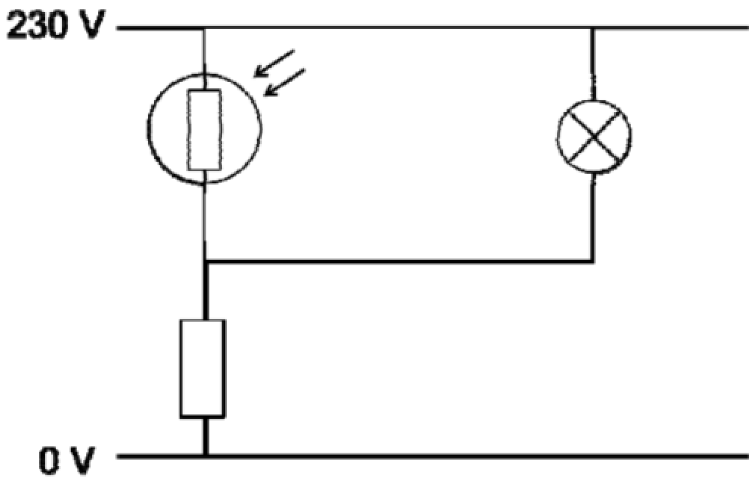


What is the resistance of resistor X?

A 1.1 Ω **B** 2.0 Ω

C 6.7 Ω **D** 10.0 Ω

10 A lamp is connected to a light-dependent resistor (LDR) and a fixed resistor as shown in the diagram below.



How does the brightness of the lamp vary as the LDR is exposed to brighter light?

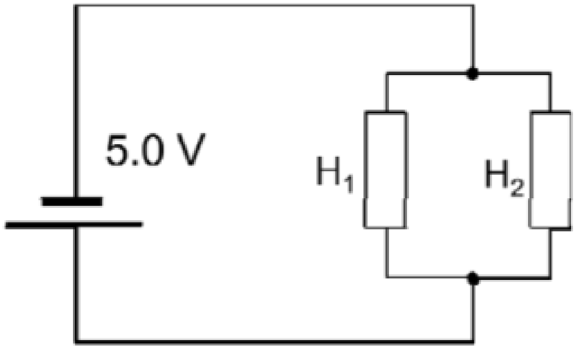
A As potential difference across the LDR increases, the lamp will become brighter.

B As potential difference across the LDR decreases, the lamp will become brighter.

C As potential difference across the LDR increases, the lamp will become dimmer.

D As potential difference across the LDR decreases, the lamp will become dimmer.

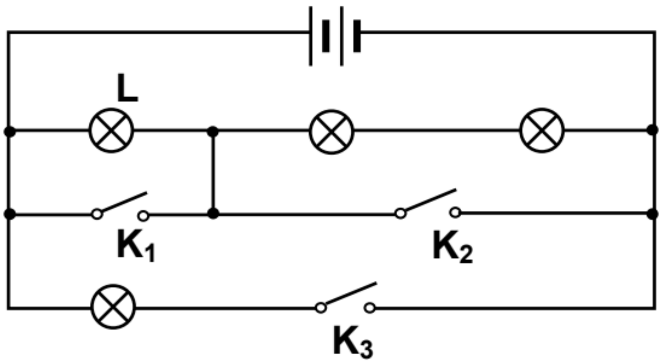
11 The figure below shows a 10 V, 50 W heater, H_1, connected in parallel to a 10 V, 25 W heater, H_2. P_1 and P_2 are powers dissipated in H_1 and H_2 respectively when connected to a 5.0 V supply.



Which of the following is correct?

	P_1	P_2
A	50 W	25 W
B	25 W	50 W
C	12.5 W	6.25 W
D	100 W	50

12 In the circuit shown, all lamps are identical.



To make lamp L as bright as possible, close

A K_1 only.

B K_2 only.

C K_3 only.

D K_1 and K_3 only.

13 Which of the statements explain(s) why the resistance of a thermistor changes as temperature rises?

I More atoms of the semiconducting material in the thermistor are free to move.

II The semiconducting material in the thermistor generates a greater voltage across its terminals.

III There are more free electrons in the semiconducting material in the thermistor as temperature rises.

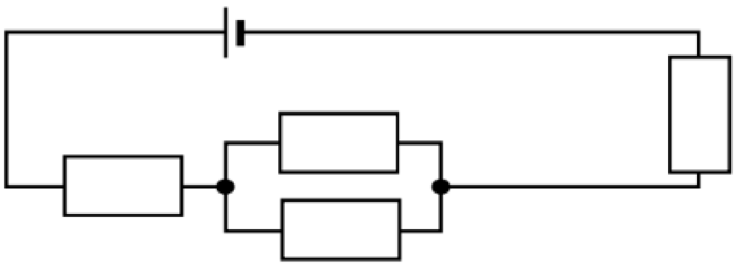
A I only

B II only

C III only

D II and III only

14 The circuit below shows a cell connected to 4 identical resistors.



Which of the following statements about the circuit is true?

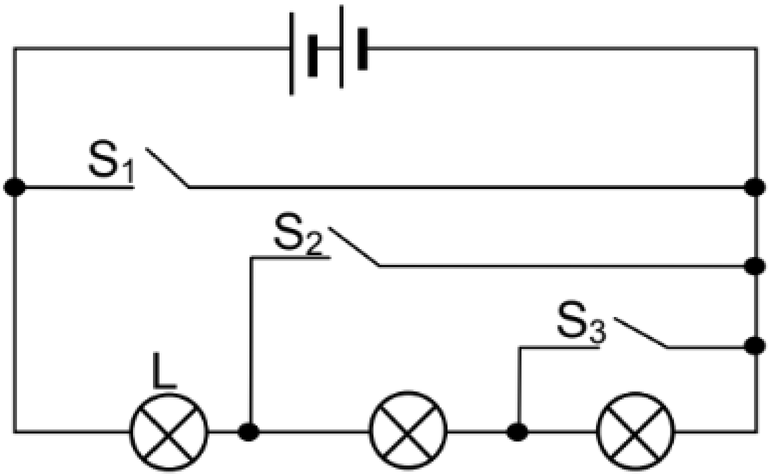
A The current through each of the resistor is the same.

B The e.m.f. of the cell is shared equally among the 4 resistors.

C The sum of the current through the resistors in parallel is equal to the total current in the circuit.

D The current in the circuit decreases as it flows from the positive terminal to the negative terminal of the cell.

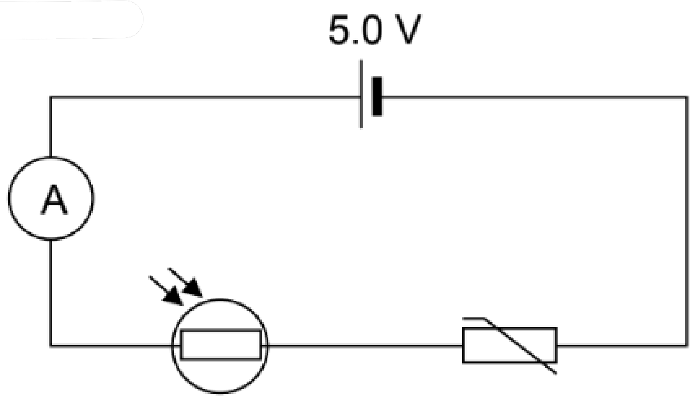
15 The diagram below shows 3 lamps connected to a battery and 3 switches.



To make lamp L as bright as possible, which switch or switches should be closed?

A S_1 only
B S_2 only
C S_1 and S_2 only
D S_3 only

16 The circuit below shows a light dependent resistor and a thermistor connected in series with an ammeter.

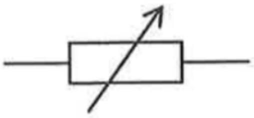


Under which of the following conditions will the reading on the ammeter be the largest?

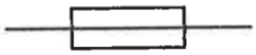
A bright and hot
B dim and cool
C bright and cool
D dim and hot

17 Which of the following symbol does not represent a type of resistor?

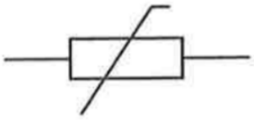
A



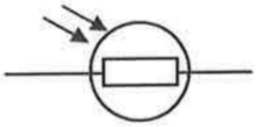
B



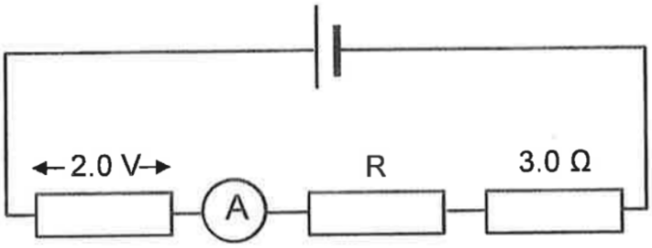
C



D



18 A 12 V cell is connected to three resistors arranged in series. The potential difference across the first resistor is 2.0 V, and the reading on the ammeter is 2.0 A.



What is the potential difference across resistor R?

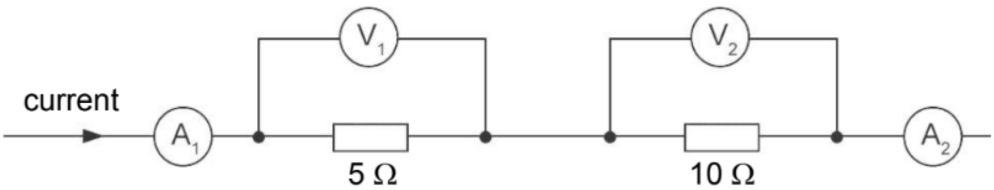
A 2.0V

B 4.0V

C 5.0V

D 6.0V

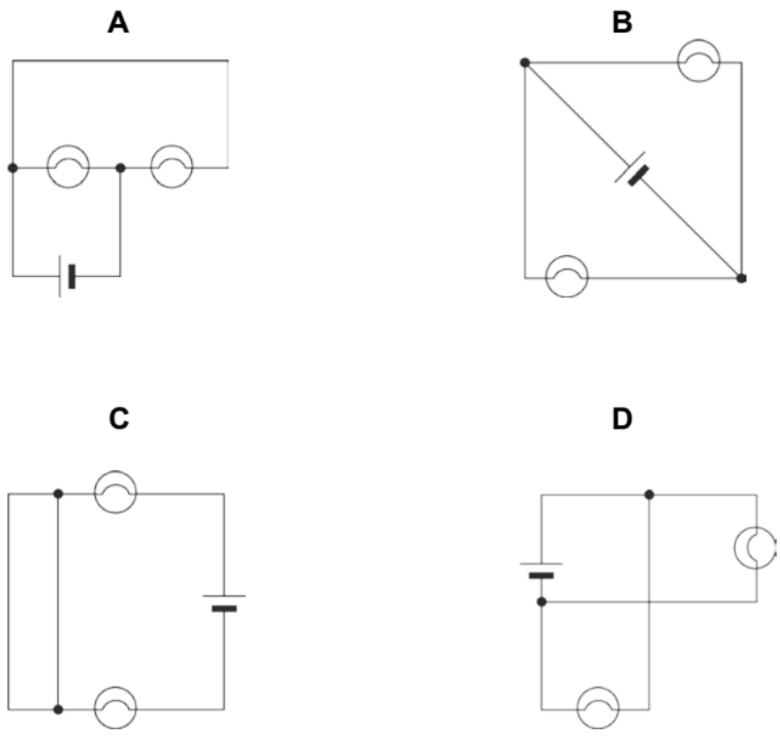
19 A current flows through two resistors connected in series as shown below. V1 and V2 are the readings on the voltmeters. A_1 and A_2 are the readings on the ammeters.



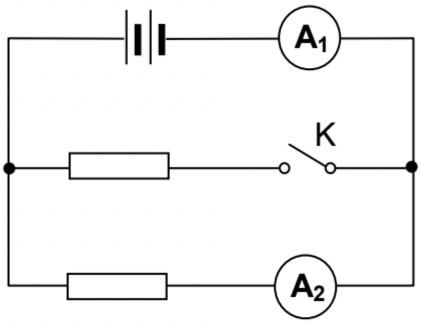
Which of the following is **correct** about the readings?

	ammeter readings	voltmeter readings
A	A_1 is greater than A_2	V_1 is less than V_2
B	A_1 is equal to A_2	V_1 is equal to V_2
C	A_1 is greater than A_2	V_1 is equal to V_2
D	A_1 is equal to A_2	V_1 is less than V_2

20 In which of the following circuits are the light bulbs not connected in parallel?



21 In the following circuit, both resistors are identical.

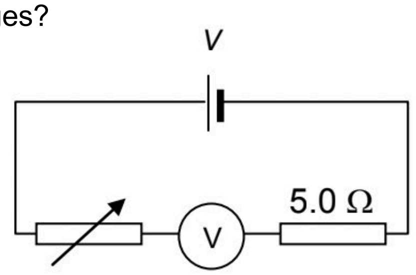


If the switch K is closed, how would the readings of ammeters A_1 and A_2 be affected?

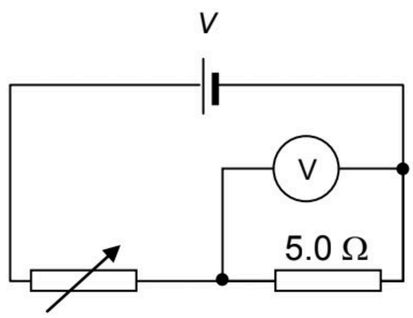
	reading of A_1	reading of A_2
A	increases	no change
B	decreases	no change
C	increases	decrease
D	no change	decrease

22 In the following circuits, the cell has negligible internal resistance and the voltmeter is an ideal meter. If the resistance of the rheostat can vary from 0 Ω to 200 Ω, in which of the following circuits will the voltmeter reading change when the resistance of the rheostat changes?

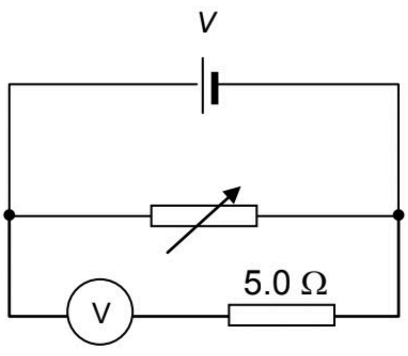
A



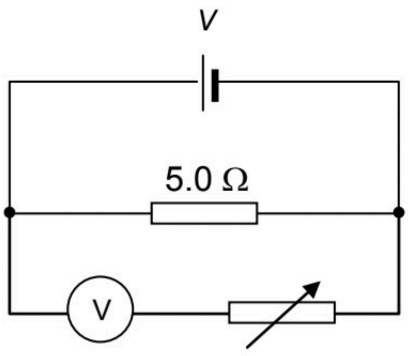
B



C

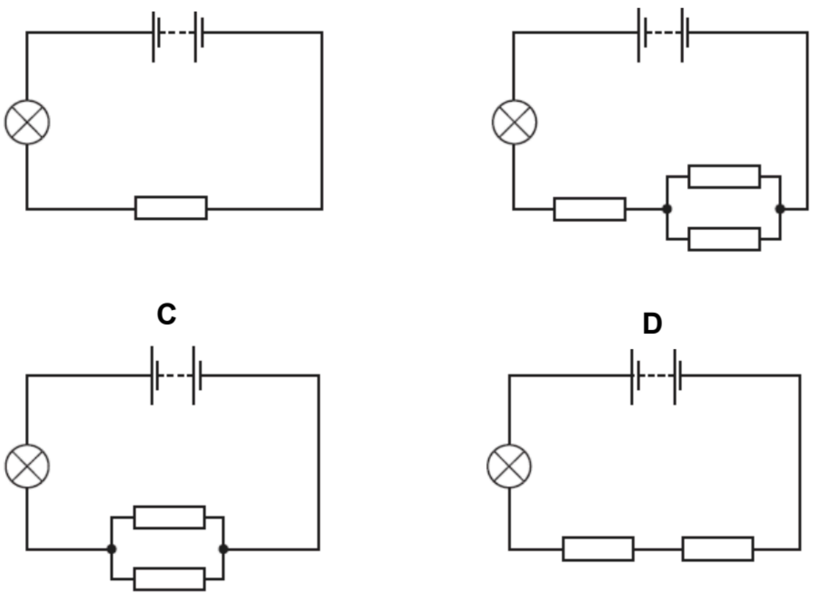


D



23 The four circuits below are all set up using identical lamps, batteries and resistors.

In which circuit will the lamp be brightest?



24 The circuit below shows two identical resistors R connected in parallel.

What is the effect on the readings of the ammeter and the voltmeter on closing the switch S in the diagram?

reading in ammeter reading in voltmeter

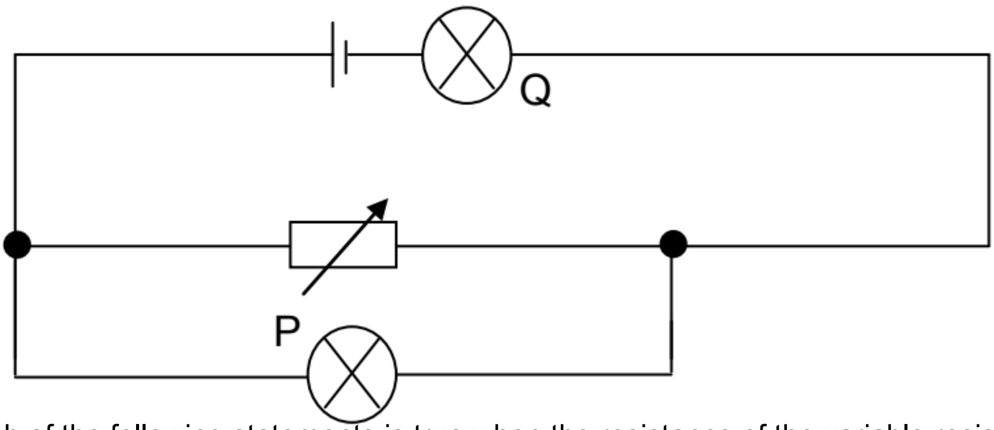
A increase increase

B decrease decrease

C increase unchanged

D decrease increase

25 Two identical lamps P and Q are connected in a circuit as shown in the figure below.



Which of the following statements is true when the resistance of the variable resistor is decreased?

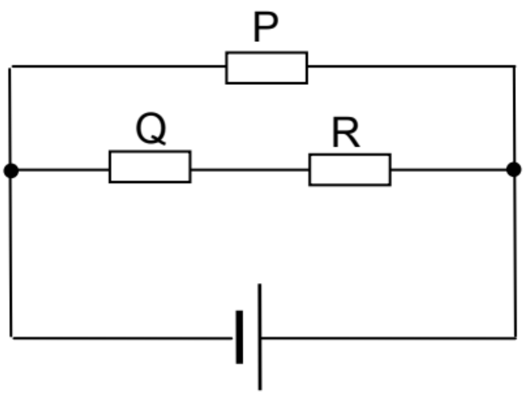
A P becomes dimmer.

B P becomes brighter.

C P remains as bright.

D P will be as bright as Q.

26 The figure below shows a simple electric circuit. P, Q and R are 3 identical resistors.



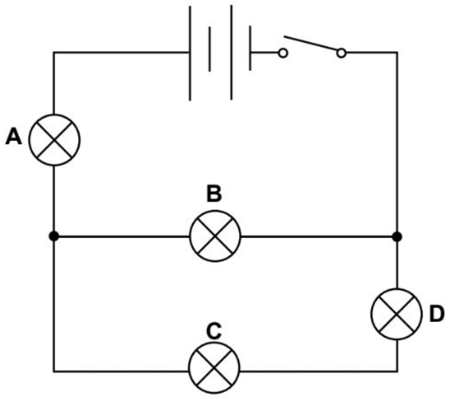
If the battery is supplying a total power of 15.0 W, what is the power dissipated as heat in resistor R?

A 2.5 W **B** 5.0 W

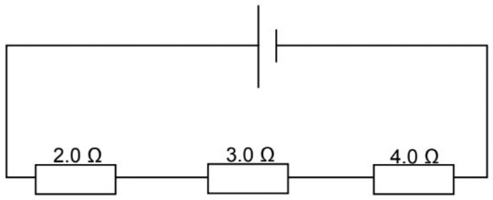
C 7.5 W **D** 10.0 W

27 When the switch in the circuit shown below is closed, all four lamps light up. When one of the lamp filaments melts, the other three lamps remain lit.

Which is the lamp filament that melted?



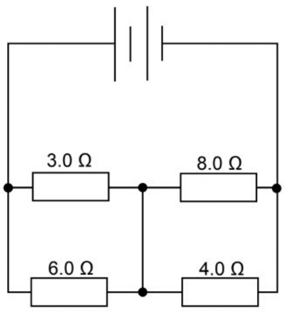
28 Three resistors are connected in series as shown. If 690 C of charge flows through the 3.0 Ω resistor in 10 minutes, what is the e.m.f. of the cell?



A 2.3 V **B** 6.9 V

C 10 V **D** 23 V

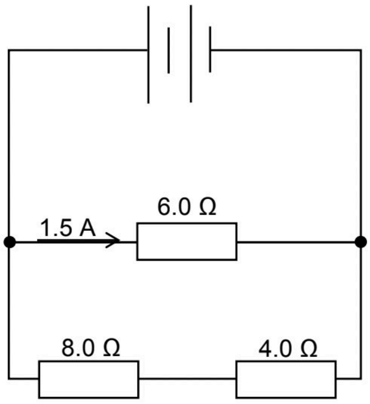
29 What is the effective resistance of the circuit shown below?



A 1.1 Ω **B** 4.7 Ω

C 5.1 Ω **D** 5.2 Ω

30 In the circuit below, the current through the 6.0 Ω resistor is 1.5 A.

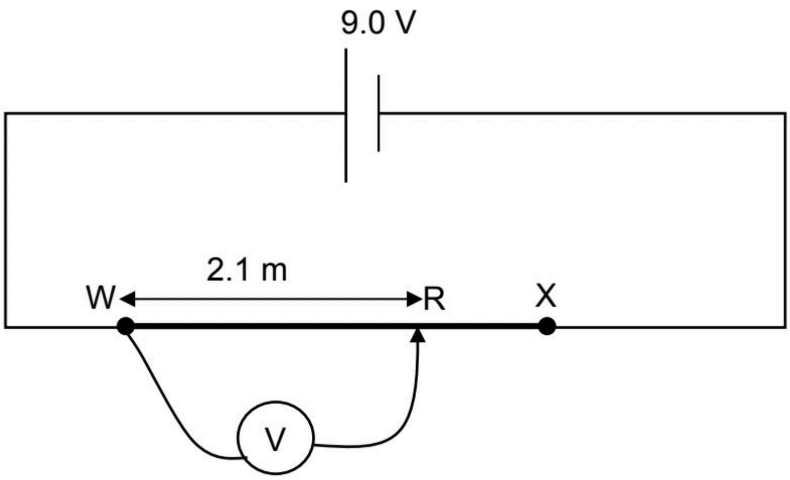


What is the potential difference across the 4.0 Ω resistor?

A 1.5 V **B** 3.0 V

C 6.0 V **D** 9.0 V

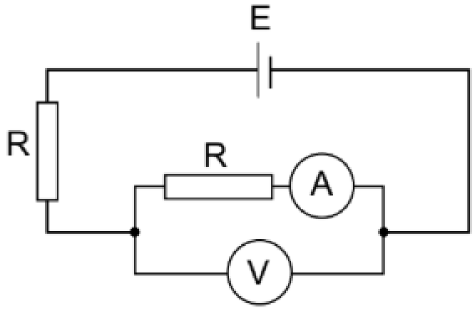
31 Resistance wire WX is connected in a circuit as shown. Wire WX is 3.0 m long and has a resistance of 8.0 Ω. What is the reading on the voltmeter when the jockey is at point R?



A 2.7 V **B** 5.6 V

C 6.3 V **D** 9.0 V

32 In the following circuit, the e.m.f of the battery is E and the resistance of each resistor is R.

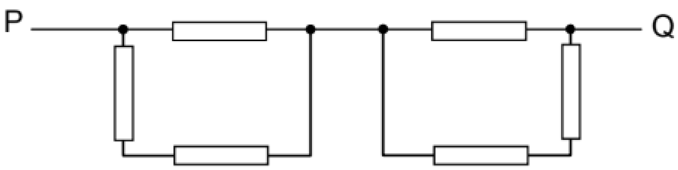


What are the readings on the voltmeter and ammeter?

reading on ammeter reading on voltmeter

	reading on ammeter	reading on voltmeter
A	ER	$\frac{E}{2}$
B	$\frac{E}{R}$	$\frac{R}{2}$
C	$\frac{E}{2R}$	$\frac{E}{2}$
D	$\frac{2E}{R}$	$\frac{R}{2}$

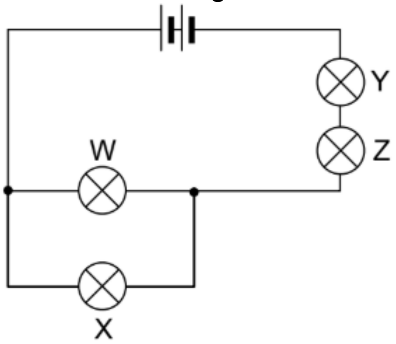
33 All the resistors in the following circuit are identical and the resistance of each of them is R.



What is the equivalent resistance across PQ?

A $\frac{4}{3}R$ **B** $2R$ **C** $\frac{8}{3}R$ **D** $6R$

34 The light bulbs in the following circuit are identical.



Which of the following statements is/are correct?

(1) Lamp W and X have the same brightness.

(2) Lamp Y and Z have the same brightness.

(3) Lamp Y is brighter than lamp W.

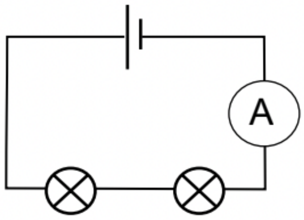
A (1) and (2) only

B (2) and (3) only

C (1) and (3) only

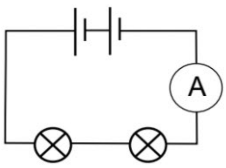
D (1), (2) and (3)

35 A cell is connected in series with an ammeter and two lamps. The current is 2 A.

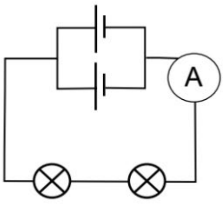


In which circuit, using identical cells, lamps and ammeters, is the current in the ammeter equal to 6 A?

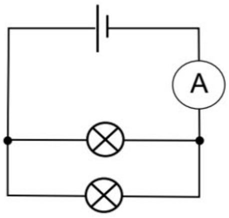
A



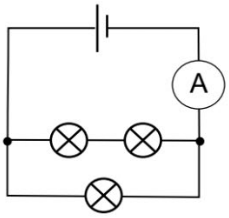
B



C

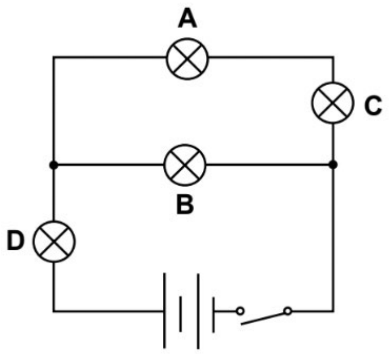


D



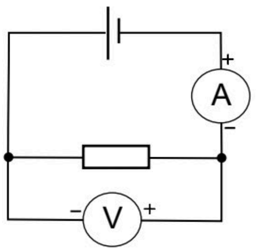
36 When the switch in the circuit shown below is closed, all four lamps light up. When a short circuit is set up across one of the lamps, only one lamp remains lit.

Which lamp has the short circuit set up across it?

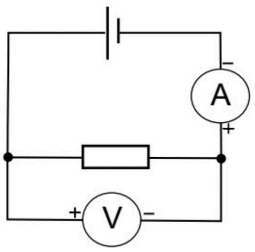


37 Which of the following shows a **correctly** connected circuit?

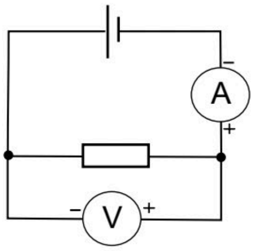
A



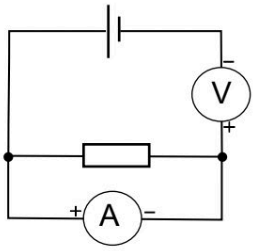
B



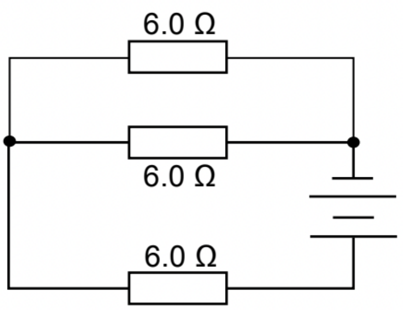
C



D



38 What is the effective resistance of the circuit shown below?



A 2.0 Ω

B 6.0 Ω

C 9.0 Ω

D 18.0 Ω

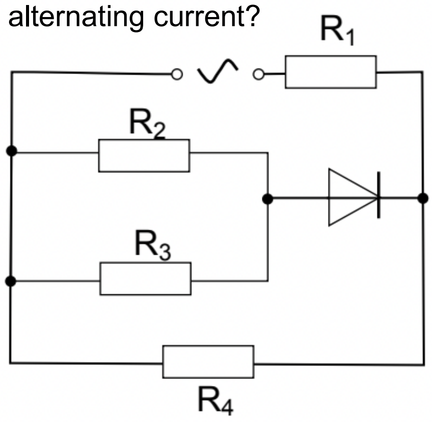
39 In the circuit shown below, an electric fan is connected in series with components X and Y, to an alternating current power supply. The resistance of component X decreases as temperature rises.

Which conditions on components X and Y will make the fan go slowest?

	X	Y
A	cold	dark
B	hot	dark
C	cold	bright
D	hot	bright

40 Four resistors are connected to an alternating current power supply and a diode.

Which resistors carry alternating current?



A R_1 only

B R_4 only

C R_1 and R_4 only

D R_2 and R_3 only

41 A potential divider consists of an unknown resistor Q and a 7500 Ω resistor connected to a 20.0 V battery.

What should be the resistance of the unknown resistor Q for the output to be 8.0 V?

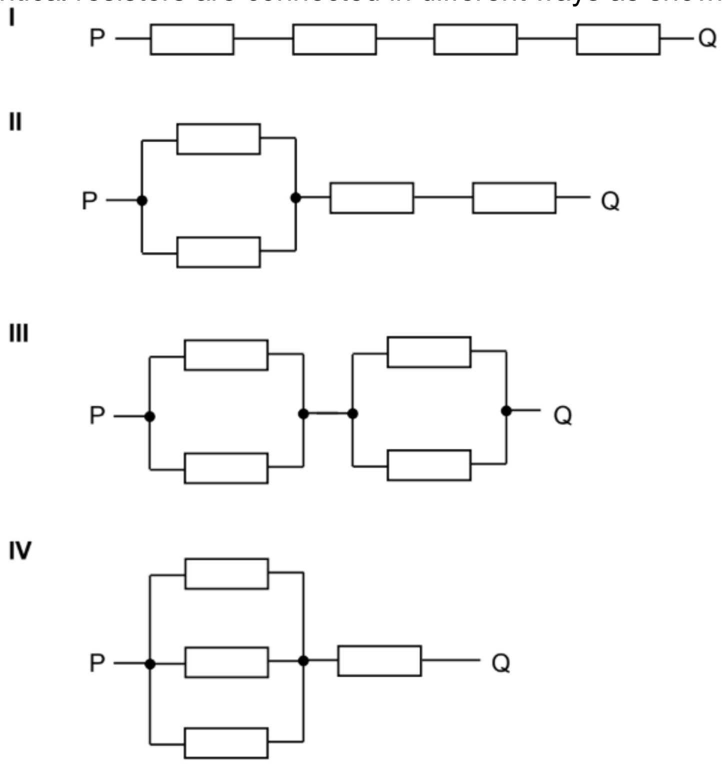
A 3000 Ω

B 4500 Ω

C 5000 Ω

D 11000 Ω

42 Four identical resistors are connected in different ways as shown below.



Which of the following is the connections arranged in ascending order of effective resistance across PQ?

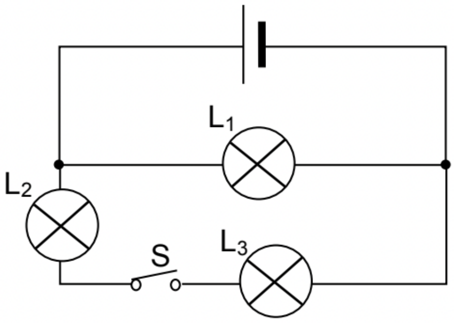
A III, IV, II, I

B IV, III, II, I

C IV, III, I, II

D III, II, IV, I

43 In the circuit below, all the lamps are identical.



When S is closed, which of the following is/are correct?

1. Brightness of L_1 remains the same and is brighter than L_2 and L_3.

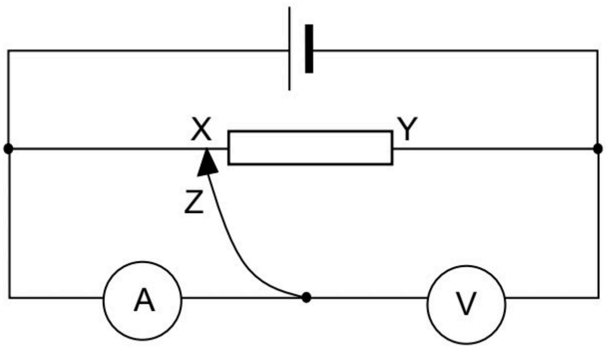
2. Brightness of L_1 decreases.

3. Brightness of L_1 is the same as L_3.

A 1 only **B** 2 only

C 1 and 2 only **D** 2 and 3 only

44 The circuit below was set up by a student.



What happens to the ammeter reading when contact Z is shifted from X to Y?

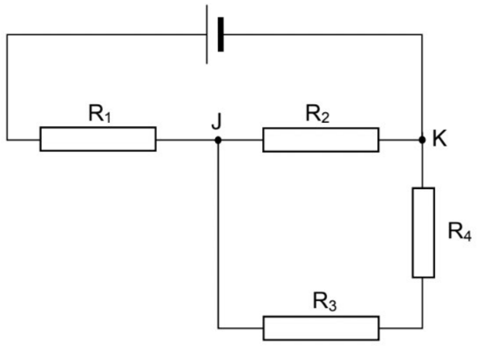
A Reading remains unchanged.

B Reading becomes lower.

C Reading becomes very high.

D Reading becomes zero.

45 The circuit below consists of four identical resistors.



At which point in the circuit should an ammeter be inserted such that it gives the largest reading?

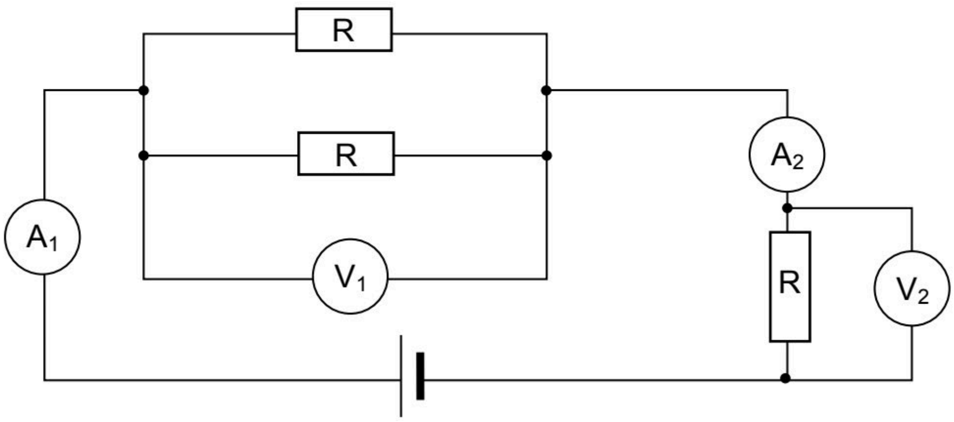
A Between point K and R_2.

B Between point J and R_2.

C Between point J and R_1.

D Between point K and R_4.

46 The circuit below shows three identical resistors R.



Which statement is correct?

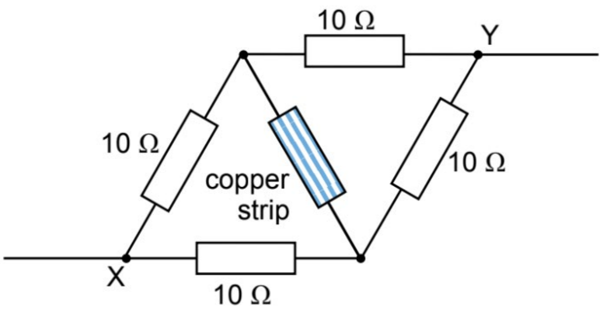
A The reading of A_1 is higher than A_2.

B The reading of A_1 is lower than A_2.

C The reading of V_1 is higher than V_2.

D The reading of V_1 is lower than V_2.

47 Four 10 Ω resistors are connected with a copper strip as shown in the circuit below.

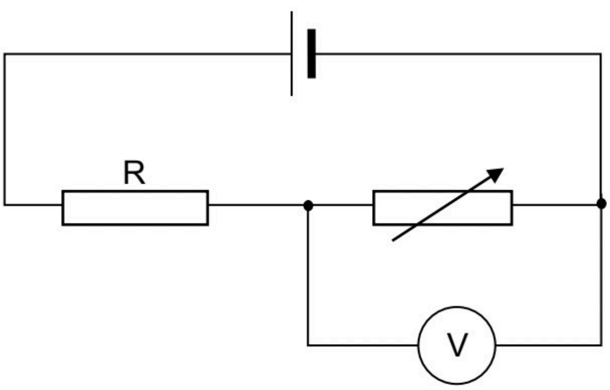


What is the equivalent resistance between X and Y?

A 5.0 Ω **B** 10 Ω

C 20 Ω **D** 40 Ω

48 The circuit below shows a resistor R and a rheostat connected in series. A voltmeter is connected across the rheostat.



Which of the following changes will make the reading on the voltmeter decrease?

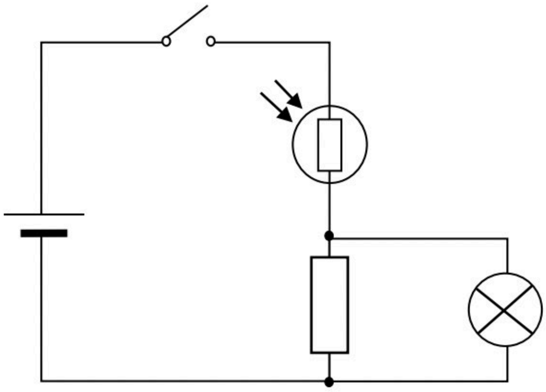
A Replace the battery with one of higher e.m.f.

B Decrease the resistance of R.

C Reduce resistance of the rheostat.

D Connect R in parallel with the rheostat instead.

49 The circuit below shows a light-dependent resistor (LDR) used to adjust the brightness of a bulb. The bulb is at normal brightness when the switch is closed.



The intensity of the light shining on the LDR is slowly increased.

Which of the following statements correctly explains the brightness of the bulb?

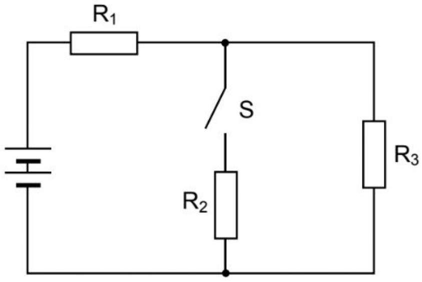
A The bulb becomes dimmer because the potential difference across the fixed resistor decreases.

B The bulb becomes dimmer because the potential difference across the fixed resistor increases.

C The bulb becomes brighter because the potential difference across the fixed resistor decreases.

D The bulb becomes brighter because the potential difference across the fixed resistor increases.

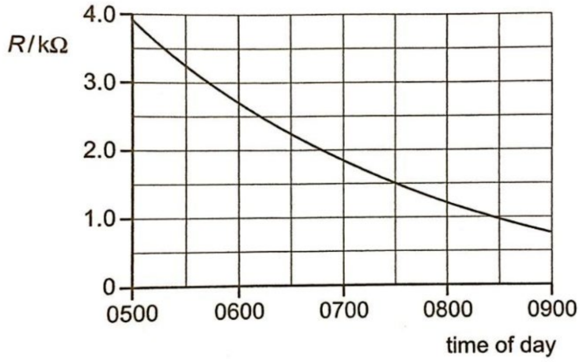
50 The diagram shows a network of resistors R_1, R_2 and R_3 connected to a battery.



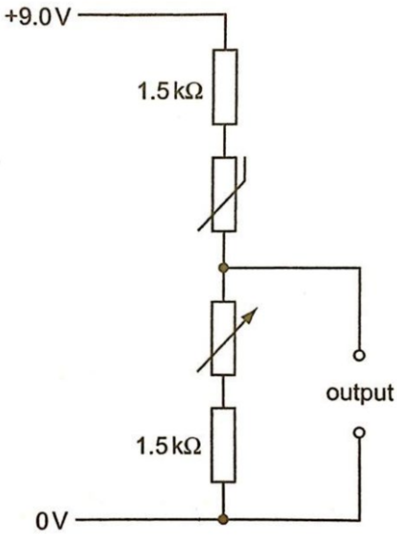
When the switch S is closed, what happens to the potential difference (p.d.) across R_1 and across R_3?

	p.d. across R_1	p.d. across R_3
A	decreases	decreases
B	decreases	stays the same
C	increases	decreases
D	increases	stays the same

51 The graph shows how the resistance R of a thermistor varies during part of a day.



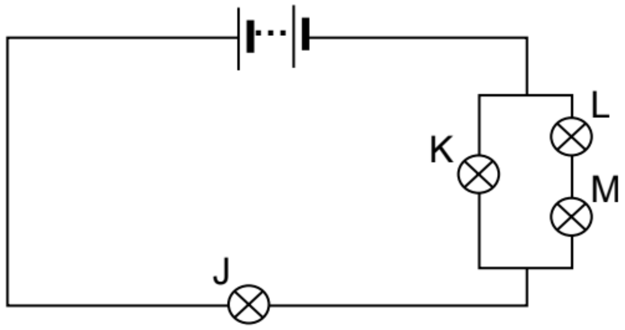
The thermistor is connected in the potential divider circuit shown below.



To obtain an output of 6.0 V at the time of 0730, to which value should the variable resistor be set?

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

52 Four identical light bulbs, J, K, L and M, are connected in a circuit as shown below.

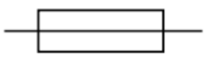


Which row shows the brightness of the light bulbs in the correct order from the dimmest to the brightest?

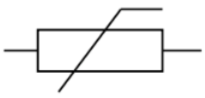
	Dimmest ----> Brightest		
A	K	M	J
B	M	K	J
C	J	M	K
D	J	K	M

53 Which of the following circuit components is not a type of resistor?

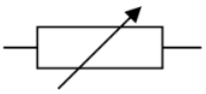
A



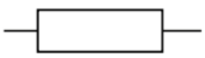
B



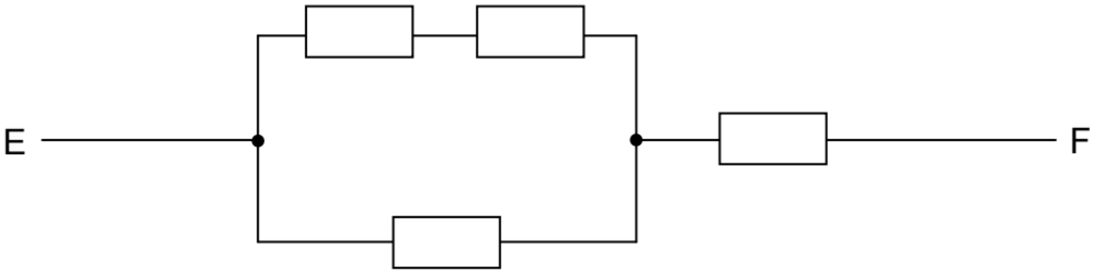
C



D



54 The circuit diagram shows a network of identical resistors each of resistance *R*.



What is the effective resistance across the points E and F?

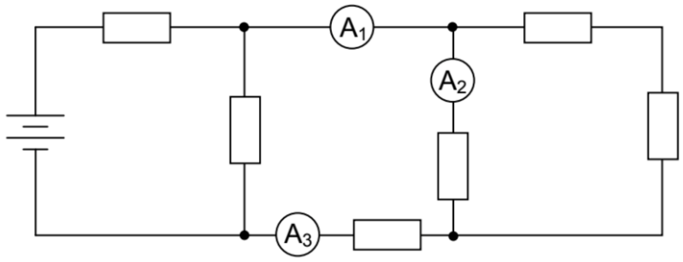
A $R / 4$

B $4R / 3$

C $5R / 3$

D $5R / 2$

55 Five identical resistors are arranged in a circuit with ammeters as shown in the diagram below.



Which ammeters have the same reading?

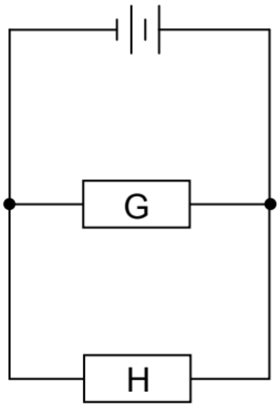
A A_1 and A_2

B A_2 and A_3

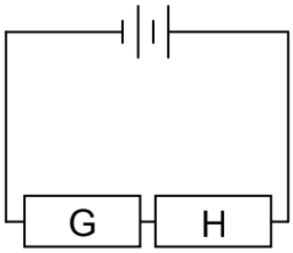
C A_1 and A_3

D None of them

56 Resistors G and H are connected in parallel to the power supply as shown in the diagram below. The ratio of the power dissipated for G to H is 5 : 6.



They are then connected in series to the same supply as shown in the diagram below.



What is the ratio of the power dissipated for G to H when they are connected in series?

A 5 : 6

B 6 : 5

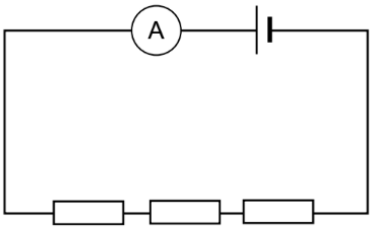
C 25 : 36

D 36 : 25

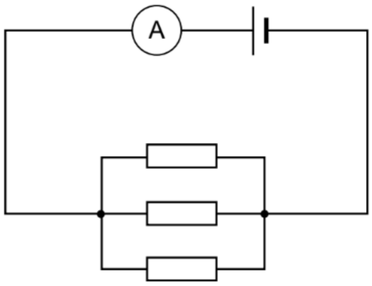
57 A 2.0 V cell is connected to an ammeter and three identical resistors.

In which of the following arrangements does the ammeter give the largest reading?

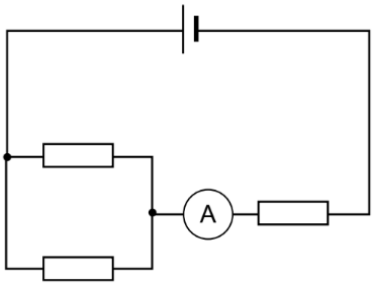
A



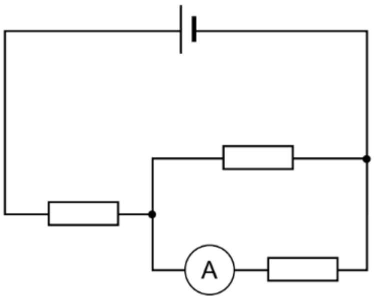
B



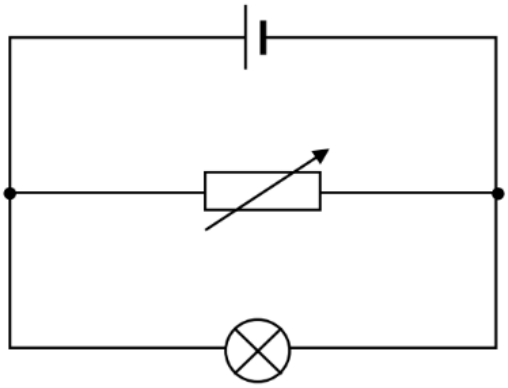
C



D



58 A variable resistor and a light bulb are connected in parallel to an accumulator and the lamp shines brightly.



When the resistance of the variable resistor is halved, the bulb will

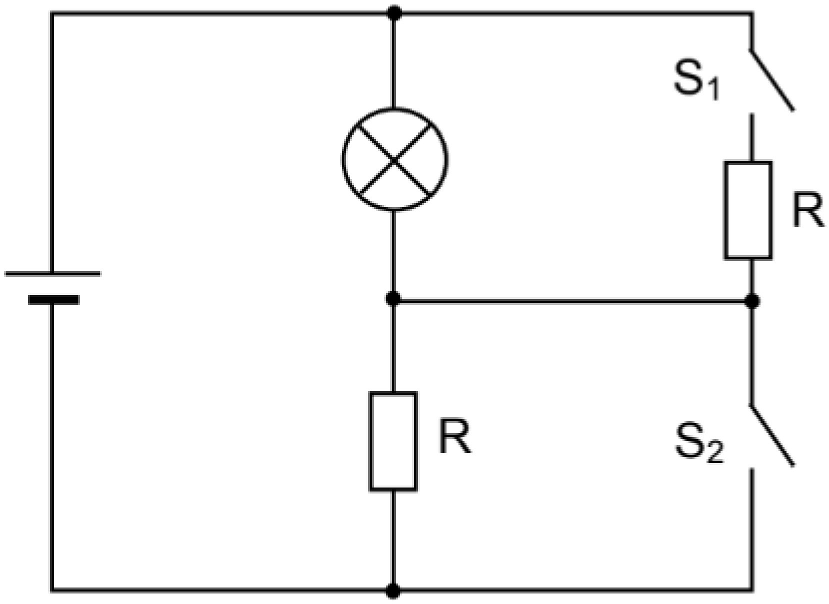
A probably burn out.

B shine more brightly.

C shine much less brightly.

D shine as brightly as before.

59 The bulb in the circuit below is lit with normal brightness when both switches S_1 and S_2 are opened.



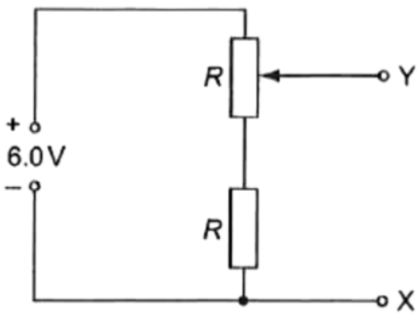
What happens to the brightness of the bulb if only S1 or S2 is closed?

	only S_1 is closed	only S_2 is closed
A	increases	decreases
B	increases	increases
C	decreases	decreases
D	decreases	increases

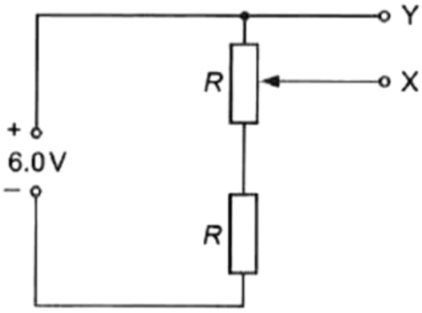
60 A potential divider has a constant supply of 6.0 V as shown in the diagrams.

Which circuit will provide a potential difference between X and Y that can be varied between zero and 3.0 V?

A

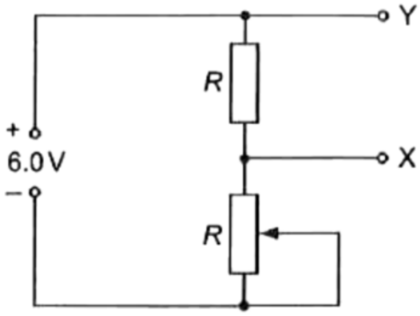


B

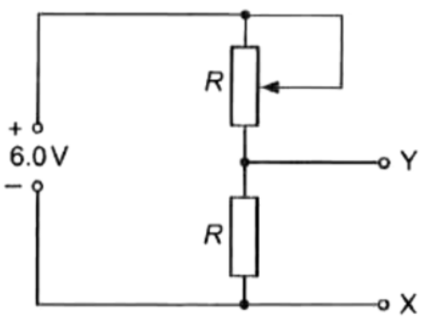


A

C



D



61 Three identical resistors are connected in parallel. The equivalent resistance increases by 700 Ω when one resistor is removed and connected in series with the remaining two, which are still in parallel.

What is the resistance of each resistor?

A 300 Ω

B 382 Ω

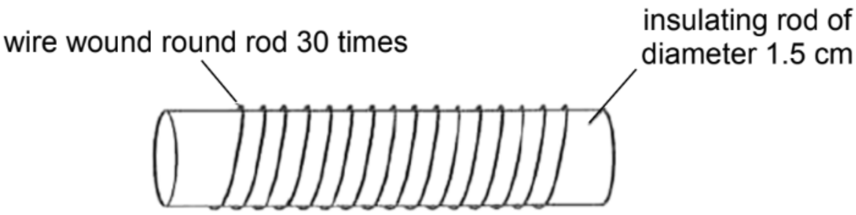
C 600 Ω

D 700 Ω

62 The material of a wire has a resistivity 1.3 x 10-8 Ω m.

The wire has diameter 0.50 mm and its length is just enough to enable it to be wound tightly around an insulating rod 30 times. The rod has a diameter 1.5 cm.

Given: circumference of a circle of radius r = 2πr.



What is the resistance of the wire?

A 1.1 x 101 Ω

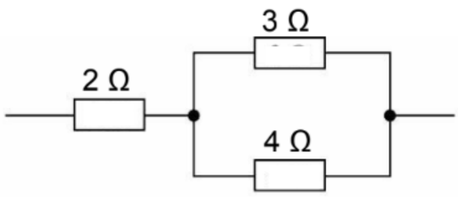
B 9.4 x 10-2 Ω

C 7.0 x 10-4 Ω

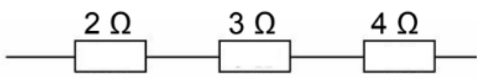
D 4.7 x 10-5 Ω

63 Which resistor combination has the lowest effective resistance?

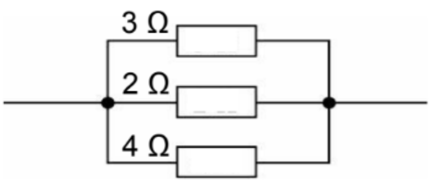
A



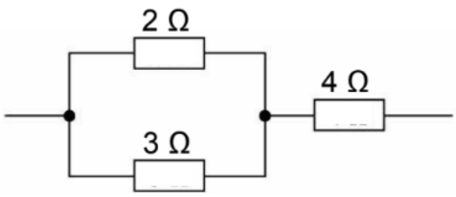
C



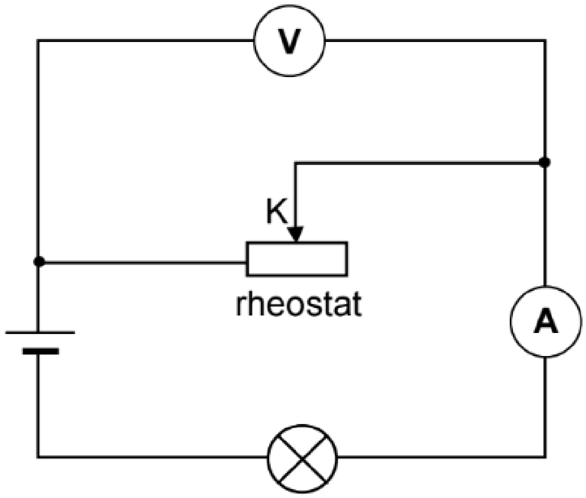
B



D



64 The following circuit is set up.



If the wire at K connecting the rheostat moves towards the left, how will the reading of the meters and the brightness of the bulb change?

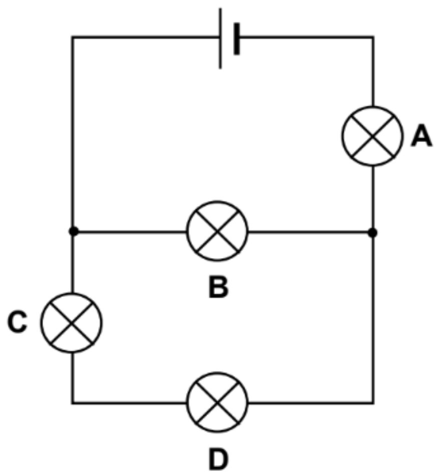
A The reading of the voltmeter decreases and the light bulb becomes brighter.

B The reading of the voltmeter increases and the light bulb becomes dimmer.

C The reading of the ammeter decreases and the light bulb becomes brighter.

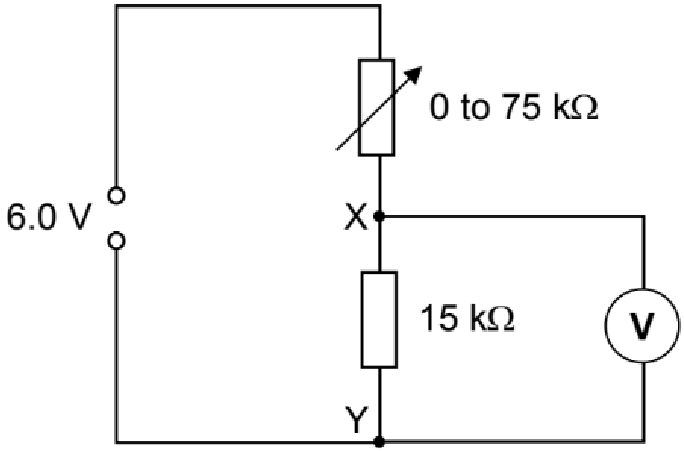
D The reading of the ammeter increases and the light bulb becomes dimmer.

65 Four lamps are lit up by a battery as shown below.



Which lamp, if disconnected, would cause all the other lamps to go off (not light up)?

66 The diagram shows a fixed resistor and a variable resistor connected in a circuit with a power supply and a voltmeter.



What is the range of potential difference (p.d.) that can be obtained between points X and Y?

A zero to 1.0 V

B zero to 6.0 V

C 1.0 to 5.0 V

D 1.0 to 6.0 V

D.C. CIRCUIT STRUCTURED QUESTIONS

1

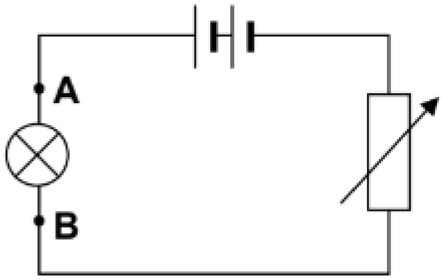


Fig. 10.1

Describe the effect on the light bulb in the circuit shown in Fig. 10.1 above if

(a) a piece of copper wire is connected between the points A and B;

....

....[1]

(b) a second identical light bulb is connected between the points A and B;

....

....[1]

(c) one of the two cells is connected in the opposite way (its terminals are reversed).

....

....[1]

2 A system of resistors can be constructed such that they are capable of providing several different resistance values depending on the way they are connected. Fig.17.1 shows how one such system is connected across AB.

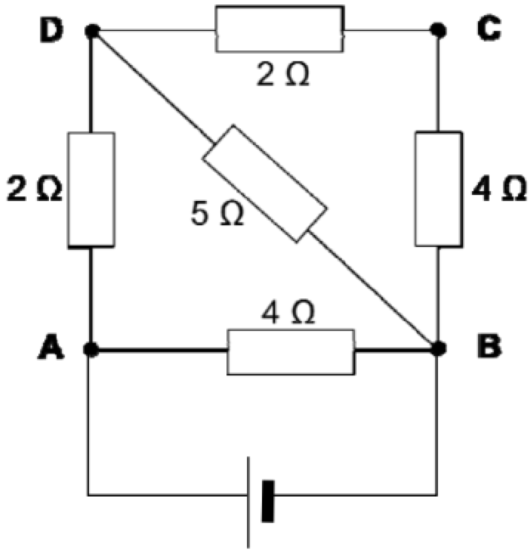


Fig. 17.1

Calculate the effective resistance across AB.

effective resistance = ... [2]

3 A thermistor is placed outside a room and is connected to an air-conditioning unit inside the room as shown in Fig. 21.1.

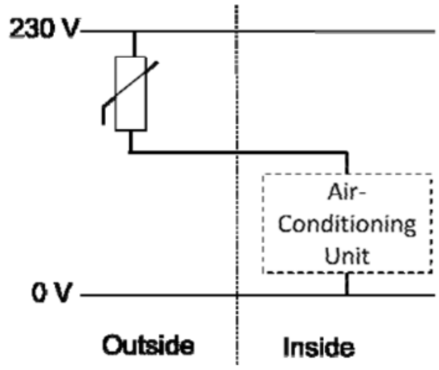


Fig. 21.1

Fig. 21.2 below shows how the potential difference across this thermistor changes with temperature.

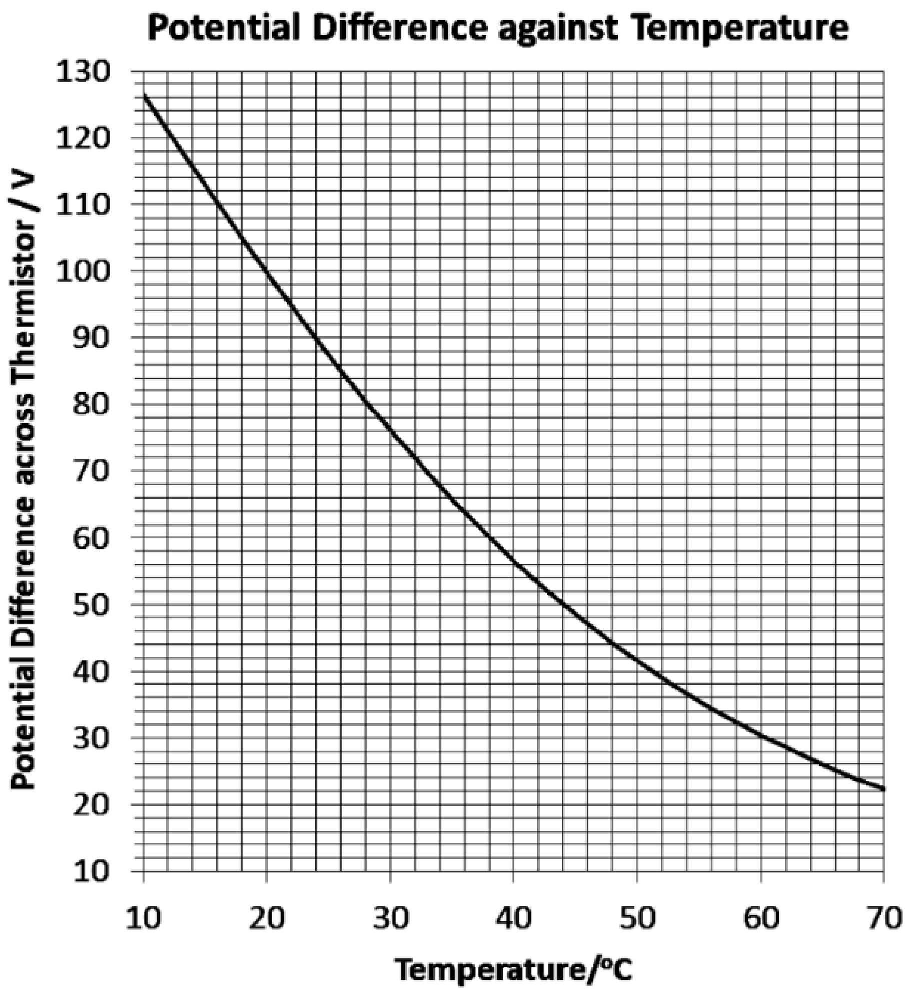


Fig. 21.2

(a) State and explain what happens to the resistance of the thermistor as temperature increases.

…………………………………………………………………………………………

…………………………………………………………………………………………

………………………………………………………………………………………… [1]

(b) Using Fig 21.1 and Fig. 21.2, state whether the potential difference across the air conditioning unit increases, decreases, or remains the same, when the temperature outside the room increases.

. …………………………………………………………………………………………

………………………………………………………………………………………… [1]

(c) The air conditioning unit automatically switches on when the potential difference across it exceeds 154 V.

State the temperature at which the air-conditioning unit switches on.

temperature = ... [1]

(d) The resistance of the thermistor is 1630 Ω when the temperature is 40°C. Assume that the resistance of the air-conditioning unit is fixed.

(i) From Fig. 21.2, determine the potential difference across the thermistor when the temperature is 40°C.

potential difference = ... [1]

(ii) Calculate the current flowing through the thermistor when the temperature is 40°C.

current = ... [1]

(iii) Determine the potential difference across the air-conditioning unit when the temperature is 40°C.

potential difference = ... [1]

(iv) Calculate the resistance of the air-conditioning unit.

resistance = ... [2]

(e) Based on your answer in part (d) (iv), determine the resistance of the thermistor at 58°C.

resistance = ... [2]

4 In the circuit shown in Fig. 9 below, the resistance of the battery and the meters may be ignored.

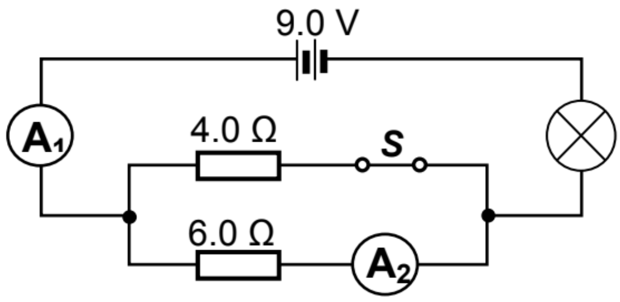


Fig. 9

The reading of ammeters A1 is 2.5 A and the reading on A2 is 1.0 A.

(a) Determine the current flowing through the 4.0 Ω resistor.

current = ...[1]

(b) Calculate potential difference across the 6.0 Ω resistor.

potential difference = ...[1]

(c) Calculate the potential difference across the bulb.

potential difference = ...[1]

(d) Suggest and explain how the brightness of the bulb will be affected when switch S is opened.

....

....

....

....

.... [2]

5 The variation of resistance R of a LDR with the intensity of the light falling on it is shown in Fig. 12.1.

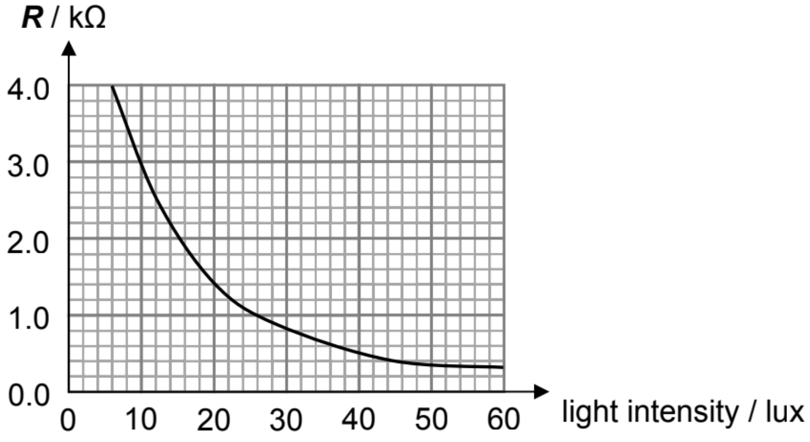


Fig. 12.1

(a) Describe how the resistance of an LDR changes as the intensity of light falling on it changes. Explain why the resistance of the LDR is dependent on the light intensity.

....

....

....

....

.... [2]

Fig. 12.2 shows how the LDR can be used in a control circuit to switch on the lights in a classroom when the illumination in the classroom drops below 20 lux.

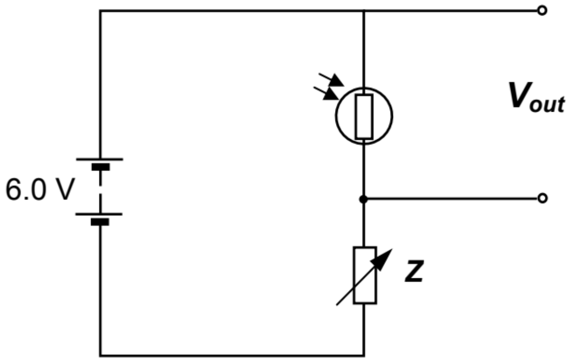


Fig. 12.2

The lights comes on when the potential difference Vout reaches 4.0 V at 20 lux.

(b) With reference to Fig. 12.1, calculate the electrical energy dissipated in the LDR in 10 s when the intensity of light falling on it is 20 lux.

energy dissipated = ... [2]

(c) Explain why the power consumed by the control circuit is smaller when the room is dark.

....

....

....

....

.... [2]

(d) Determine the value of the resistor Z for the control unit to operate correctly.

Z = ... [2]

(e) Feedback from students in the class indicates that the room is too dark before the light comes on. Suggest and explain how the the value of the resistor, Z should be adjusted to switch on the lights before the classroom becomes too dark.

....

....

....

....

.... [2]

6 A circuit is shown in Fig. 6.1 in which the connecting wires have negligible resistance. The current in the 18.0 Ω resistor is 0.50 A.

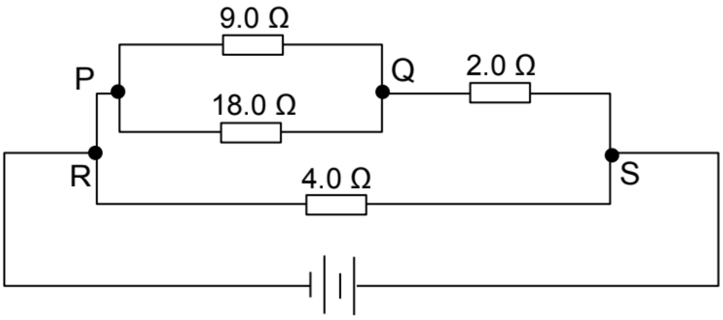


Fig. 6.1

Calculate:

(a) the potential difference between P and Q,

potential difference = ...[1l

(b) the current in the 2.0 Ω resistor,

current = ...[1]

(c) the potential difference between R and S,

potential difference = ...[2]

(d) the power dissipated by the 4.0 Ω resistor.

power = ...[2]

7 A number of identical lamps are each marked 8.0 V, 2.0 W.

The lamps are connected in series to a 240 V mains supply and each lamp lights up with normal brightness.

(a) Calculate

(i) the number of lamps connected,

number of lamps = ...[1]

(ii) the total resistance of the lamps connected in series.

total resistance = ...[3]

(b) The filament in one of the lamps burns out and this lamp is replaced by a new lamp marked 10 V, 2.0 W.

(i) Compare the resistance of the replacement lamp to the original lamp when they are operating at normal brightness.

....

....

....

....[2]

(ii) State and explain if the other original 8.0 V, 2.0 W lamps will be brighter, dimmer or at normal brightness when this replacement lamp is connected in series with them.

....

....

....

....

....[3]

8 In the circuit shown in Fig. 8.1, a 4.0 Ω resistor, a variable resistor and a lamp are connected to a 12.0 V supply.

The variable resistor has a range of resistance from 0 to 15.0 Ω.

The lamp operates at normal brightness when there is a potential difference of 3.0 V across it.

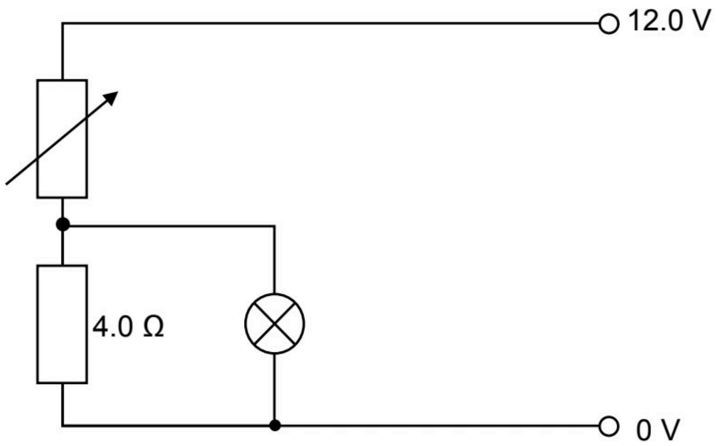


Fig. 8.1

(a) Determine the resistance of the variable resistor when the lamp is operating at normal brightness. Assume the resistance of the lamp is much greater than that of the 4.0 Ω resistor.

resistance of variable resistor = ……………..….[2]

(b) The variable resistor is now replaced with a fixed resistor as shown in Fig.9.2.

The 4.0 Ω resistor is replaced with a thermistor which has a resistance that will decrease when its temperature increases.

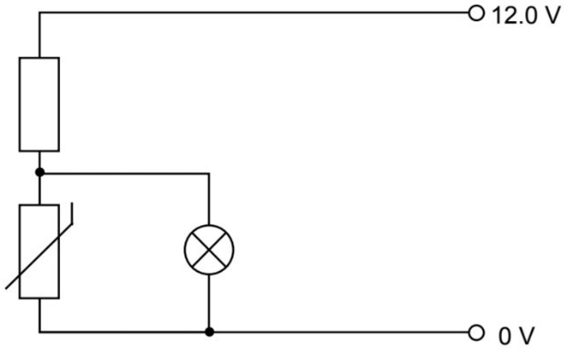


Fig. 9.2

State and explain what kind of physical conditions in the environment will cause the lamp to light up.

....

....

....

....

....

.... [3]

9 Fig. 9.1 shows a circuit with three resistors, an ammeter and a voltmeter connected to a 6.0 V battery.

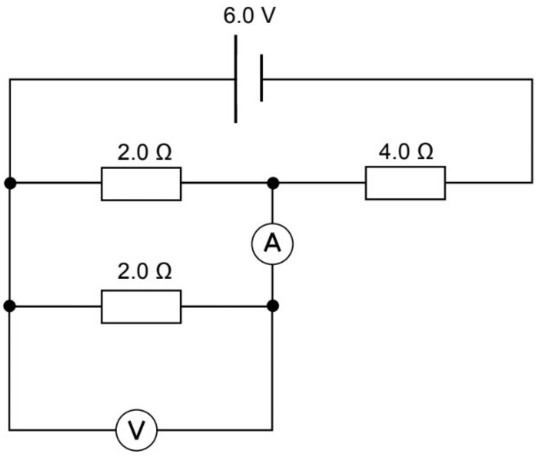


Fig. 9.1

(a) Determine the effective resistance of the circuit.

Show all working clearly.

effective resistance of circuit = ...[2]

(b) Determine the readings on the voltmeter and the ammeter.

Show all working clearly.

voltmeter reading = ...[1]

ammeter reading = ...[1]

10 Fig. 6.1 shows a circuit diagram of a torch using six 1.5 V cells to light a bulb with resistance 18 Ω.

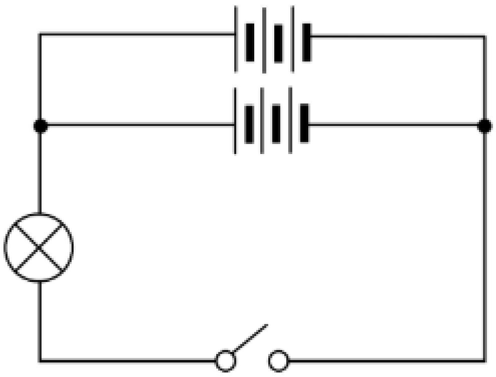


Fig. 6.1

(a) Calculate the current through the bulb when the torch is switched on.

current = ... [2]

(b) Hence, calculate the amount of electrical charge passing through the bulb each second.

charge = ... [1]

11 Fig. 8.1 and Fig. 8.2 show two circuits. Each circuit is connected with three identical light bulbs each with resistance 1.0 k and a battery with an electromotive force (e.m.f.) of 5.0 V.

In Fig. 8.2, the wire W connected across PQ has negligible resistance.

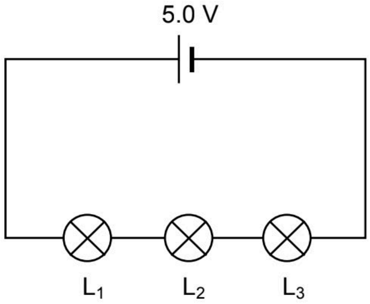


Fig. 8.1

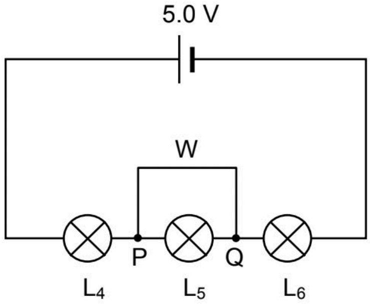


Fig. 8.2

State and explain which circuit has a greater current flowing through it.

....

....

....

....

....[2]

12 A light-dependent resistor (LDR) has a resistance which decreases with increase in light intensity.

On a sunny day, the LDR has a resistance of 0.56 kΩ.

On a cloudy day, the resistance rises to 4.0 kΩ. At night, the resistance is 20 kΩ. The LDR is connected in the circuit shown in Fig. 9.1.

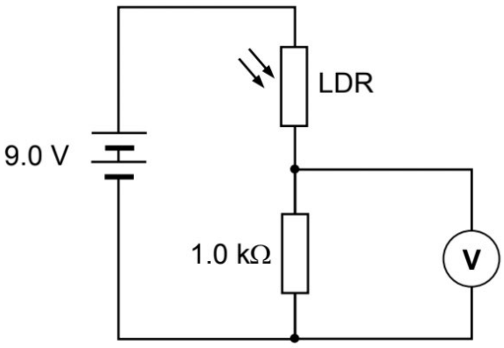


Fig. 9.1

(a) Determine the voltmeter reading on a sunny day.

voltmeter reading = ... [2]

(b) State and explain any change in the voltmeter reading as the light intensity decreases from day to night.

....

....

....

....[2]

12 Either

Fig. 11.1 shows an apparatus set up by a student in which an ammeter is used to indicate the level of liquid in a tank. The equivalent circuit is shown in Fig. 11.2.

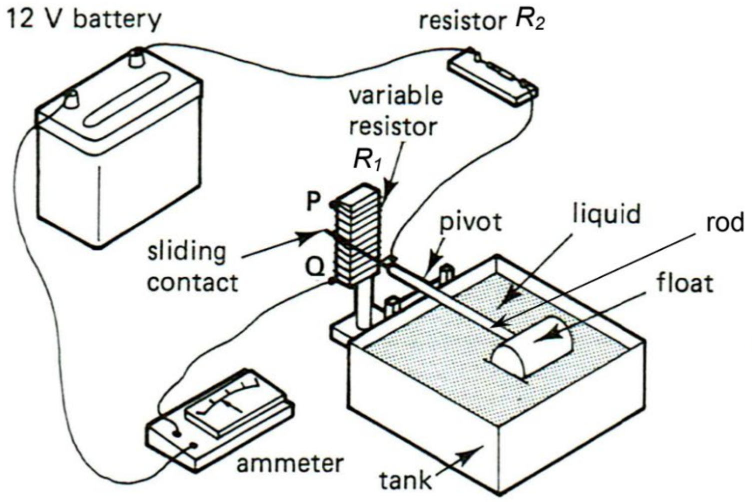


Fig. 11.1

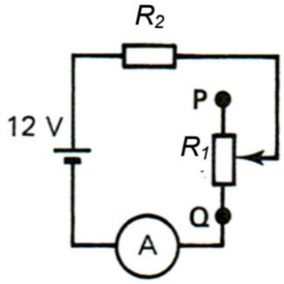


Fig. 11.2

The variable resistor R1 is made from a length of bare resistance wire PQ coiled around an insulator (with turns not touching each other). Assume the rod (shown in

Fig. 11.1) connects the sliding contact to the float and this rod is always in contact with the fixed pivot.

When the tank is empty, the sliding contact is at point P, and when it is full of liquid, the sliding contact is at Q.

(a) Describe and explain what happens to the ammeter reading as the tank is being filled with liquid.

....

....

....

....

.... [2]

(b) The resistance of the variable resistor R_1 can vary from 0 to 90 Ω. The resistor R_2 has a resistance of 10 Ω. The resistance of the ammeter is so small that it can be ignored.

(i) Calculate the ammeter reading when

1. the tank is full; and

ammeter reading = ……………………….. [2]

2. the tank is empty.

ammeter reading = ……………………….. [1]

(ii) Explain why resistor R_2 is included in the circuit.

……..……………………………………………………………………………

……..……………………………………………………………………………

………………………………………………………………………………….[1]

(iii) This apparatus could be a simple model of a system used inside a car. Suggest what this system is.

……………………………………………………………………………….... [1]

(c) Explain the meaning of an *electric current*.

……………………………………………………………………………………... [1]

(d) Another system inside a car is the headlights circuit which consists of two headlights (lamps). Both headlights are connected in parallel to a 12 V battery.

The total charge that a battery can supply without being recharged is expressed in the unit of ampere-hour (A h). A typical 12 V car battery has a rating of 60 A h.

A driver forgot to switch off his car headlights after parking his car. If each of the two headlights draws a current of 3.0 A from the battery, determine the time taken for this battery to become “dead” or “flat”.

time taken = ……………………….. [2]

13 Fig. 7.1 shows a simple fire alarm that uses a thermistor as a sensor.

The electric bell rings when the surrounding temperature increases beyond a set temperature.

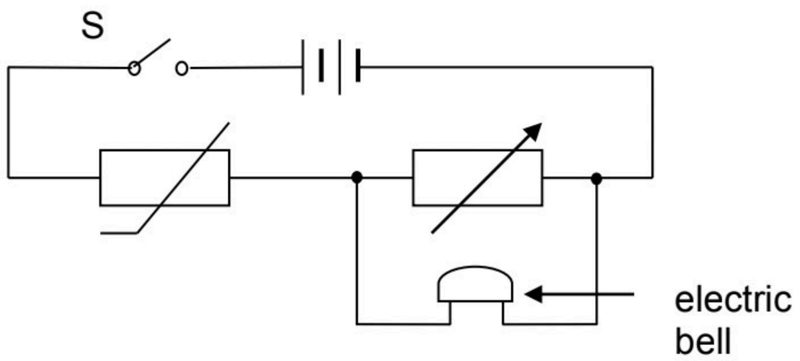


Fig. 7.1

(a) Explain how the fire alarm works.

....

....

....

....

....

.... [2]

(b) State one way in which the above fire alarm could be made to ring at a lower temperature. Explain clearly how this is achieved.

....

....

....

....

....

.... [2]

14 Fig. 8.1 shows a circuit constructed with three resistors R_1, R_2 and R_3 and three switches S_1, S_2 and S_3.

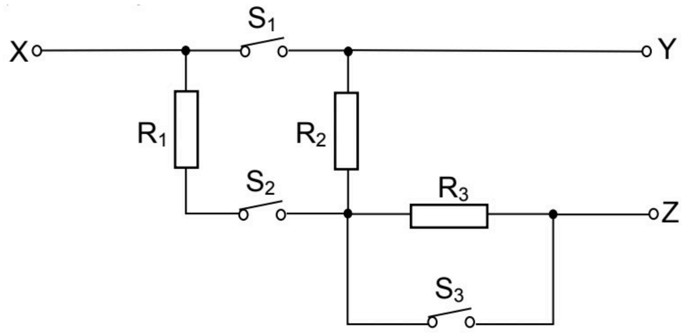


Fig. 8.1

The table below shows the resistance between terminals X and Z for different settings of the switches.

switch S_1	switch S_2	switch S_3	resistance between X and Z / Ω
open	closed	open	9.0
closed	open	open	8.0
closed	open	closed	3.0
open	closed	closed	4.0

(a) Determine the resistance of R_1, R_2 and R_3.

resistance of resistors R_1 = ……….., R_2 = ……….. and R_3 = ……….[3]

(b) Switches S_1 and S_2 are now closed and S_3 is now open.

Calculate the resistance between terminals Y and Z.

resistance = ……………………….. [2]

15 Fig. 9.1 shows part of a 240 V mains lighting circuit. Lamps A and B are rated '50 W, 240 V' and '100 W, 240 V' respectively.

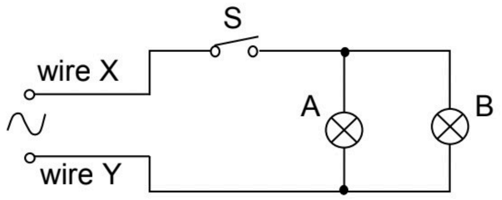


Fig. 9.1

(a) State which is the live wire, X or Y. Explain how you arrived at the conclusion.

....

....

.... [1]

(b) Determine the current in wire X and the current in wire Y when switch S is closed. [3]

current in wire X = ...

current in wire Y = ...

(c) If lamp A blows, state and explain the effect (if any) on the brightness of lamp B.

....

....

....

.... [2]

15 Either

A student sets up the circuit in Fig. 14.1 to find out how the resistance of a constantan wire is affected by its length. Constantan is a copper-nickel alloy.

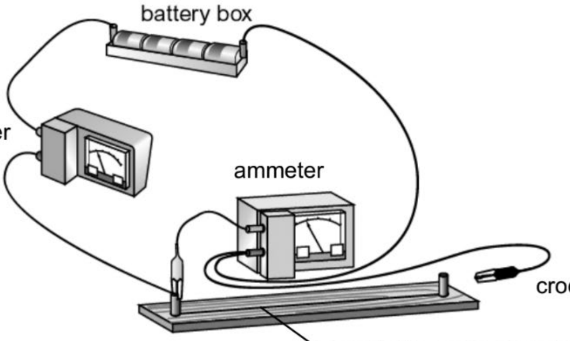


Fig. 14.1

(a) Identify and explain the mistake(s) made by the student in connecting the circuit in Fig. 14.1.

....

....

.... [1]

(b) The mistake(s) in the circuit in Fig. 14.1 are corrected. Draw a circuit diagram of the corrected circuit in the space below.

....

....

.... [2]

(c) After fixing the mistake, the student carries out the experiment and obtains the results shown in Fig. 14.2.

(i) Complete the last row in Fig. 14.2 by calculating the resistance *R* of the constantan wire for each length *l* of the wire. [2]

length of the wire *l* / m	0.10	0.20	0.30	0.40
voltage *V* / V	0.50	1.00	1.40	1.90
current *I* / A	0.50	0.50	0.50	0.50

Fig. 14.2

(ii) Plot a graph of the resistance *R* of the constantan wire against its length *l* in Fig. 14.3. [2]

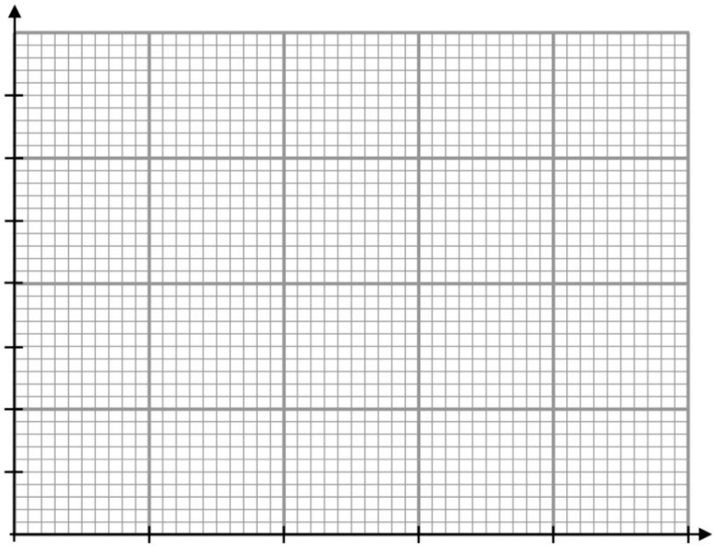


Fig. 14.3

(iii) Hence, state the relationship between the resistance of the constantan wire and its length. Explain how you arrive at this relationship.

....

....

.... [2]

(iv) If the diameter of the constantan wire is larger, explain how the graph plotted in Fig. 14.3 would be affected.

....

....

.... [1]

16 A simple d.c. motor is shown in Fig. 8.1.

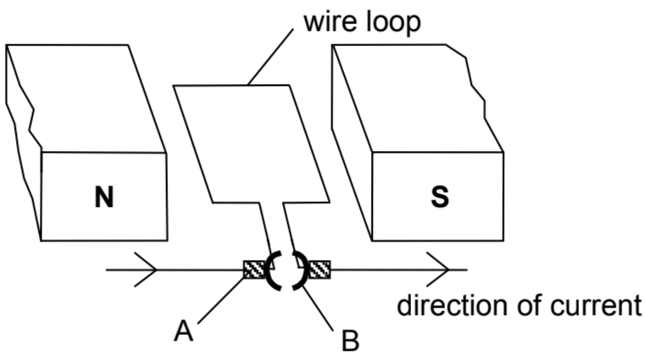


Fig. 8.1

(a) Name parts A and B.

A: .... [1]

B: .... [1]

(b) Explain how part B allows the coil to rotate continuously in the same direction.

....

....

....

.... [2]

17 EITHER

A circuit is set up as shown in Fig. 12.1. XY is a 60 cm long resistance wire of resistance 10 Ω and the slider S is placed such that XS is 40 cm.

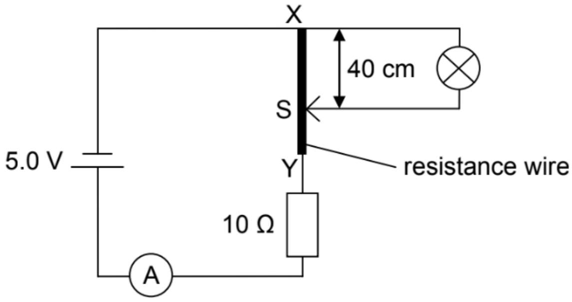


Fig. 12.1

(a) **(i)** Redraw the circuit representing the resistance wire as two resistors XS and SY. [1]

(ii) The resistance of the lamp is 10 Ω.

Determine the effective resistance of the circuit.

effective resistance = ... [3]

(iii) Find the potential difference across the lamp.

potential difference = ... [2]

(b) The slider S is now placed at X and slowly moved towards Y.

(i) Sketch a graph in Fig. 12.2 to show how the power of the lamp vary with the length of XS [2]

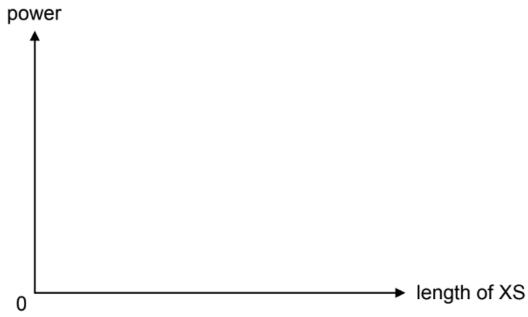


Fig. 12.2

(ii) State and explain how the ammeter reading changes.

....

....

.... [2]

18 Fig. 10.1 shows an electrical circuit with an ammeter and a voltmeter.

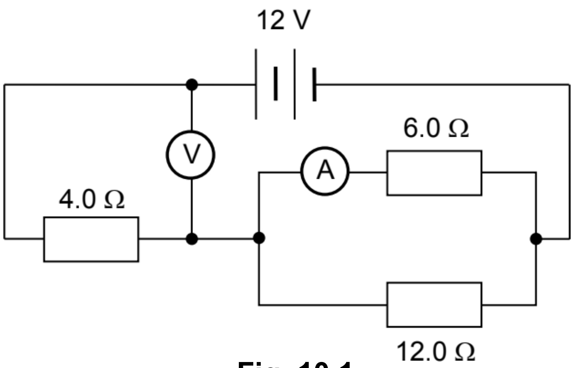


Fig. 10.1

(a) Calculate the effective resistance of this circuit.

effective resistance = ... [1].

(b) Determine the readings on the voltmeter and the ammeter.

voltmeter reading = ... [1].

ammeter reading = ... [1].

ANSWERS FOR D.C. CIRCUIT MCQ

Q1: A	Q11: C	Q21: A	Q31: C	Q41: C	Q51: C	Q61: C
Q2: C	Q12: B	Q22: B	Q32: C	Q42: A	Q52: B	Q62: B
Q3: D	Q13: C	Q23: C	Q33: A	Q43: A	Q53: A	Q63: B
Q4: A	Q14: C	Q24: C	Q34: D	Q44: C	Q54: C	Q64: A
Q5: B	Q15: B	Q25: A	Q35: D	Q45: C	Q55: C	Q65: A
Q6: B	Q16: A	Q26: A	Q36: B	Q46: D	Q56: B	Q66: D
Q7: C	Q17: B	Q27: B	Q37: B	Q47: B	Q57: B	
Q8: B	Q18: B	Q28: C	Q38: C	Q48: C	Q58: D	
Q9: D	Q19: D	Q29: B	Q39: A	Q49: D	Q59: D	
Q10: D	Q20: C	Q30: B	Q40: C	Q50: C	Q60: B	

ANSWERS FOR D.C. CIRCUIT STRUCTURED QUESTIONS

1

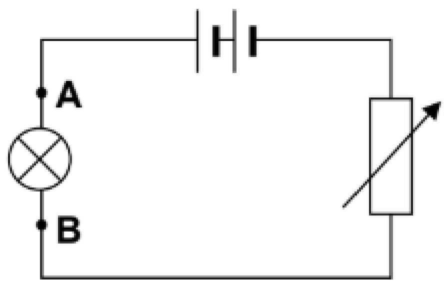


Fig. 10.1

Describe the effect on the light bulb in the circuit shown in Fig. 10.1 above if

(a) a piece of copper wire is connected between the points A and B;

The copper wire causes a short circuit. The light bulb would not light up (or would go off). [1]

(b) a second identical light bulb is connected between the points A and B;

The second light bulb is connected in parallel, causing the effective resistance across AB decreases, so the p.d. across AB decreases. The original light bulb would become dimmer (or would become less bright). [1]

(c) one of the two cells is connected in the opposite way (its terminals are reversed).

The net e.m.f. of the cells become zero. The light bulb would not light up (or would go off). [1]

2 A system of resistors can be constructed such that they are capable of providing several different resistance values depending on the way they are connected. Fig.17.1 shows how one such system is connected across AB.

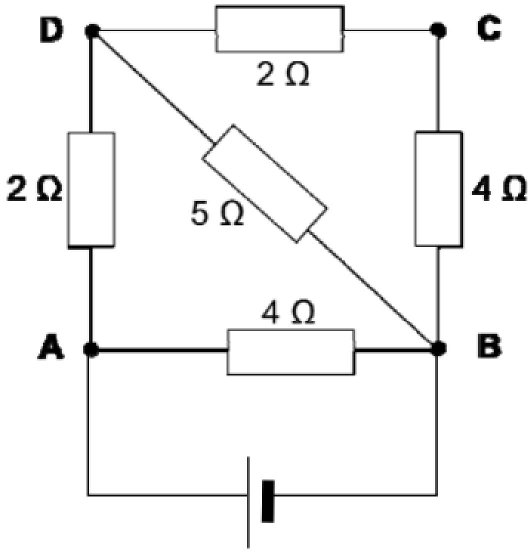


Fig. 17.1

Calculate the effective resistance across AB.

Across DB: $1/R_1 = 1/5 + 1/6$

$R_1 = 2.727\ \Omega$

Top loop of AB: $R_2 = 2 + 2.727 = 4.727\ \Omega$

Therefore, across AB: $1/R_{eff} = 1/4.727 + 1/4$

Therefore, $R_{eff} = 2.17\ \Omega$ (3 s.f.)

[2]

3 A thermistor is placed outside a room and is connected to an air-conditioning unit inside the room as shown in Fig. 21.1.

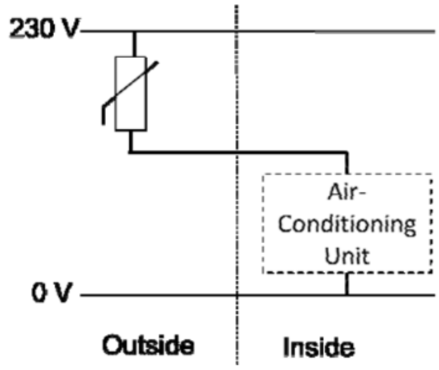


Fig. 21.1

Fig. 21.2 below shows how the potential difference across this thermistor changes with temperature.

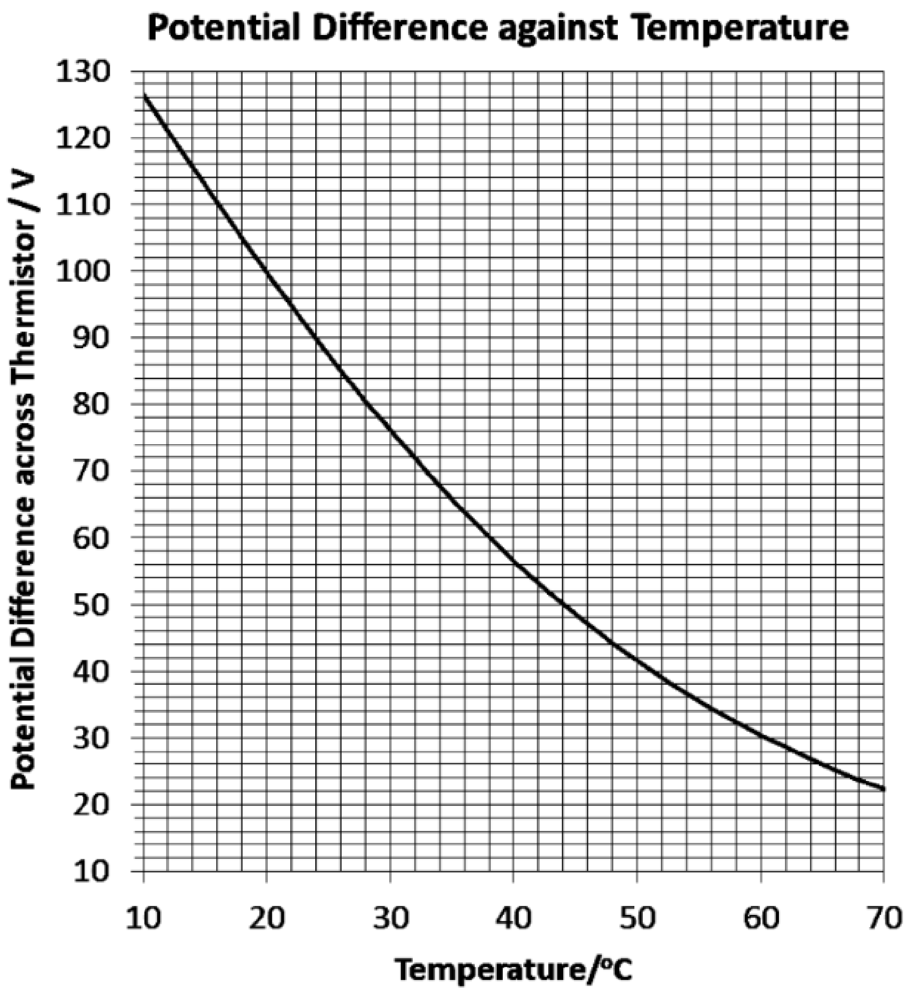


Fig. 21.2

(a) State and explain what happens to the resistance of the thermistor as temperature increases.

As temperature increases, resistance of the thermistor decreases due to the increase in concentration of free mobile electrons.

OR

Since potential difference across the thermistor decreases as the temperature increases, it implies that the resistance of the thermistor decreases. [1]

(b) Using Fig 21.1 and Fig. 21.2, state whether the potential difference across the air conditioning unit increases, decreases, or remains the same, when the temperature outside the room increases.

The potential difference across the air-conditioning unit increases because the potential difference across the thermistor decreases. [1]

(c) The air conditioning unit automatically switches on when the potential difference across it exceeds 154 V.

State the temperature at which the air-conditioning unit switches on.

temperature = 30°C [1]

(d) The resistance of the thermistor is 1630 Ω when the temperature is 40°C. Assume that the resistance of the air-conditioning unit is fixed.

(i) From Fig. 21.2, determine the potential difference across the thermistor when the temperature is 40°C.

potential difference = 56 V [1]

(ii) Calculate the current flowing through the thermistor when the temperature is 40°C.

Current in circuit = 56/1630 = 0.034355 A

= 0.034 A or 34 mA (2 s.f.)

[1]

(iii) Determine the potential difference across the air-conditioning unit when the temperature is 40°C.

p.d. across air conditioning unit = 230 – 56 = 174 V

[1]

(iv) Calculate the resistance of the air-conditioning unit.

Therefore, resistance of air conditioning unit

= 174/0.034355

= 5060 Ω (3 s.f.)

[2]

(e) Based on your answer in part (d) (iv), determine the resistance of the thermistor at 58°C.

At 58°C, p.d. across thermistor is 32 V (from graph)

p.d. across air conditioning unit = 230 – 32 = 198 V

Current through thermistor = 198/**5060** = 0.03913 A

Therefore, resistance of thermistor = 32/0.03913 = 818 Ω (3 s.f.)

[2]

4 In the circuit shown in Fig. 9 below, the resistance of the battery and the meters may be ignored.

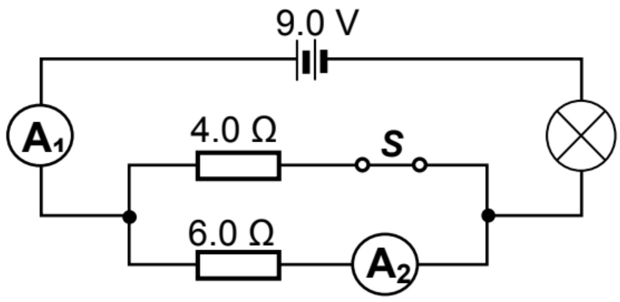


Fig. 9

The reading of ammeters A1 is 2.5 A and the reading on A2 is 1.0 A.

(a) Determine the current flowing through the 4.0 Ω resistor.

I =2.5 A - 1.0 A = 1.5 A [1]

(b) Calculate potential difference across the 6.0 Ω resistor.

V = IR = 1.0 A x 6.0 . = 6.0 V [1]

(c) Calculate the potential difference across the bulb.

V = 9.0 V - 6.0 V = 3.0 V [1]

(d) Suggest and explain how the brightness of the bulb will be affected when switch S is opened.

When S is opened, the effective resistance of the circuit increases and current through the bulb decreases.

Since $P = I^2R$ and at constant R, $P \propto I^2$, the bulb is dimmer as power dissipated in it decreases when current through the bulb decreases.

OR

When S is opened, the effective resistance of the fixed resistor increases. Hence, the p.d. across the 6.0 n resistor increases and the p.d. across the bulb decreases.

Since $P = V^2/R$ and at constant R, $P \propto V^2$, the bulb is dimmer as power dissipated in it decreases when p.d. across the bulb decreases. [2]

5 The variation of resistance R of a LDR with the intensity of the light falling on it is shown in Fig. 12.1.

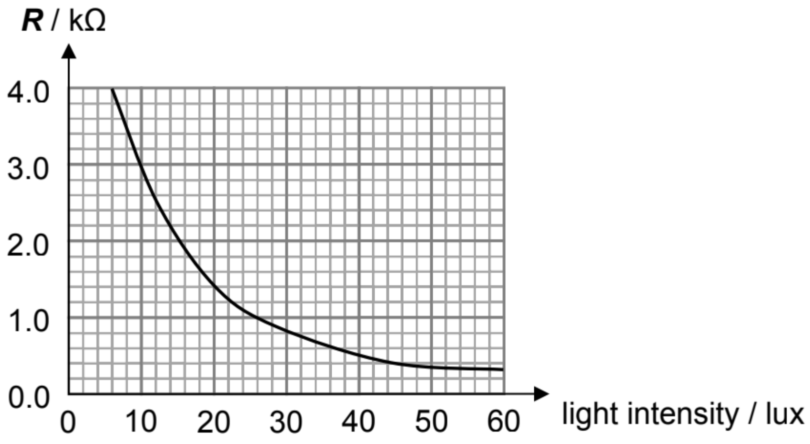


Fig. 12.1

(a) Describe how the resistance of an LDR changes as the intensity of light falling on it changes. Explain why the resistance of the LDR is dependent on the light intensity.

The resistance of an LDR decreases as the light intensity increases.

The resistance changes because when light energy falls on it, extra **free electrons** are released which makes it a better conductor.

[2]

Fig. 12.2 shows how the LDR can be used in a control circuit to switch on the lights in a classroom when the illumination in the classroom drops below 20 lux.

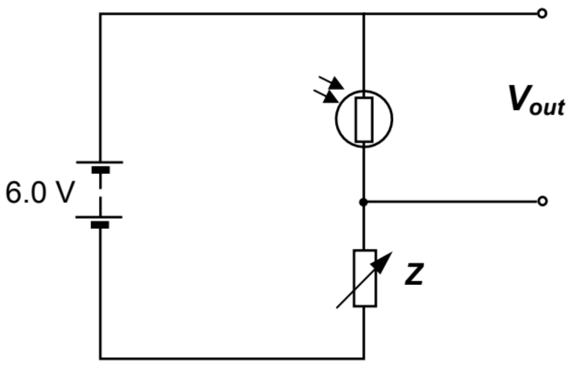


Fig. 12.2

The lights comes on when the potential difference Vout reaches 4.0 V at 20 lux.

(b) With reference to Fig. 12.1, calculate the electrical energy dissipated in the LDR in 10 s when the intensity of light falling on it is 20 lux.

Resistance = 1400 Q

Energy = $V^2/R \times t = 4.0^2/1400 \times 10 = 0.11$ J

[2]

(c) Explain why the power consumed by the control circuit is smaller when the room is dark.

When the room is dark, the resistance of the LDR is very high, hence R_{total} is also high.

This causes a small current to flow in the circuit, hence power consumption is low by using $P = I^2R$. [2]

(d) Determine the value of the resistor Z for the control unit to operate correctly.

Resistance of **LDR= 1400** at 20 lux when p.d. across LDR = 4.0 V

Hence, p.d. across Z = 2.0 V, resistance of Z = **700 Q** [2]

(e) Feedback from students in the class indicates that the room is too dark before the light comes on. Suggest and explain how the the value of the resistor, Z should be adjusted to switch on the lights before the classroom becomes too dark.

If light intensity is more than 20 lux, the resistance of LDR will decrease to lower than 1400 Q.

For V_{out} to remain at 4.0 V to switch on the classroom lights, the resistance of Z

will need to decrease to below 700 (based on the formula

V_{out}= 4.0 V = $[R_{ldr}/(R_{ldr} + R)] \times 6.0$ V [2]

6 A circuit is shown in Fig. 6.1 in which the connecting wires have negligible resistance. The current in the 18.0 Ω resistor is 0.50 A.

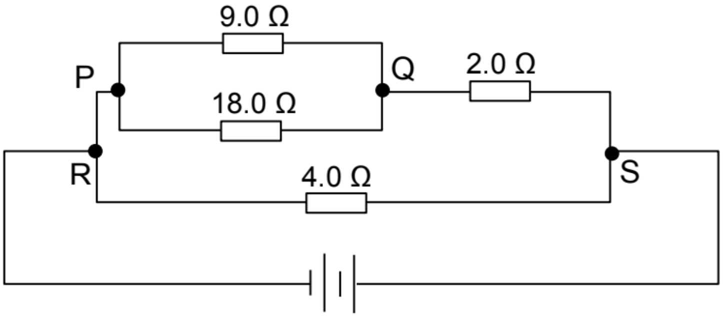


Fig. 6.1

Calculate:

(a) the potential difference between P and Q,

$V=IR = 0.50 \times 18.0 = 9.0$ V [1]

(b) the current in the 2.0 Ω resistor,

Current = 0.50 + 2(0.50) = 1.50 A [1]

(c) the potential difference between R and S,

Potential difference between R and S = (1.50 A x 2.0) + 9.0 V

= 3.0 V + 9.0 V = 12 V [2]

(d) the power dissipated by the 4.0 Ω resistor.

Power = $V^2/R = 12^2/4 = 36$ W [2]

7 A number of identical lamps are each marked 8.0 V, 2.0 W.

The lamps are connected in series to a 240 V mains supply and each lamp lights up with normal brightness.

(a) Calculate

(i) the number of lamps connected,

Number of lamps connected in series = e.m.f / p.d. of each lamp = 240/ 8.0 = 30

[1]

(ii) the total resistance of the lamps connected in series.

P = VI, hence current through each lamp I= P/V = 2.0/ 8.0 = 0.25 A [1]

e.m.f. = I R_{eff}

Total resistance of 30 lamps, R_{eff} = e.m.f. / I = 240 / 0.25 [1] = 960 Ω

OR

P = V^2/R → resistance of one lamp, R = V^2/P = 8^2/2.0 = 32 Ω

Total R = 30 x 32 = 960 Ω [3]

(b) The filament in one of the lamps burns out and this lamp is replaced by a new lamp marked 10 V, 2.0 W.

(i) Compare the resistance of the replacement lamp to the original lamp when they are operating at normal brightness.

P = VI, current in replacement lamp I = P/V = 2.0/10 = 0.20 A is less than the original lamp. [1]

Resistance of the replacement lamp is therefore greater than original lamp. [1]

OR

P = V^2/R → resistance of replacement lamp R = 10^2/2.0 = 50 Ω > 32 Ω greater than original lamp [2]

(ii) State and explain if the other original 8.0 V, 2.0 W lamps will be brighter, dimmer or at normal brightness when this replacement lamp is connected in series with them.

The lamps will be dimmer. [1]

As the replacement lamp has a greater resistance, connecting it in series to the circuit will increase the effective resistance of the circuit. [1] This will decrease the amount of current through the lamps. [1]

OR The replacement lamp has a greater resistance. Using the potential divider method (for resistors in series), the p.d. across the replacement lamp would be higher, so the p.d. across the remaining lamps would be smaller, given the same e.m.f. 240 V. Hence, the remaining lamps will be dimmer. [3]

8 In the circuit shown in Fig. 8.1, a 4.0 Ω resistor, a variable resistor and a lamp are connected to a 12.0 V supply.

The variable resistor has a range of resistance from 0 to 15.0 Ω.

The lamp operates at normal brightness when there is a potential difference of 3.0 V across it.

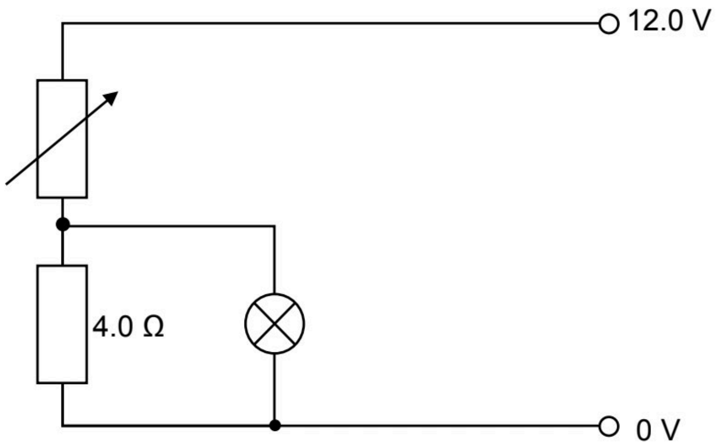


Fig. 8.1

(a) Determine the resistance of the variable resistor when the lamp is operating at normal brightness. Assume the resistance of the lamp is much greater than that of the 4.0 Ω resistor.

Assume the resistance of the lamp is much greater than that of 4.0 Ω resistor, so the current mainly flows through the two resistors in series. Using potential divider method, p.d. across lamp = p.d. across R_1 4.0 Ω resistor, $V_1 = 3.0$ V

p.d. across variable resistor: V_2 with resistance R_2

V_2 / e.m.f = $R_2 / (R_1 + R_2)$ → (12.0 – 3.0) / 12.0 = $R_2 / (4.0 + R_2)$ [1] $R_2 = 12$ Ω [1]

OR

$V_2 / V_1 = R_2 / R_1$

[2]

(b) The variable resistor is now replaced with a fixed resistor as shown in Fig.9.2.

The 4.0 Ω resistor is replaced with a thermistor which has a resistance that will decrease when its temperature increases.

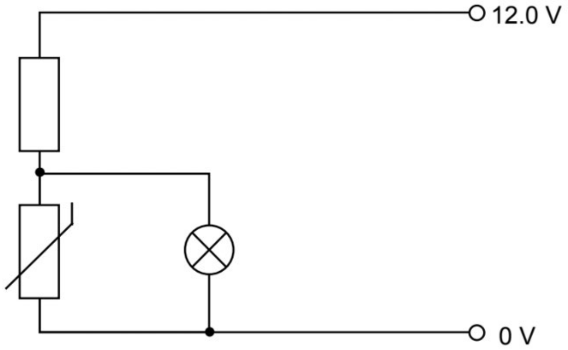


Fig. 9.2

State and explain what kind of physical conditions in the environment will cause the lamp to light up.

A colder environment / a lower temperature will cause the lamp to light up. When the temperature decreases, the resistance of the thermistor increases /p.d. across the lamp is the same as the p.d across the thermistor.

When the resistance of the thermistor is high, the p.d. across the thermistor (lamp) is also high / more current flows through the lamp

Hence, the lamp will light up.

[3]

9 Fig. 9.1 shows a circuit with three resistors, an ammeter and a voltmeter connected to a 6.0 V battery.

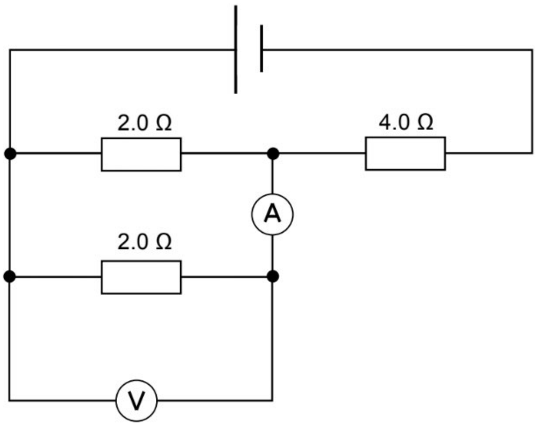


Fig. 9.1

(a) Determine the effective resistance of the circuit.

Show all working clearly.

$R = (\frac{1}{2} + \frac{1}{2})^{-1} + 4.0$ [1] $= 5.0\ \Omega$

[2]

(b) Determine the readings on the voltmeter and the ammeter.

Show all working clearly.

potential divider: $V = (1/(4+1)) \times 6.0 = 1.2$ V [1]

$I = V/R = 1.2/2.0 = 0.60$ A [1]

10 Fig. 6.1 shows a circuit diagram of a torch using six 1.5 V cells to light a bulb with resistance 18 Ω.

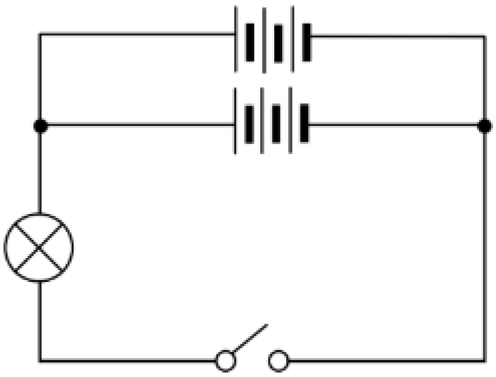


Fig. 6.1

(a) Calculate the current through the bulb when the torch is switched on.

V = IR I = V / R = (1.5 × 3) / 18

= 0.25 A [2]

(b) Hence, calculate the amount of electrical charge passing through the bulb each second.

I = Q / t Q = I x t = 0.25 A x 1 s = 0.25 C

Substitution of correct values into formula must be shown.

[1]

11 Fig. 8.1 and Fig. 8.2 show two circuits. Each circuit is connected with three identical light bulbs each with resistance 1.0 k and a battery with an electromotive force (e.m.f.) of 5.0 V.

In Fig. 8.2, the wire W connected across PQ has negligible resistance.

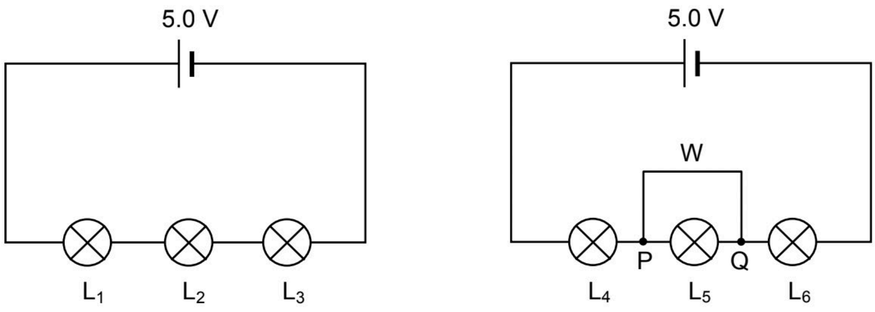


Fig. 8.1 **Fig. 8.2**

State and explain which circuit has a greater current flowing through it.

In Fig. 8.2, the conducting wire PQ connected across the light bulb L_5 produces a short circuit, so no current is passing through L_5. The effective resistance of this circuit is 2.0 kΩ, smaller than 3.0 kΩ in Fig. 8.1.

Hence, for the same e.m.f. in the two circuits, the current in Fig. 8.2 is greater.

OR

Fig. 8.1 current = e.m.f. / R_1 = 5.0 V / 3000 Ω = 1.7 mA

Fig. 8.2 current = e.m.f. / R_1 = 5.0 V / 2000 Ω = 2.5 mA

Hence, the current in Fig. 8.2 is greater.

[2]

12 A light-dependent resistor (LDR) has a resistance which decreases with increase in light intensity.

On a sunny day, the LDR has a resistance of 0.56 kΩ.

On a cloudy day, the resistance rises to 4.0 kΩ. At night, the resistance is 20 kΩ. The LDR is connected in the circuit shown in Fig. 9.1.

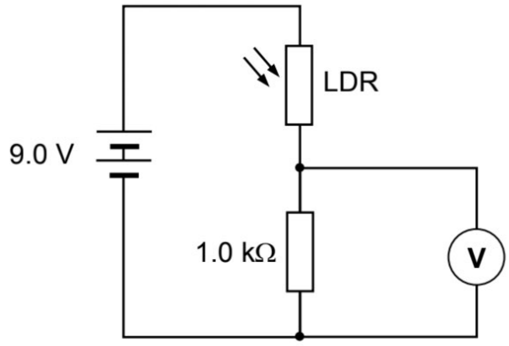


Fig. 9.1

(a) Determine the voltmeter reading on a sunny day.

Using potential divider approach:

$$\frac{V_1}{\text{e.m.f.}} = \left(\frac{R_1}{R_1+R_2}\right) \rightarrow V_1 = \left(\frac{R_1}{R_1+R_2}\right) \times \text{e.m.f.} = \left(\frac{1.0}{1.0+0.56}\right) \times 9.0\text{ V}$$

$$V_1 = 5.769 \approx 5.8\text{ V}$$

[2]

(b) State and explain any change in the voltmeter reading as the light intensity decreases from day to night.

As the light intensity decreases, the resistance of the LDR increases and the p.d. across the LDR also increases (based on potential divider).

Hence, the p.d. V_R across the resistor decreases (same e.m.f. = $V_{LDR} + V_R$) and the voltmeter reading decreases.

OR total resistance in the circuit increases, so current I decreases, hence the p.d. V_R across the resistor decreases (where $V_R = IR$)

and the voltmeter reading decreases.

[2]

12 Either

Fig. 11.1 shows an apparatus set up by a student in which an ammeter is used to indicate the level of liquid in a tank. The equivalent circuit is shown in Fig. 11.2.

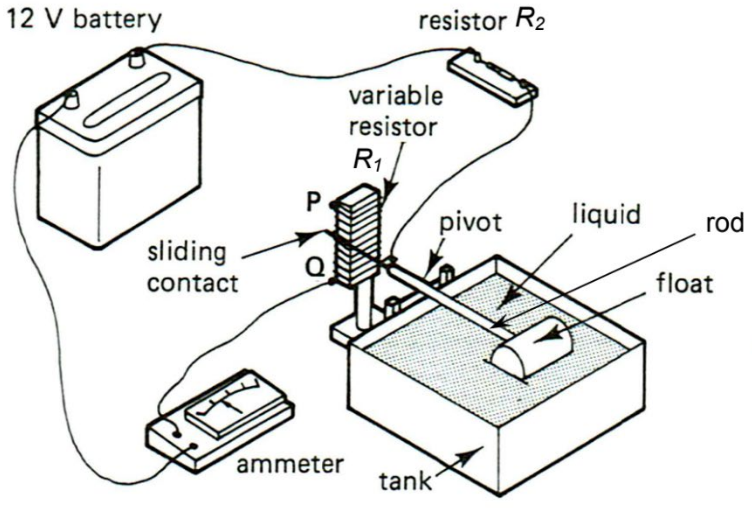


Fig. 11.1

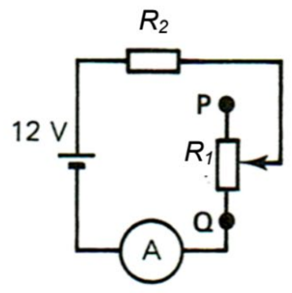


Fig. 11.2

The variable resistor R1 is made from a length of bare resistance wire PQ coiled around an insulator (with turns not touching each other). Assume the rod (shown in

Fig. 11.1) connects the sliding contact to the float and this rod is always in contact with the fixed pivot.

When the tank is empty, the sliding contact is at point P, and when it is full of liquid, the sliding contact is at Q.

(a) Describe and explain what happens to the ammeter reading as the tank is being filled with liquid.

As the liquid flows into the tank, the float moves upwards and the sliding contact moves downwards from P towards Q.

The resistance of R_1 in the circuit decreases, so the current and hence the ammeter reading **increases**.

. [2]

(b) The resistance of the variable resistor R_1 can vary from 0 to 90 Ω. The resistor R_2 has a resistance of 10 Ω. The resistance of the ammeter is so small that it can be ignored.

(i) Calculate the ammeter reading when

1. When tank is full: sliding contact at Q, $R_1 = 0$ Ω

effective resistance $R_{eff} = R_1 + R_2 = 0 + 10 = 10$ Ω

e.m.f. = $I_{total} \cdot R_{eff} \rightarrow I = 12$ V / 10 Ω = 1.2 A [2]

2. When tank is empty: effective resistance $R_{eff} = 90 + 10 = 10$ Ω

I_{total} = e.m.f. / $R_{eff} \rightarrow I = 12$ V / 100 Ω = 0.12 A [1]

(ii) Explain why resistor R_2 is included in the circuit.

This resistor is used to prevent a large current which may damage circuit components when the resistance of R_1 becomes 0 Ω (or when the tank is full). [1]

(iii) This apparatus could be a simple model of a system used inside a car. Suggest what this system is.

The fuel gauge / the system which indicates the amount of petrol/fuel [1]

(c) Explain the meaning of an *electric current*.

An electric current is the rate of flow of charge.. [1]

(d) Another system inside a car is the headlights circuit which consists of two headlights (lamps). Both headlights are connected in parallel to a 12 V battery.

The total charge that a battery can supply without being recharged is expressed in the unit of ampere-hour (A h). A typical 12 V car battery has a rating of 60 A h.

A driver forgot to switch off his car headlights after parking his car. If each of the two headlights draws a current of 3.0 A from the battery, determine the time taken for this battery to become "dead" or "flat".

$I = Q / t \rightarrow Q = It$

60 A h = 2 x 3.0 A x t

t = 60 / 6 = 10 hours [2]

13 Fig. 7.1 shows a simple fire alarm that uses a thermistor as a sensor.

The electric bell rings when the surrounding temperature increases beyond a set temperature.

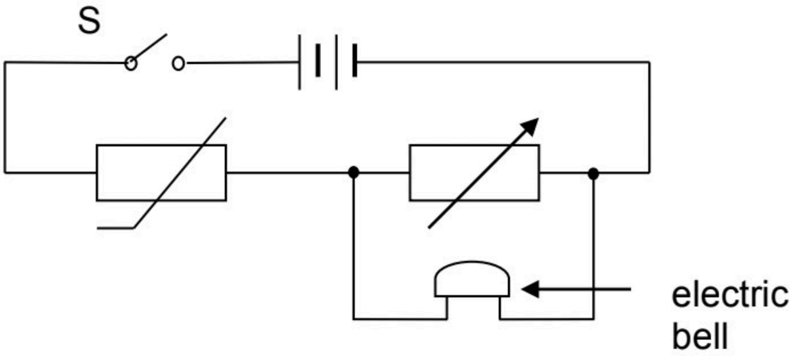


Fig. 7.1

(a) Explain how the fire alarm works.

At high temperature, resistance of thermistor decreases. [1]

PD across thermistor decreases OR Total resistance decreases.

PD across bell increases OR Total current increases.

Current flowing through bell increases and activate bell. [1]

[2]

(b) State one way in which the above fire alarm could be made to ring at a lower temperature. Explain clearly how this is achieved.

Set the variable resistance to a higher value. [1]

PD across bell greater than PD across thermistor. [1]

[2]

14 Fig. 8.1 shows a circuit constructed with three resistors R_1, R_2 and R_3 and three switches S_1, S_2 and S_3.

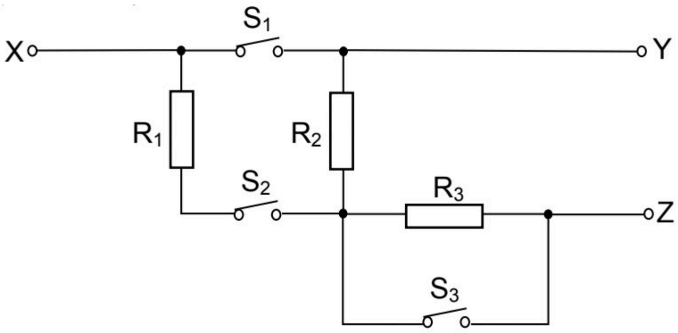


Fig. 8.1

The table below shows the resistance between terminals X and Z for different settings of the switches.

switch S_1	switch S_2	switch S_3	resistance between X and Z / Ω
open	closed	open	9.0
closed	open	open	8.0
closed	open	closed	3.0
open	closed	closed	4.0

(a) Determine the resistance of R_1, R_2 and R_3.

resistance of resistors R_1 = ……….., R_2 = ……….. and R_3 = ……….[3]

With S_1 and S_3 open and S_2 closed, the circuit is effectively a series connection of R_1 and R_3:

$R_1 + R_3 = 9.0\ \Omega$

With S_1 closed, S_2 and S_3 open, the circuit is effectively a series connection of R_2 and R_3:

$R_2 + R_3 = 8.0\ \Omega$

With S_1 and S_3 closed and S_2 open, the circuit is effectively just R_2: $R_2 = 3.0\ \Omega$

Hence $R_3 = 5.0\ \Omega$ and $R_1 = 4.0\ \Omega$

(i) $R_1 = 4.0\ \Omega$ [1]

(ii) $R_2 = 3.0\ \Omega$ [1]

(iii) $R_3 = 5.0\ \Omega$ [1]

(b) Switches S_1 and S_2 are now closed and S_3 is now open.

Calculate the resistance between terminals Y and Z.

With S_1 and S_2 are now closed and S_3 is now open, the effective resistance between Y and Z is effectively:

$R_{eff} = (1/4.0 + 1/3.0)^{-1} + 5.0$ [1]

$= 6.7\ \Omega$ (2 s.f.) [1] [2]

15 Fig. 9.1 shows part of a 240 V mains lighting circuit. Lamps A and B are rated '50 W, 240 V' and '100 W, 240 V' respectively.

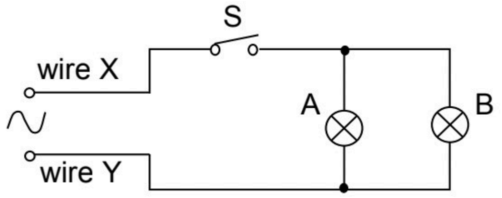


Fig. 9.1

(a) State which is the live wire, X or Y. Explain how you arrived at the conclusion.

Wire X is the 'Live' wire.

Switches are <u>always placed in the live wire</u> OR so that the <u>lamp would</u> <u>not be live</u> when the switch is open. [1]

(b) Determine the current in wire X and the current in wire Y when switch S is closed. [3]

$I_A = 50/240 = 0.2083 = 0.208$ A [1]

$I_B = 100/240 = 0.416 = 0.416$ A [1]

$I_X = I_A + I_B = 0.625$ A or 0.63 A (2 s.f.)

$I_Y = 0.63$ A (2 s.f.) [1] – (ecf from I_A & I_B with $I_X = I_Y$)

Only if both correct

(c) If lamp A blows, state and explain the effect (if any) on the brightness of lamp B.

It would not be affected [1]

As the lamps are <u>connected in parallel</u>, the voltage of lamp **B** is constant. [1]

[2]

15 Either

A student sets up the circuit in Fig. 14.1 to find out how the resistance of a constantan wire is affected by its length. Constantan is a copper-nickel alloy.

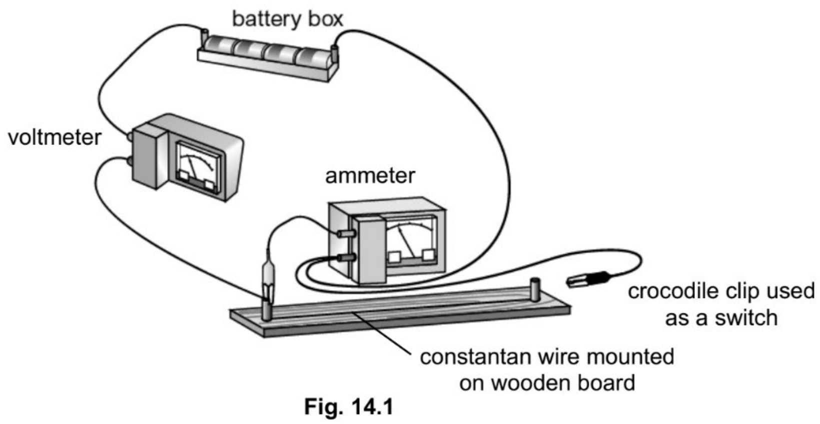


Fig. 14.1

(a) Identify and explain the mistake(s) made by the student in connecting the circuit in Fig. 14.1.

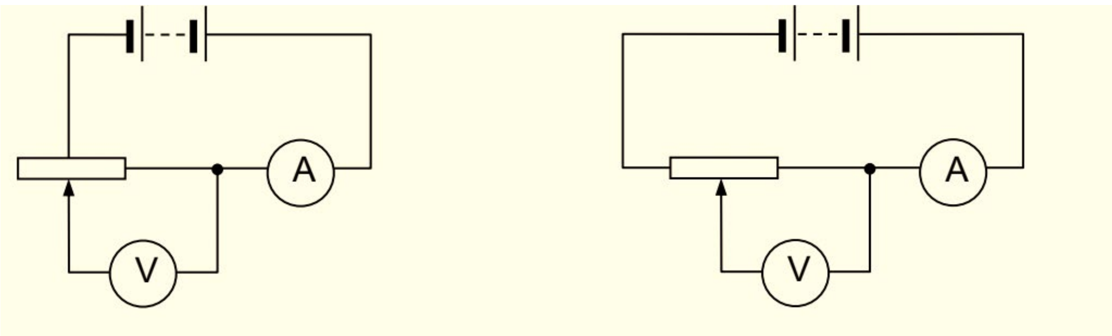
The voltmeter is wrongly connected in series when it should be connected in parallel with the constantan wire,

while the ammeter is wrongly connected in parallel when it should be connected in series with the wire. [1]

(b) The mistake(s) in the circuit in Fig. 14.1 are corrected. Draw a circuit diagram of the corrected circuit in the space below.

correct circuit symbols & circuit connections clearly indicating how the crocodile clip acts as a variable connection

ammeter is connected in series and voltmeter is connected in parallel



[2]

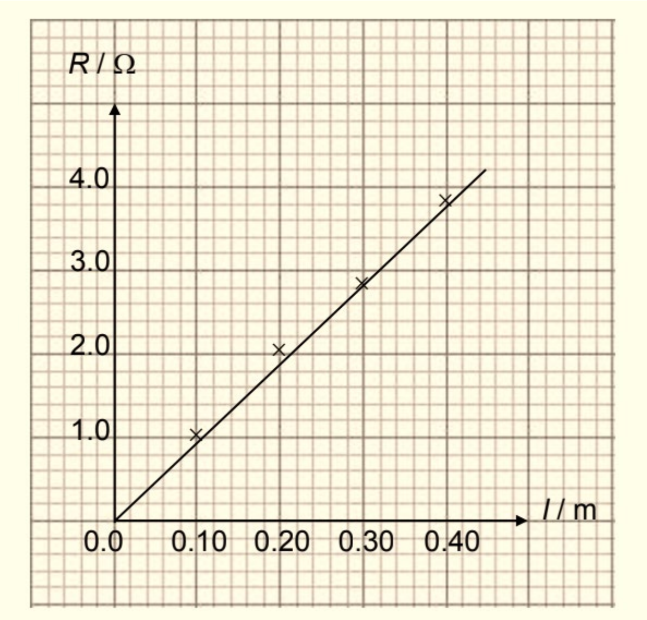
(c) After fixing the mistake, the student carries out the experiment and obtains the results shown in Fig. 14.2.

(i) Complete the last row in Fig. 14.2 by calculating the resistance *R* of the constantan wire for each length *l* of the wire. [2]

length of the wire *l* / m	0.10	0.20	0.30	0.40
voltage *V* / V	0.50	1.00	1.40	1.90
current *I* / A	0.50	0.50	0.50	0.50
resistance	1.0	2.0	2.8	3.8

Fig. 14.2

(ii) Plot a graph of the resistance *R* of the constantan wire against its length *l* in Fig. 14.3. [2]



(iii) Hence, state the relationship between the resistance of the constantan wire and its length. Explain how you arrive at this relationship.

The resistance of the wire is directly proportional to its length.

It is because the graph is a straight line and the line passes through the origin [2]

(iv) If the diameter of the constantan wire is larger, explain how the graph plotted in Fig. 14.3 would be affected.

Resistance of the wire is inversely proportional to the cross-sectional area of the wire, hence the resistance decreases. The slope of the graph becomes smaller / more gentle. [1]

16 A simple d.c. motor is shown in Fig. 8.1.

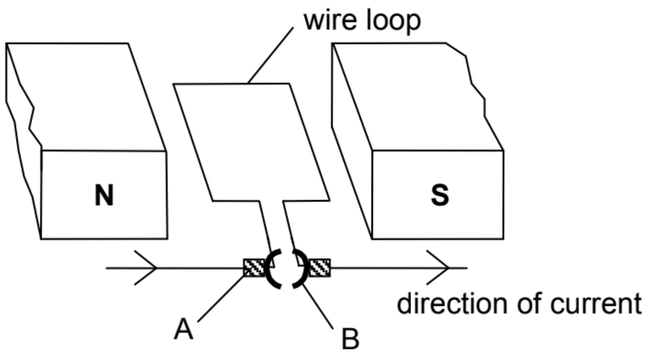


Fig. 8.1

(a) Name parts A and B.

A: carbon brush [1]

B: split ring commutator [1]

(b) Explain how part B allows the coil to rotate continuously in the same direction.

The split ring commutator swap contact with the carbon brushes every half a cycle.

OR

The direction of current flowing in the coil reverses every half a cycle.

Hence, the forces reverse direction, allowing the coil to rotate continuously.

[2]

17 EITHER

A circuit is set up as shown in Fig. 12.1. XY is a 60 cm long resistance wire of resistance 10 Ω and the slider S is placed such that XS is 40 cm.

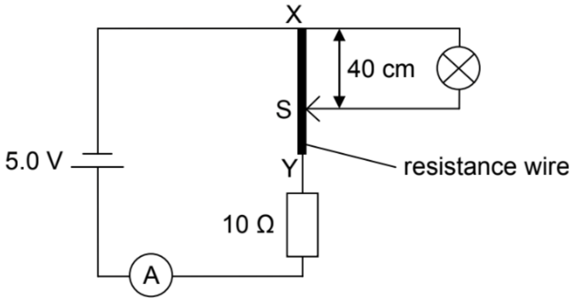
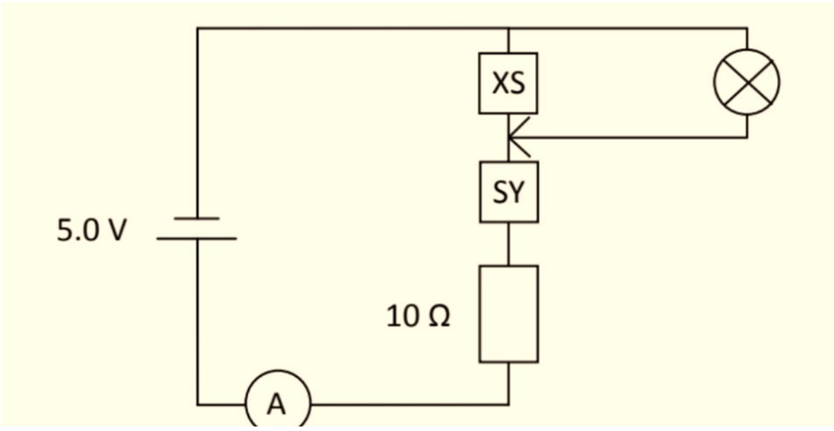


Fig. 12.1

(a) **(i)** Redraw the circuit representing the resistance wire as two resistors XS and SY. .[1]



(ii) The resistance of the lamp is 10 Ω.

Determine the effective resistance of the circuit.

Total effective resistance of bulb and XS

= 2/3 (10 Ω) (10 Ω) / 2/3 (10 Ω) + (10 Ω)= 4.0 Ω

Total effective resistance of the circuit = 4.0 Ω + 10/3 Ω + 10 Ω

= 17.33 Ω

= 17 Ω (2 sf) [3]

(iii) Find the potential difference across the lamp.

p.d. across lamp = 4.0 Ω /17.33 Ω × 5.0 V

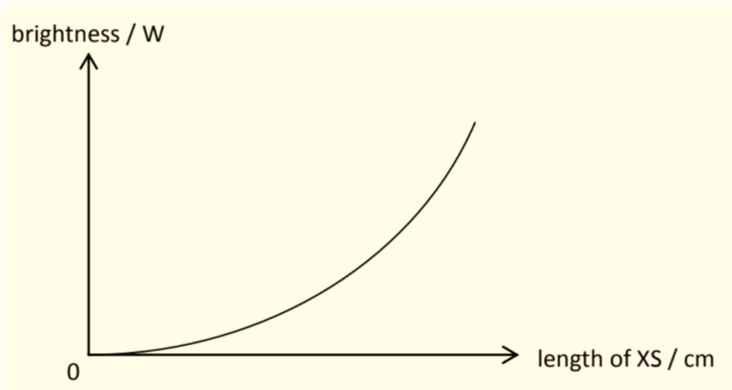
= 1.153 V

= 1.2 V (2 sf)

[2]

(b) The slider S is now placed at X and slowly moved towards Y.

(i) Sketch a graph in Fig. 12.2 to show how the power of the lamp vary with the length of XS [2]



(ii) State and explain how the ammeter reading changes.

The ammeter reading will increase.

The total effective resistance will decrease as the slider moves from X to Y.

[2]

18 Fig. 10.1 shows an electrical circuit with an ammeter and a voltmeter.

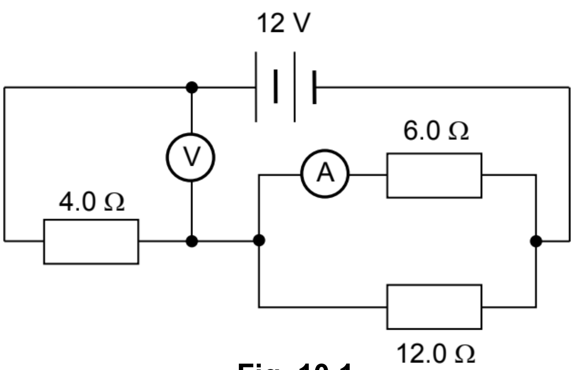


Fig. 10.1

(a) Calculate the effective resistance of this circuit.

Effective resistance of 6 Ω and 12 Ω resistors:

$1/R = 1/R1+1/R2 \rightarrow 1/R = 1/6+1/12 \rightarrow R = 4.0\ \Omega$

$R_e = 4.0 + 4.0 = 8.0\ \Omega$ [1]

[1].

(b) Determine the readings on the voltmeter and the ammeter.

p.d. across the parallel branches = 4/8 × 12 V = 6.0 V →

voltmeter reading = 6.0 V [1]

current through 6.0 Ω resistor = V / R = 6.0 V / 6.0 Ω = 1.0 A →

ammeter reading = 1.0 A [1]