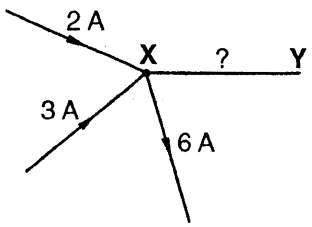
TOPIC 18 D.C. Circuits

1 The diagram shows the magnitude and directions of the electric currents entering and leaving junction **X**.

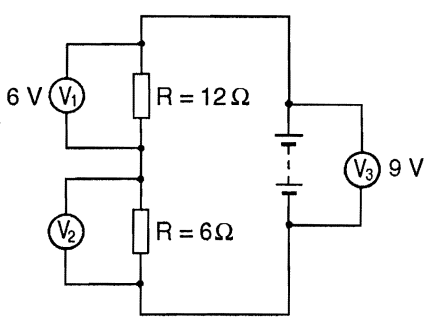


What will be the magnitude and direction of the current in the wire **XY**?

	magnitude	*direction*
A	1 A	**X** to **Y**
B	1 A	**Y** to **X**
C	5 A	**X** to **Y**
D	5 A	**Y** to **X**
E	8 A	**X** to **Y**

J90/I/29

2 The diagram shows a circuit.

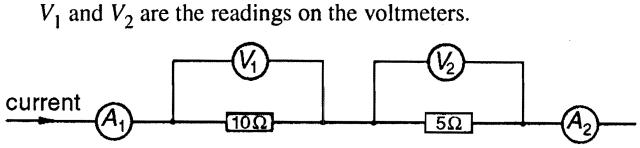


What is the reading on voltmeter V_2?

A 3 V
B 6 V
C 9 V
D 15 V
E 18 V

J90/I/30

3 A current flows in two resistors connected in series as shown in the diagram. A_1 and A_2 are the readings on the ammeter, V_1 and V_2 are the readings on the voltmeters.

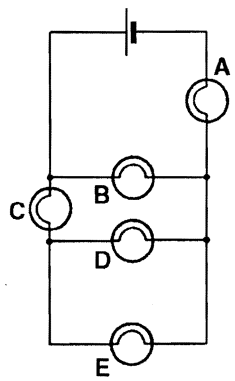


Which of the following correctly describes the ammeter and voltmeter readings?

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

N90/I/28

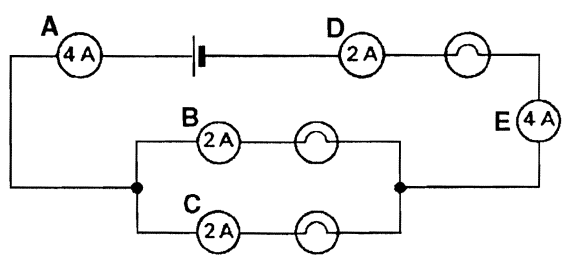
4 A battery lights all five lamps as shown in the circuit diagram.



Which lamp, if removed, would cause all the lamps to go out?

N90/I/29

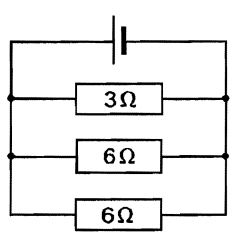
5 The diagram shows ammeter readings in a circuit.



Which ammeter is showing a faulty reading?

J91/I/30

6 The diagram shows a circuit.

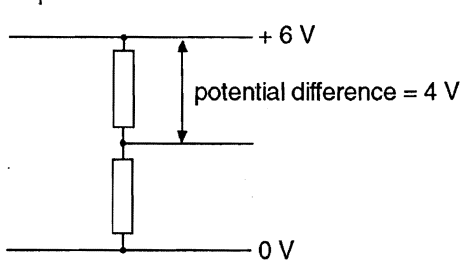


What is the effective resistance of the three resistors?

A 0.67 Ω
B 1.50 Ω
C 6.70 Ω
D 15.0 Ω
E 108 Ω

N91/I/28

7 Two resistors are connected in series between + 6 V and 0 V wires. The potential difference across one resistor is 4 V.

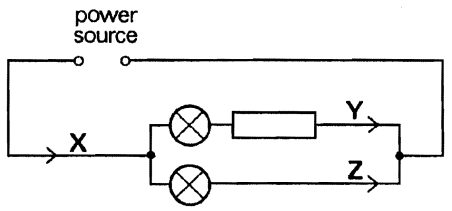


What is the potential difference across the other resistor?

A 10 V
B 6 V
C 4 V
D 2 V
E 0 V

N91/I/29

8 In the circuit below, the bulbs are identical.



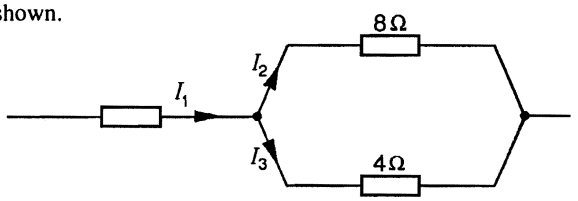
The values of the currents at **X**, **Y** and **Z** are measured.

Which set of values could be obtained?

	X	Y	Z
A	6 A	4 A	2 A
B	6 A	2 A	4 A
C	8 A	4 A	2 A
D	8 A	2 A	4 A
E	10 A	5 A	5 A

J92/I/29

9 In the diagram I_1 is the current supplied by a source. I_2 and I_3 are the currents in each branch of the parallel arrangement shown.



Which of the following statements concerning I_1, I_2 and I_3 is correct?

A I_1 is equal to I_2 but bigger than I_3.

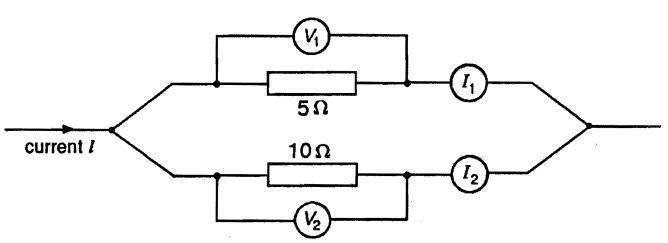
B I_2 is bigger than I_3 but smaller than I_1.

C I_2 is equal to I_3 but smaller than I_1.

D I_3 is bigger than I_2 but smaller than I_1.

N92/I/29 ; J95/I/27

10 A current flows towards the junction of two resistors connected in parallel. The ammeter readings are I_1 and I_2, and the voltmeter readings are V_1 and V_2.



Which of the following is correct?

	ammeter readings	*voltmeter readings*
A	$I_1 < I_2$	$V_1 > V_2$
B	$I_1 < I_2$	$V_1 < V_2$
C	$I_1 = I_2$	$V_1 < V_2$
D	$I_1 = I_2$	$V_1 = V_2$
E	$I_1 > I_2$	$V_1 = V_2$

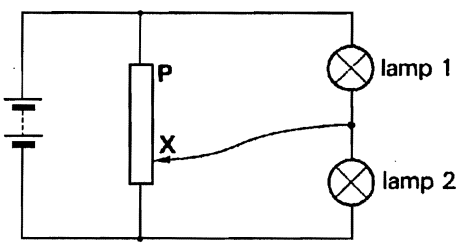
N93/I/29

11 What is the smallest total resistance which can be obtained using only a 6 Ω resistor and a 12 Ω resistor?

A 2 Ω
B 4 Ω
C 6 Ω
D 8 Ω
E 12 Ω

J93/I/28

12 The diagram shows a potential divider circuit.

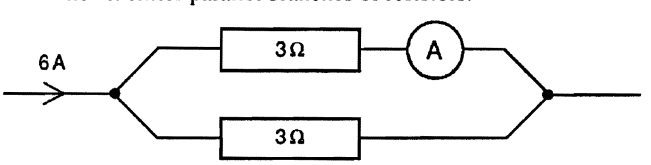


What happens to the brightness of the lamps as the contact **X** is moved towards end **P** of the potential divider?

	lamp 1	*lamp* 2
A	brighter	brighter
B	brighter	stays same
C	brighter	dimmer
D	dimmer	brighter
E	dimmer	stays same

N93/I/36

13 The current of 6 A flows in the circuit shown. It splits up when it enters parallel branches of resistors.

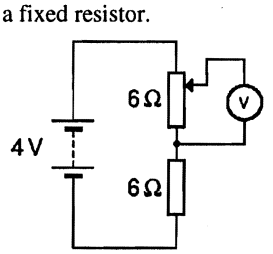


What is the reading on the ammeter?

A 2 A
B 3 A
C 6 A
D 12 A

J94/I/29

14 The diagram shows a circuit with a potential divider joined in series with a fixed resistor.

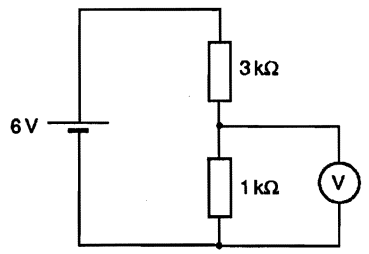


What are the minimum and maximum readings which can be obtained on the voltmeter?

	minimum reading/V	*Maximum reading*/V
A	0	2
B	0	6
C	2	4
D	6	12

J94/I/33

15 The diagram shows a circuit.

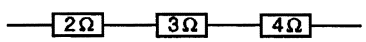


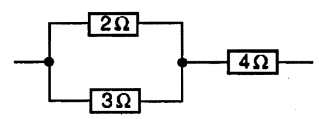
What is the reading of the voltmeter?

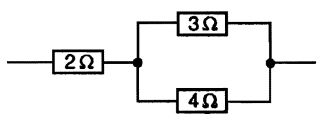
A 1 V
B 1.5 V
C 2 V
D 3 V

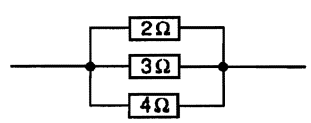
N94/I/28

16 Which resistor combination has the **lowest** resistance?

A


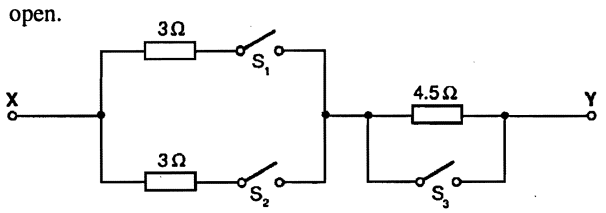
B


C


D


N94/I/29

17 The diagram shows a circuit in which all the switches are open.

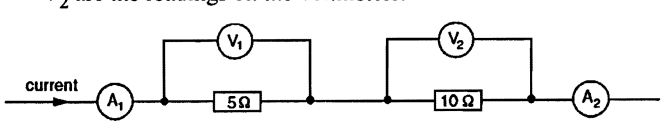


Which switch positions would obtain a resistance of 6Ω between **X** and **Y**?

	S_1	S_2	S_3
A	closed	closed	closed
B	closed	closed	open
C	open	closed	closed
D	open	open	closed

N95/I/30

18 A current flows in two resistors connected in series as shown. A_1 and A_2 are the readings on the ammeters. V_1 and V_2 are the readings on the voltmeters.

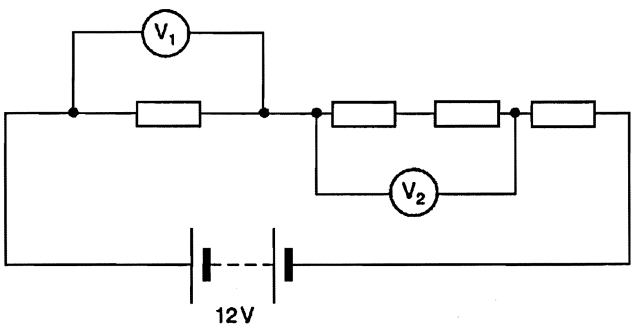


Which of the following correctly describes the ammeter and the voltmeter readings?

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

J96/I/29

19 The circuit diagram shows four identical resistors connected in series with a 12 V battery.

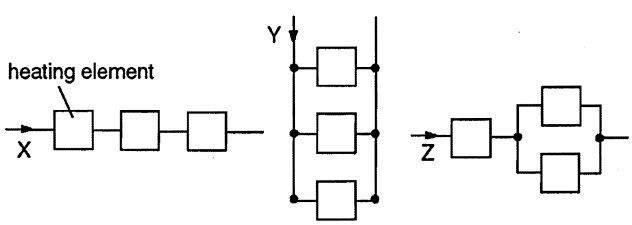


What would be the readings on voltmeters V_1 and V_2?

	voltmeter readings	
	V_1	V_2
A	1 V	2 V
B	2 V	4 V
C	3 V	6 V
D	4 V	8 V

N96/I/28

20 Three identical heating elements are wired up to the mains in the three ways shown.

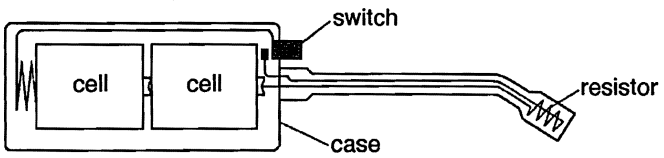


What is the **increasing** order of current drawn from the mains supply of these arrangements?

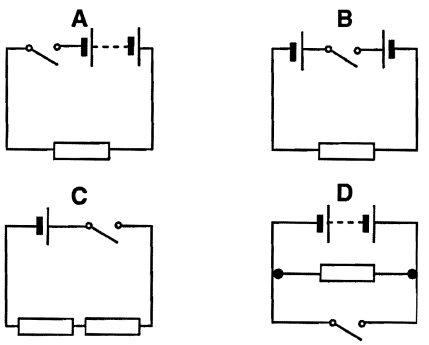
	current drawn from mains supply *lowest* ⟶ *highest*		
A	X	Y	Z
B	X	Z	Y
C	Y	Z	X
D	Y	X	Z

N96/I/29

21 The diagram shows the components of a lighter for a gas cooker.

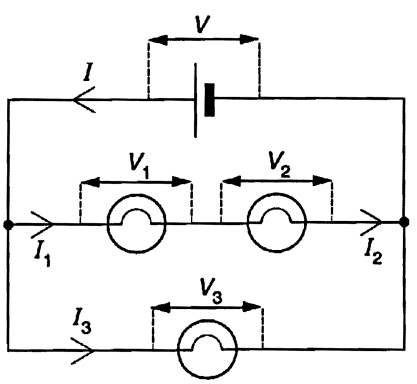


Which circuit diagram for this lighter is correct?



J97/I/27

22 The circuit shows identical lamps connected to a cell.

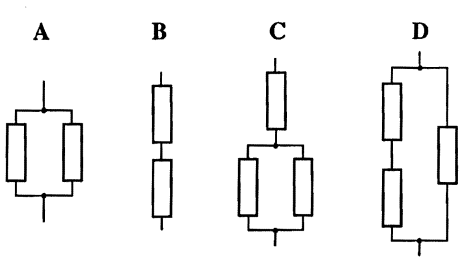


Which pair of equations is correct for this circuit?

	potential difference	*current*
A	$V = V_1 + V_2 + V_3$	$I = I_1 + I_2 + I_3$
B	$V = V_1 + V_2$	$I = I_1 + I_2$
C	$V = V_1 + V_2$	$I = I_1 + I_3$
D	$V = V_3$	$I = I_3$

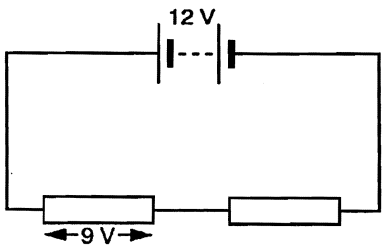
N97/I/29

23 Which combination of identical resistors gives the **lowest** total value?



J98/I/29

24 A battery is connected to two resistors in series. The p.d. across the battery is 12V and the p.d. across one resistor is 9V.



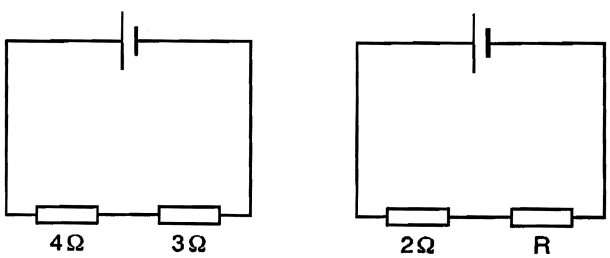
What is the p.d. across the other resistor?

A 3 V
B 6 V
C 9 V
D 21 V

N98/I/28

25 The same cell is used in both of the circuits shown. The current is the same in each case.

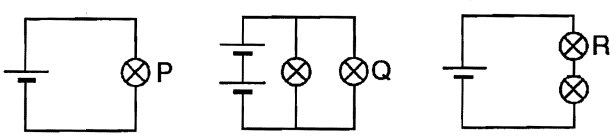
What is the resistance of resistor R?



A 1 Ω
B 1.5 Ω
C 5 Ω
D 6 Ω

N98/I/29

26 Similar cells are used to light similar lamps in the circuits below.

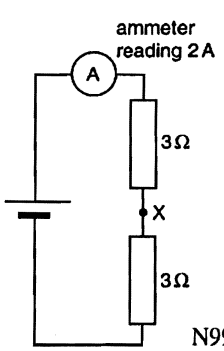


Which lamp is brightest and which is dimmest?

	brightest	dimmest
A	Q	P
B	Q	R
C	R	P
D	R	Q

J99/I/28

27 The diagram shows an electrical circuit.



What is the current at point X?

A 1 A
B 2 A
C 3 A
D 4 A

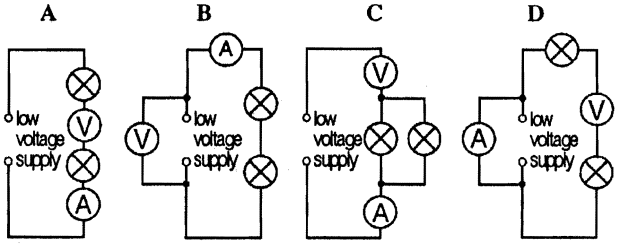
N99/I/27

28 A circuit contains a low voltage supply in series with 2 bulbs.

An ammeter in the circuit measures the current in the bulbs and a voltmeter measures the voltage of the supply.

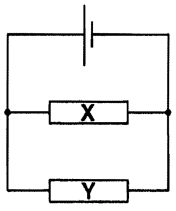
Which diagram shows the correct circuit?

A B C D



N99/I/28

29 The diagram shows two resistors connected in parallel across a voltage source.



Which statement is true for this circuit?

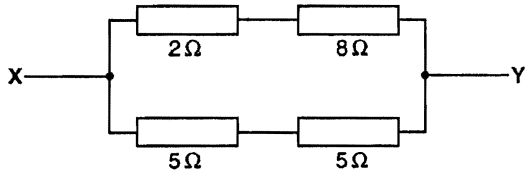
A The combined resistance is equal to the sum of the resistances.

B The current at every point in the circuit is the same.

C The current from the source is equal to the sum of the currents in **X** and in **Y**.

D The sum of the p.d's across **X** and across **Y** is equal to the p.d. across the voltage source. J2000/I/27

30 The diagram shows part of an electric circuit.

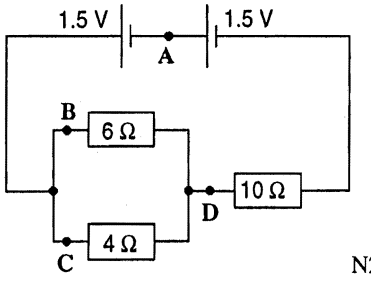


What is the effective resistance between **X** and **Y**?

A $^1/_{20}\ \Omega$ **C** $5\ \Omega$

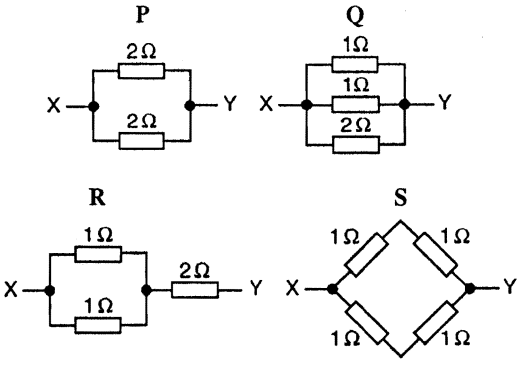
B $^1/_5\ \Omega$ **D** $20\ \Omega$ J2000/I/28

31 In the circuit shown, at which point is the current the smallest?



N2000/I/28

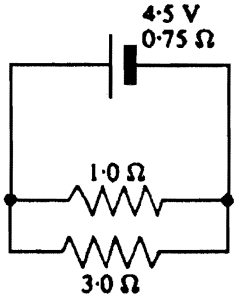
32 Which two resistor combinations have the same effective resistance between X and Y?



A **P** and **Q** **C** **Q** and **R**

B **P** and **S** **D** **R** and **S** N2000/I/29

33 The diagram shows a battery which has e.m.f. 4.5 V and internal resistance 0.75 Ω connected as shown to resistors of resistance 3.0 Ω and 1.0 Ω.



Calculate

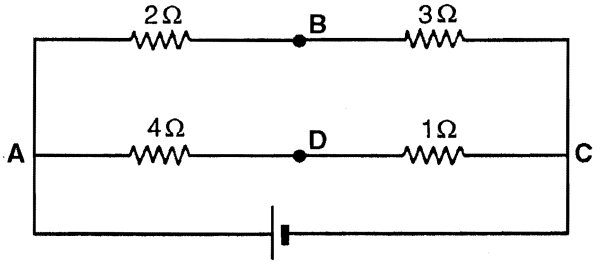
(i) the combined resistance of the 3.0 Ω and 1.0 Ω resistors.

(ii) the current delivered by the battery,

(iii) the current passing through the 1.0 Ω resistor.

J80/I/10

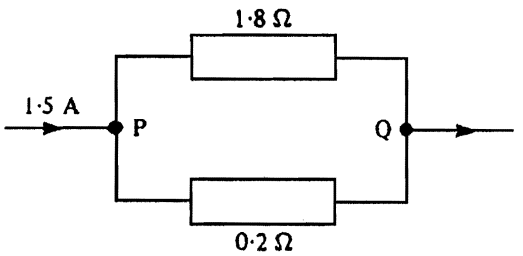
34 The diagram shows four resistors connected to an accumulator of e.m.f. 2.0 V and negligible internal resistance. The resistances of the individual resistors are shown on the diagram.



Calculate the total current flowing from the accumulator.

The points B and D are now joined by a wire. Indicate, with a reason, the direction in which you would expect current to flow in the wire BD. J81/I/19

35 *(a)* The diagram shows two resistors connected into a circuit in which a current of 1.5 A is flowing.



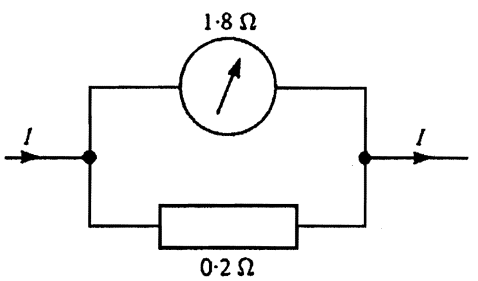
Calculate

(i) the effective resistance of the two resistors connected in parallel,

(ii) the potential difference between P and Q.

(iii) the current in the 1.8 Ω resistor.

(b) A galvanometer, which has resistance 1.8 Ω and which gives a full-scale deflection for a current through it of 0.6 A. is connected as shown below.



(i) What value of current *I* will produce a full-scale deflection in the galvanometer?

(ii) Suggest how, using the same galvanometer, the arrangement might he modified to measure a current *I* larger than that calculated in *(b)* (i).

(iii) What advantage is gained by designing a galvanometer so that it has a very small resistance?

N82/II/3

36 A resistor has a resistance of 5 Ω. What is meant by this statement?

You are given a constant 12 V d.c. source, a variable resistor, a suitable ammeter and a suitable voltmeter. Describe an experiment you would carry out to confirm that the resistance of the resistor is 5 Ω. Draw a diagram of the circuit you would use, state clearly the readings you would take and show how the resistance could be obtained from them.

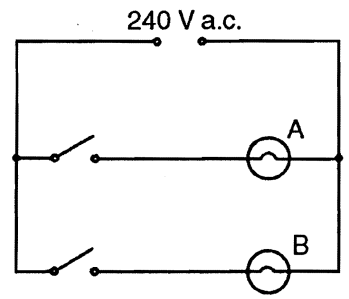
Three resistors of resistance 2 Ω, 4 Ω and 6 Ω are connected in parallel. Calculate

(a) the effective resistance of the combination.

(b) the current drawn from a 12 V battery (of negligible internal resistance) connected across the combination.

J84/II/10

37 In the circuit shown in the diagram the two electric lamps, A and B, connected across a 240 V supply, are each of 60 W and each has its own switch. The internal resistance of the supply is negligible. The switch of lamp A is then closed but the switch of lamp B is left open.



• represents wires connected at a junction

From lamp A, calculate

(a) the current flowing through it.

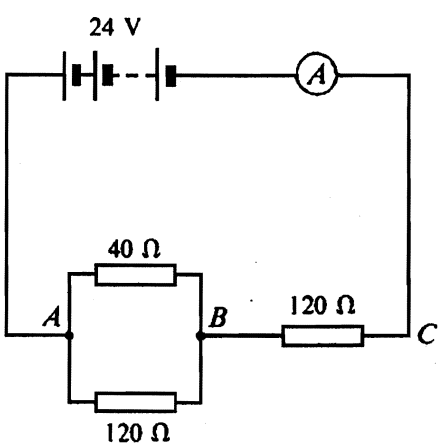
(b) the resistance of its filament.

Does the current through lamp A change when the switch of lamp B is now also closed? Explain your answer.

N84/I/10

38 State Ohm's Law: under what conditions does it apply?

Describe an experiment you could perform to demonstrate Ohm's law, using a given resistor. Make clear how you would use your observations to confirm the law.



In the circuit illustrated, the battery and ammeter have negligible internal resistances.

(i) Calculate the effective resistance of the two resistors connected in parallel.

(ii) Calculate the current flowing in the ammeter.

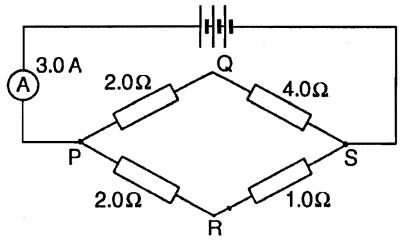
(iii) Find the potential difference between points *A* and *B*.

(iv) Write down the current flowing through the 40 Ω resistor.

Would you expect a voltmeter of resistance 120 Ω to register the value you have calculated in (iii) when connected to points *A* and *B* ? Give a reason for your answer.

J85/II/10

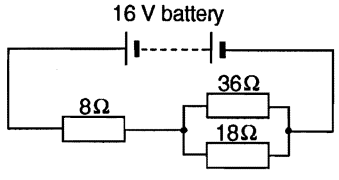
39



In the circuit shown above the ammeter reads 3·0 A Calculate the currents in the pathways PQS and PRS.

Calculate the potential differences between P and Q, P and R, and hence between Q and R. N85/I/10

40 The battery in the circuit illustrated has an e.m.f. of 16 V and negligible internal resistance.

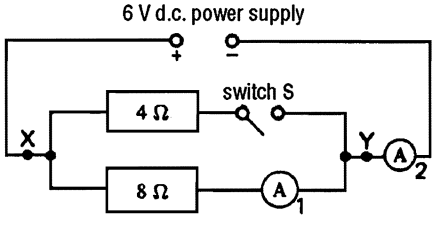


Calculate

(a) the combined resistance of the two resistors connected in parallel,

(b) the current flowing through the 8 Ω resistor. J87/I/10

41 *(b)* In the circuit shown below, the resistances of the ammeters may be ignored.



Explain each of the following observations.

(i) When the switch S is closed, the current through ammeter 1 is less than that through ammeter 2.

(ii) When switch S is opened, the current through ammeter 2 falls.

(iii) When S is open, the current through each ammeter is the same.

Calculate the effective resistance between points X and Y when S is closed. [8]
J88/II/10*(b)*

42 A number of 8 Ω resistors are available. Draw diagrams to show how you could connect a suitable number of these resistors to give an effective resistance of

(a) 24 Ω, [1]

(b) 4 Ω, [1]

(c) 18 Ω. [2]
N88/I/13

43 *(b)* The coil of an ammeter has a resistance of 0.5 Ω. A resistor of resistance 0.25 Ω is connected between the terminals of the ammeter, and a current of 2 A passes as shown in Fig. 1.

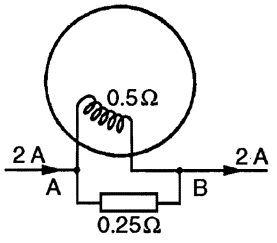


Fig. 1

(i) Calculate the effective resistance of the coil and the resistor when connected as shown in Fig. 1.

(ii) Calculate the potential difference between the points A and B.

(iii) Calculate the current in the coil of the ammeter. [4]
J89/II/6*(b)*

44 The battery in the circuit shown in Fig. 2 has an e.m.f. of 6.0 V and negligible resistance.

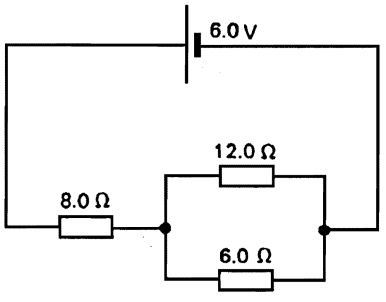
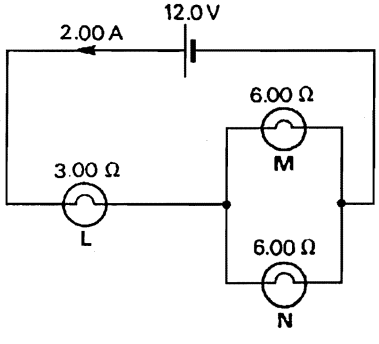


Fig. 2

(a) Calculate the combined resistance of the 12.0 Ω and the 6.0 Ω resistors connected in parallel. [2]

(b) Calculate the current in the 8.0 Ω resistor. [2]
N89/I/13

45 The diagram shows three 6-V filament lamps connected to a 12-V supply of negligible internal resistance. The resistance of each lamp is shown on the diagram. The current through the battery is 2.00 A.



(a) Determine the current through each lamp.

(b) Calculate the voltage across each lamp.

(c) Lamp **L** is taken from its socket. State and explain what happens to the brightness of lamp **M** and what happens to the brightness of lamp **N**.

(d) Lamp **L** is now replaced in its socket and lamp **M** is taken from its socket. State and explain what happens to the brightness of lamp **L** and what happens to the brightness of lamp **N**. [8] J91/II/7

46 **Figure 3** shows a battery of e.m.f. 6.0 V connected to a switch S and to two resistors in parallel, each of resistance 3.0 Ω.

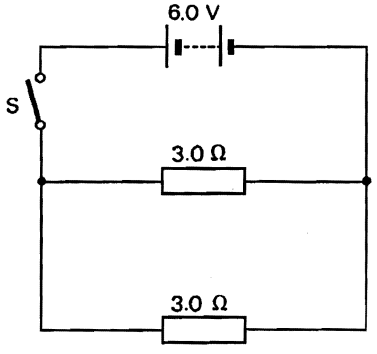


Fig. 3

The switch S is closed for a period of 5.0 minutes. Calculate

(a) the current through each resistor,

Current through each resistor = ...

(b) the current through the battery,

Current through the battery = ...

(c) the total charge which passes through the battery,

Total charge through the battery = ...

(d) the energy supplied by the battery.

Energy supplied by the battery = ... [7]
J93/II/5

47 (a) **Figure 4.1** shows a d.c. series circuit. The e.m.f. of the battery is 12V and the maximum resistance of the variable resistor is 75 W.

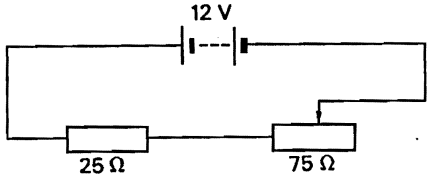


Fig. 4.1

Determine

(i) the minimum possible current through the circuit,

(ii) the maximum possible current through the circuit,

(iii) the minimum possible voltage across the 25 Ω fixed resistor,

(iv) the maximum possible voltage across the 25 Ω fixed resistor,

(v) the maximum power which can be dissipated in the 25 Ω fixed resistor. [8]

(b) The variable resistor of **Fig. 4.1** is replaced by a thermistor. The variation of resistance with temperature of the thermistor is given in **Fig. 4.2.**

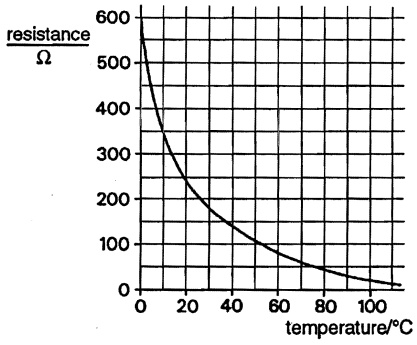


Fig. 4.2

The thermistor is placed first in melting pure ice and then in steam at standard atmospheric pressure. In each case the temperature of the thermistor is allowed to become constant.

(i) What is the resistance of the thermistor at the temperature of melting pure ice?

(ii) What is the resistance of the thermistor at the temperature of the steam?

(iii) At which of these temperatures does the resistance of the thermistor change more rapidly with temperature? Give your reasons for your answer.

(iv) What is the change in voltage across the thermistor as its temperature increases from the ice temperature to the steam temperature? Show your working clearly. [7]
J93/II/10

48 Figure 5 shows a circuit consisting of a battery of e.m.f. 6.0 V and two pairs of 3.0 W resistors in series, these pairs of resistors being connected in parallel.

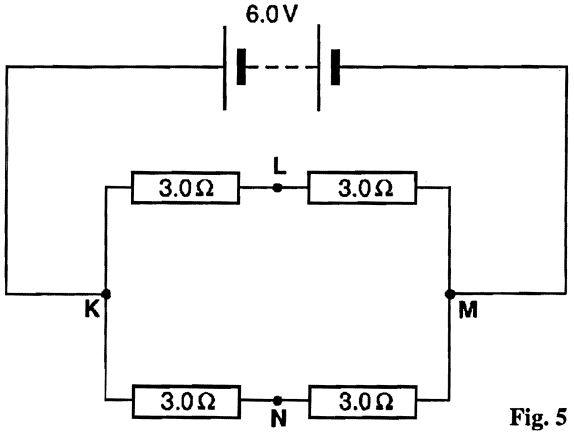


Fig. 5

(a) (i) What is the total resistance of the path **KLM**?

(ii) What is the total resistance of the path **KNM**?

(iii) What is the resistance of the circuit between **K** and **M**? [3]

(b) Calculate

(i) the current through the battery,

(ii) the power developed in the battery. [4]

N94/II/5

49 Fig. 6 shows a battery of e.m.f. 6.0 V in series with resistors of resistance 4.0 Ω and 8.0 Ω.

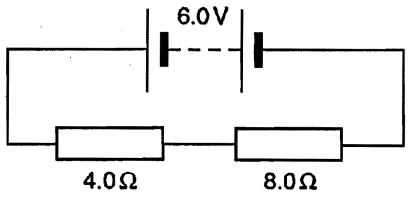


Fig. 6

(a) For the circuit shown in Fig. 6,

(i) explain what is meant by an 'e.m.f. of 6.0 V',

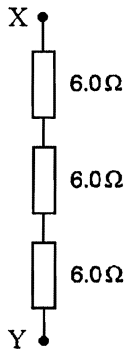
(ii) calculate the current through the battery,

(iii) calculate the power developed in the battery,

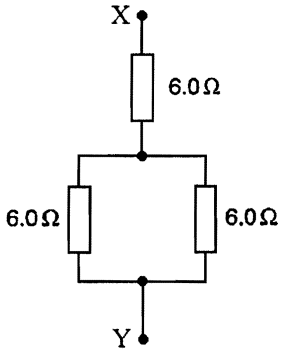
(iv) calculate the voltage across the 4.0 Ω resistor and that across the 8.0 Ω resistor. [8]

J96/II/10*(a)*

50 Fig. 7.1 shows three combinations of resistors, connected between points X and Y. All the resistors have resistance 6.0 Ω.



combination A



combination B

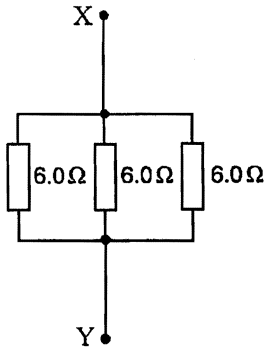


Fig. 7.1 Combination C

(a) Calculate the total resistance between the points X and Y of each combination.

(i) total resistance of combination A = ...

(ii) total resistance of combination B = ...

(iii) total resistance of combination C = ... [4]

(b) Points X and Y in combination B are connected to a battery that provides a potential difference of 1.35 V across XY, as shown in Fig. 7.2. Calculate the currents I_1, I_2 and I_3 in each resistor of the combination.

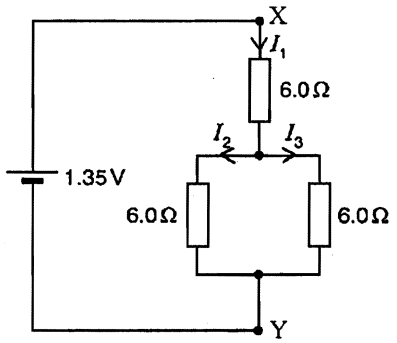


Fig. 7.2

[3]

J99/II/4

ANSWERS

1. **B**	2. **A**	3. **C**	4. **A**	5. **D**
6. **B**	7. **D**	8. **B**	9. **D**	10. **E**
11. **B**	12. **D**	13. **B**	14. **A**	15. **B**
16. **D**	17. **B**	18. **B**	19. **C**	20. **B**
21. **A**	22. **C**	23. **A**	24. **A**	25. **C**
26. **B**	27. **B**	28. **B**	29. **C**	30. **C**

31. **B** 32. **B**

33. (i) 0.75 Ω (ii) 3.0 A
(iii) 2.25 A

34. 0.8 A

35. *(a)* (i) 0.18 Ω (ii) 0.27 V
(iii) 0.15 A
(b) (i) 6 A

36. *(a)* 1.09 Ω *(b)* 11 A

37. *(a)* 0.25 A *(b)* 960 Ω

38. (i) 30 Ω (ii) 0.16 A
(iii) 4.8 V (iv) 0.12 A

39. 1.0 A ; 2.0 A ; 2.0 V ; 4.0 V ; 2.0 V

40. *(a)* 12 Ω *(b)* 0.8 A

41. *(b)* 2.67 Ω

43. *(b)* (i) 0.17 Ω (ii) 0.33 V
(iii) 0.67 A

44. *(a)* 4 Ω *(b)* 0.5 A

45. *(a)* 1 A *(b)* 6 V

46. *(a)* 2 A *(b)* 4 A
(c) 1 200 C; *(d)* 7 200 J

47. *(a)* (i) 0.12 A (ii) 0.48 A
(iii) 3 V (iv) 12 V
(v) 5.76 W
(b) (i) 600 Ω (ii) 25 Ω
(iii) 0 °C (iv) 5.52 V

48. *(a)* (i) 6 Ω (ii) 6 Ω
(iii) 3 Ω
(b) (i) 2 A (ii) 12 W

49. *(a)* (i) 0.5 A (iii) 3 W

50. *(a)* (i) 18.0 Ω (ii) 9.0 Ω
(iii) 2.0 Ω
(b) $I_1 = 0.15$ A, $I_2 = 0.075$ A, $I_3 = 0.075$ A