4. Electricity and magnetism

4.3 Electric circuits

Paper 3 and 4

Question Paper

Paper 3

Questions are applicable for both core and extended candidates

1 A student investigates an electric circuit. Fig. 9.1 shows the student's circuit.

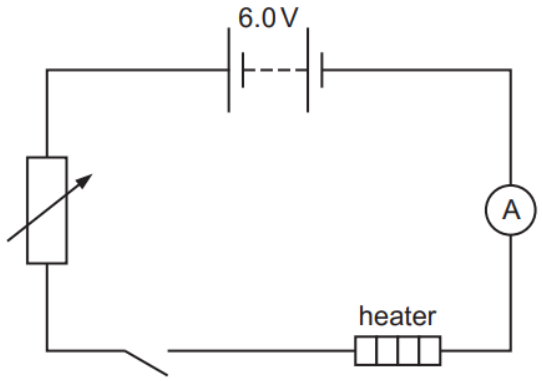


Fig. 9.1

(a) (i) Describe the purpose of the variable resistor in Fig. 9.1.

.....

..... [1]

(ii) The student uses cells with an electromotive force (e.m.f.) of 1.5 V.

Determine the number of cells needed for the 6.0 V battery in Fig. 9.1.

number of cells needed = ... [1]

(iii) The student connects another component to measure the potential difference (p.d.) across the heater.

On Fig. 9.1, draw the electrical symbol and connections for this component. [2]

(b) The p.d. across the heater is 4.0 V. The current in the heater is 1.6 A.

Calculate the energy transferred electrically by the heater in 40 s.

energy transferred = ... J [3]

[Total: 7]

2 Fig. 9.1 shows a series circuit. Two of the components in the circuit are labelled.

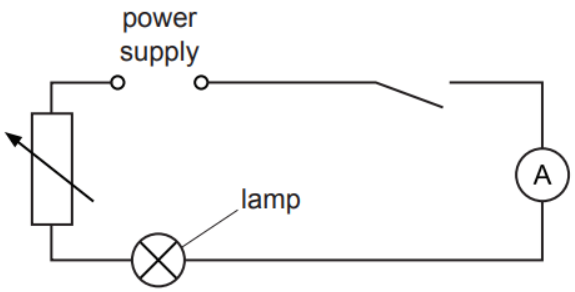


Fig. 9.1

(a) State the name of **two** other components in the circuit.

1 .....

2 .....

[2]

(b) The current in the lamp is 0.40 A. The potential difference (p.d.) across the lamp is 6.0 V.

Calculate the power dissipated in the lamp.

power = ... W [3]

(c) Draw on Fig. 9.1 to show a lamp connected in parallel with the lamp in the circuit. Use the correct symbol. [1]

[Total: 6]

3 A student uses the circuit in Fig. 8.1 to measure the resistance of the heater in the circuit.

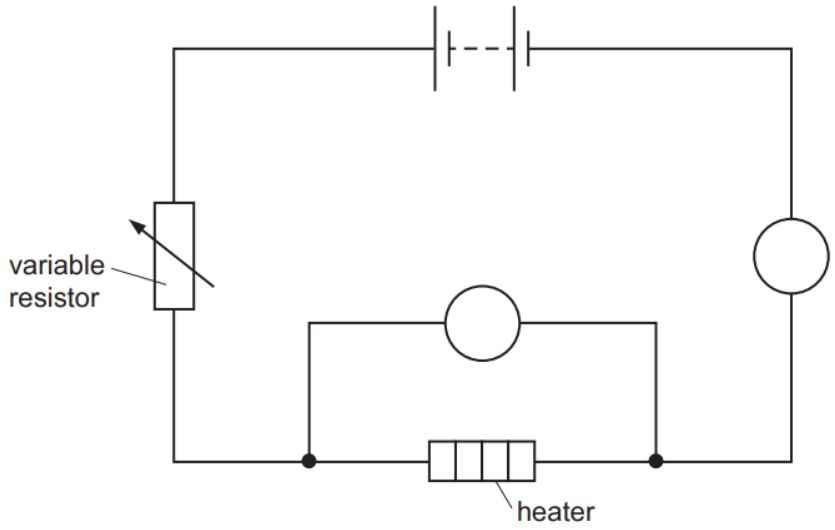


Fig. 8.1

(a) The symbols for the meters in Fig. 8.1 are incomplete.

Complete the symbols for the two meters by writing in the circles in Fig. 8.1. [2]

(b) The current in the heater is 1.4A and the potential difference (p.d.) across the heater is 8.0V.

Calculate the resistance of the heater.

resistance = ... Ω [3]

(c) The heater is switched on for 30s. The current in the heater is 1.4A and the p.d. across it is 8.0V.

Calculate the electrical energy transferred by the heater during the 30s.

energy transferred = ... J [3]

[Total: 8]

4 Fig. 8.1 shows an electric circuit set up by a student.

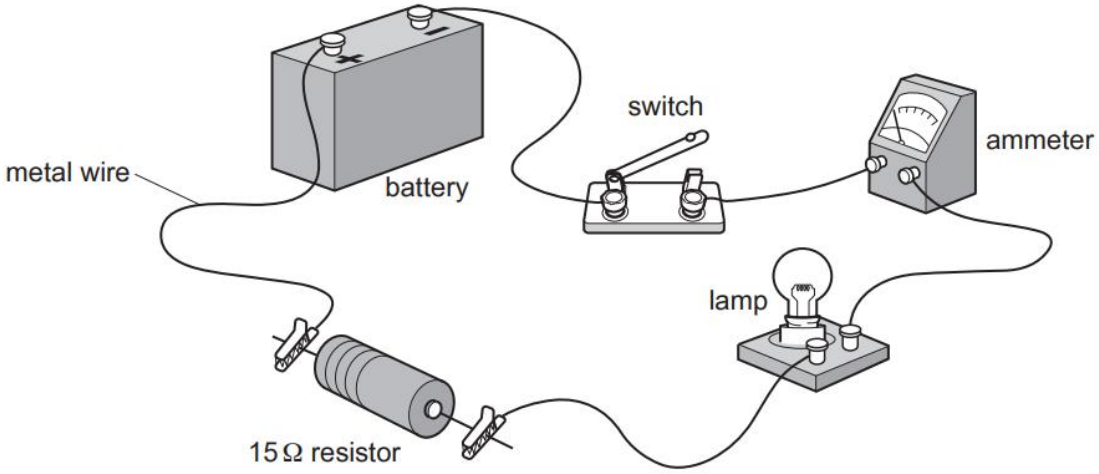


Fig. 8.1

(a) Using standard symbols, draw a circuit diagram for the student's circuit.

[4]

(b) When the switch is closed there is a current in the circuit.

State the name of the particles flowing in the metal wire.

..... [1]

(c) The current in the 15 Ω resistor in Fig. 8.1 is 0.40 A when the switch is closed.

p.d. across resistor = ... V [3]

[Total: 8]

5 A student uses the circuit in Fig. 8.1 to find the resistance of a piece of iron wire.

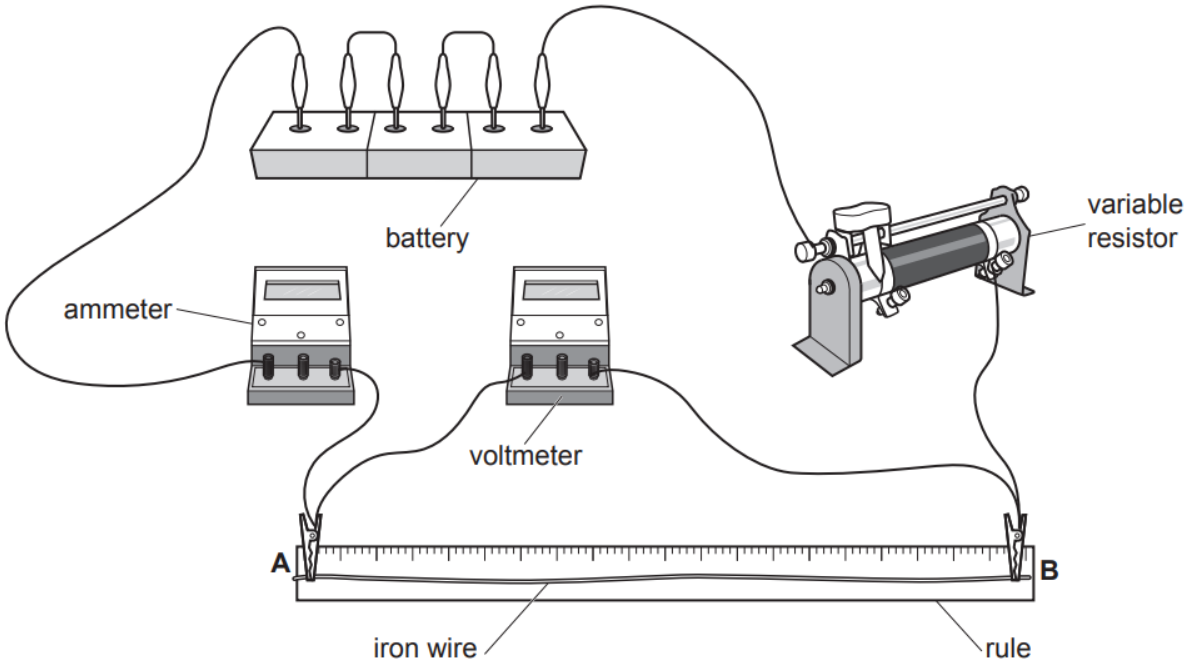
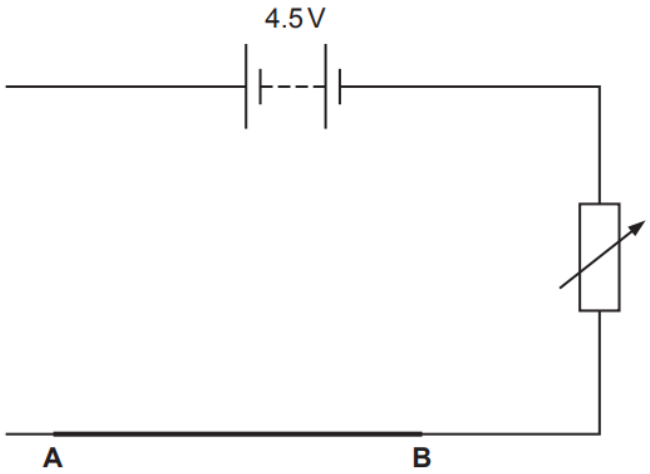


Fig. 8.1

(a) Complete Fig. 8.2 to show the circuit diagram for the arrangement shown in Fig. 8.1.

The piece of iron wire is shown as the thicker line between the points A and B.



[3]

Fig. 8.2

(b) The reading on the voltmeter is 1.56 V.

The reading on the ammeter is 0.112 A.

Calculate the resistance of the iron wire. Include the unit in your answer.

resistance = ... unit ..... [4]

[Total: 7]

6 A student has a battery-operated torch. Fig. 9.1 shows the electrical components in the torch circuit.

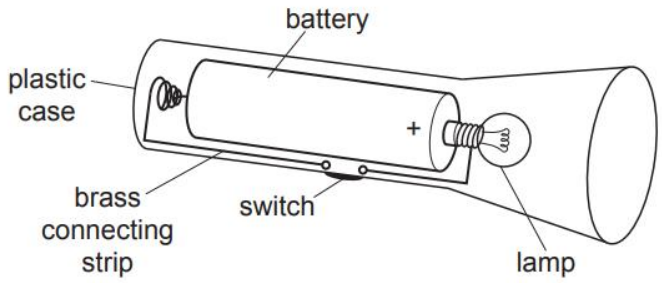


Fig. 9.1

(a) Using standard symbols, draw a circuit diagram for the circuit in the torch.

[4]

(b) When the torch is switched on, the potential difference (p.d.) across the lamp is 1.4 V and the current in the lamp is 0.26 A.

(i) State the current in the brass connecting strip.

current = ...A [1]

(ii) Calculate the resistance of the lamp.

resistance = ... Ω [3]

[Total: 8]

7 **(a)** Fig. 10.1 shows two resistors connected in series with a cell and three ammeters.

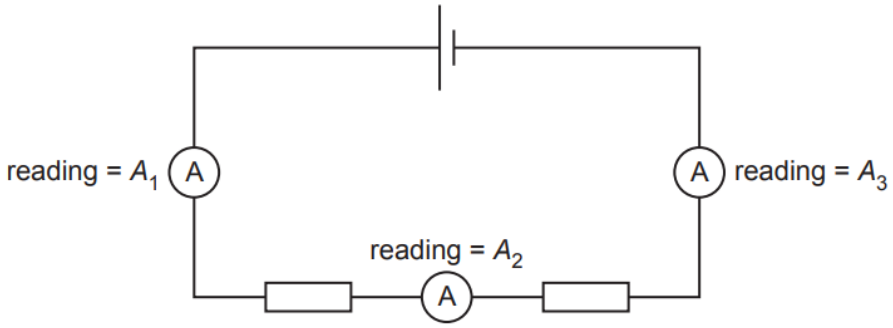


Fig. 10.1

(i) State the physical quantity that an ammeter measures.

..... [1]

(ii) Indicate the correct statement about the readings A_1, A_2 and A_3 on the ammeters in Fig. 10.1.

Tick **one** box.

A_2 is greater than A_1	
A_2 is less than A_3	
A_1 is equal to A_3	
A_1 is equal to $(A_2 + A_3)$	

[1]

(b) **(i)** Draw a circuit diagram for a battery connected to two resistors in parallel.

[2]

(ii) State **one** advantage of connecting lamps in parallel.

..... [1]

(c) Fig. 10.2 shows another circuit.

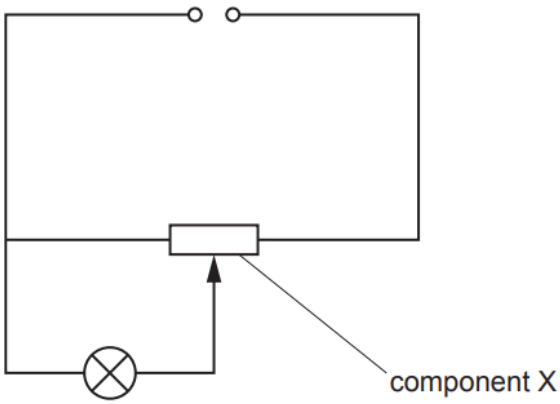


Fig. 10.2

The circuit consists of a power supply, a lamp and component X.

(i) Name component X in Fig. 10.2.

..... [1]

(ii) Suggest **one** use of the circuit.

..... [1]

(iii) Describe how to use component X and explain its effect on the circuit.

.....

.....

..... [2]

[Total: 9]

8 **(a)** Fig. 10.1 shows a lamp and a resistor connected in a circuit.

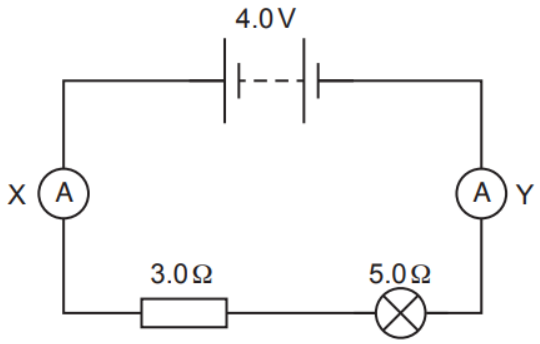


Fig. 10.1

(i) Determine the combined resistance of the 3.0 Ω resistor and the 5.0 Ω lamp.

combined resistance = ... Ω [1]

(ii) The reading on ammeter X is 0.50 A.

State the reading on ammeter Y.

reading on ammeter Y = ... A [1]

(b) In another circuit, the 3.0 Ω resistor and the 5.0 Ω lamp are connected in parallel, as shown in Fig. 10.2.

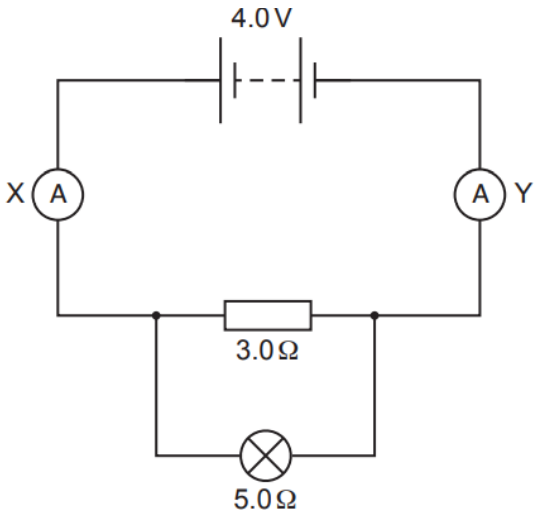


Fig. 10.2

The lamp and resistor have changed from a series to a parallel combination.

State and explain the effect of this change on the current in ammeter X.

.....

.....

.....

..... [3]

(c) The current in a different lamp is 0.40A when the potential difference (p.d.) across the lamp is 6.0V.

Calculate the resistance of the lamp.

resistance of lamp = ... Ω [3]

[Total: 8]

9 **(a)** Fig. 9.1 shows an electric circuit.

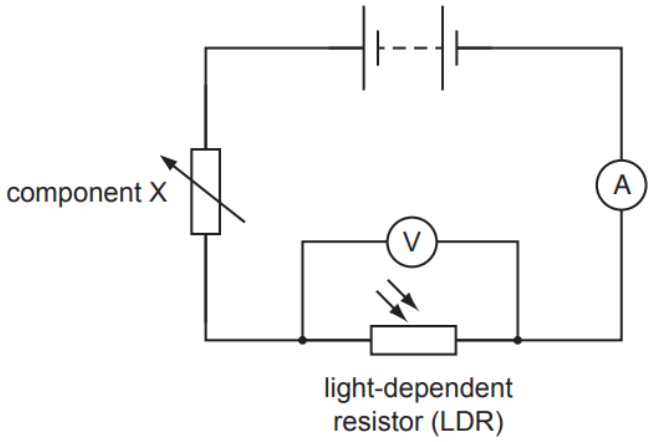


Fig. 9.1

(i) The current in the metal wires of the circuit is a flow of particles.
State the name of these particles.

..... [1]

(ii) State the name of component X.

..... [1]

(iii) The circuit is in a darkened room. The voltmeter reading is 5.5V and the ammeter reading is 0.050A.

Calculate the resistance of the light-dependent resistor (LDR).

resistance = ... Ω [3]

(b) The light in the room is switched on. The room becomes bright.

State and explain how increasing the brightness of the light that falls on the LDR changes the current in the circuit.

.....

..... [2]

[Total: 7]

10 **(a)** Fig. 12.1 shows two circuits, A and B, linked by a relay.

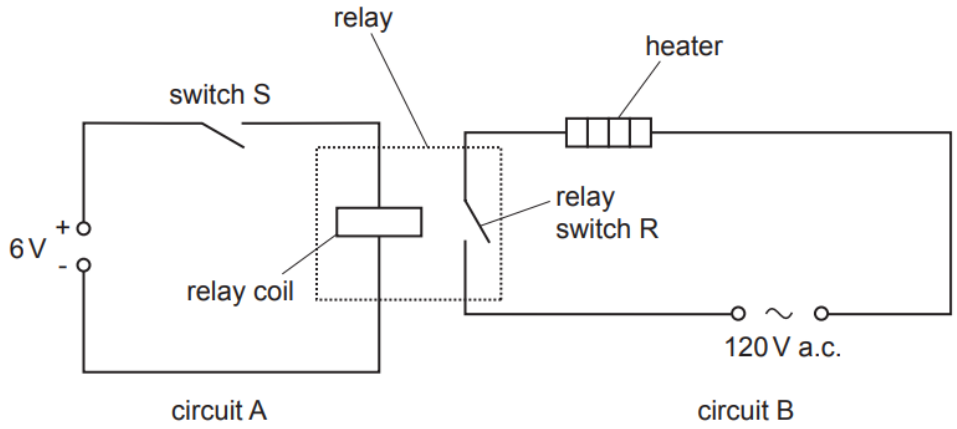


Fig. 12.1

Describe what happens in the two circuits when switch S is closed.

.....

.....

.....

.....

..... [3]

11 **(a)** A student investigates the electrical resistance of some components.

Fig. 10.1 shows an incomplete diagram of the circuit used by the student.

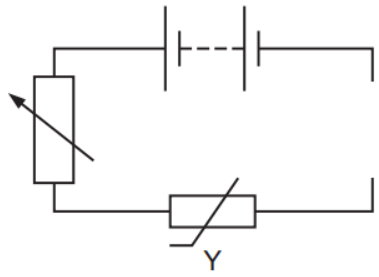


Fig. 10.1

(i) State the term used for component Y. ..... [1]

(ii) The student uses the circuit to measure the resistance of component Y.

Complete the diagram in Fig. 10.1 by adding electrical symbols to show an ammeter and a voltmeter correctly connected to determine the resistance of component Y. [3]

(b) Fig. 10.2 shows two resistors A and B.

Fig. 10.2

(i) Resistor A and resistor B are connected in series.
State the value of their combined resistance.

..... Ω [1]

(ii) Resistor A and resistor B are connected in parallel.

Compare the combined resistance when in parallel with the resistance of resistor A alone.

..... [1]

[Total: 6]

12 A teacher is investigating the resistance of a lamp.

Fig. 10.1 shows part of the circuit she uses. The circuit is incomplete.

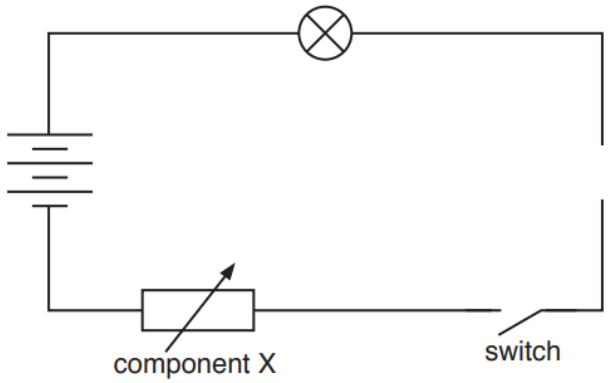


Fig. 10.1

(a) (i) To determine the resistance of the lamp, the teacher adds two meters to her circuit.

On Fig. 10.1, draw circuit symbols to show each meter correctly connected in the circuit. [3]

(ii) When the current in the lamp is 0.25 A, the potential difference (p.d.) across the lamp is 4.5 V. Calculate the resistance of the lamp.

resistance = ... Ω [3]

(b) (i) State the name of component X.

..... [1]

(ii) Describe and explain how the teacher uses component X to investigate the resistance of the lamp.

.....

.....

.....

..... [2]

[Total: 9]

13 A circuit is made from two lamps, a cell and a switch, as shown in Fig. 10.1.

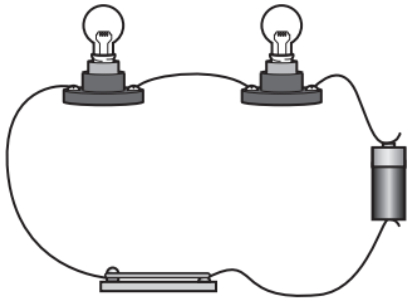


Fig. 10.1

(a) (i) Draw the circuit symbol for a cell.

[1]

(ii) State the term used for the arrangement of lamps in the circuit in Fig. 10.1.

..... [1]

(iii) The switch is closed and the lamps light.

State the name of the charged particles that are flowing through the wires

..... [1]

(b) Fig. 10.2 represents a different type of circuit.

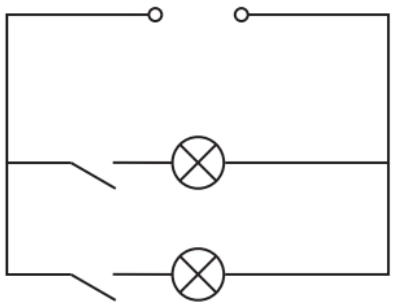


Fig. 10.2

(i) Compare Fig. 10.1 and Fig. 10.2. State **two** advantages of the type of circuit shown in Fig. 10.2 with the type of circuit shown in Fig. 10.1.

1. .....

2. .....

[2]

(ii) The potential difference across the power source in Fig. 10.2 is 3.0 V. The combined resistance of the two lamps is 12 Ω. Calculate the size of the current in the circuit.

current = ... A [3]

[Total: 8]

14 A student makes a circuit to switch on a 6.0 V lamp from two different switches X and Y.

Fig. 9.1 shows the circuit.

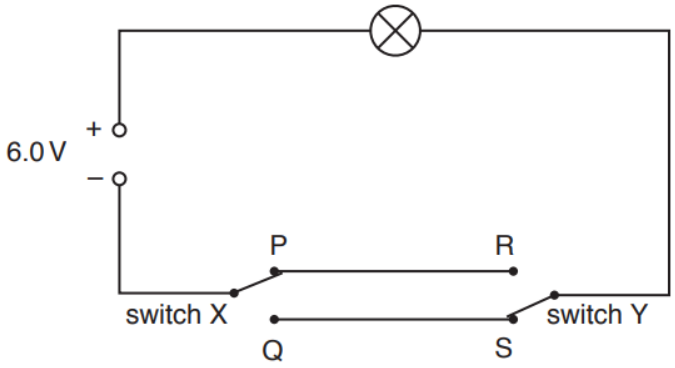


Fig. 9.1

(a) Switch X is in position P. State the position of switch Y for the lamp to be lit.

..... [1]

(b) The current in the lamp is 0.50 A when the potential difference (p.d.) across the lamp is 6.0 V. Calculate the resistance of the lamp. Include the unit.

resistance = ... [4]

(c) The student connects another 6.0 V lamp in parallel with the first lamp, as shown in Fig. 9.2.

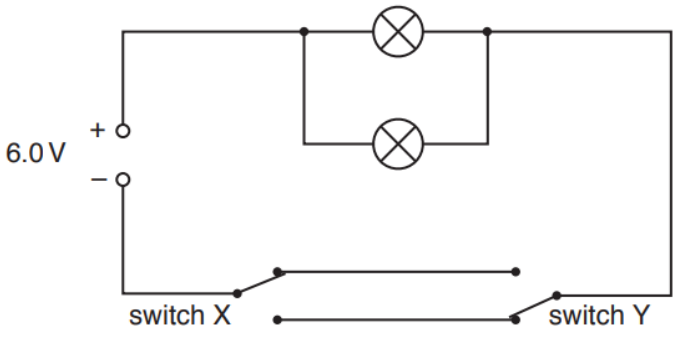


Fig. 9.2

Give **two** advantages of connecting the lamps in parallel.

.....

.....

..... [2]

[Total: 7]

15 **(a)** A teacher demonstrates the action of a device. Fig. 10.1 shows the symbol for the device.

Fig. 10.1

State the name of this device.

..... [1]

(b) Fig. 10.2 shows another device being used in a circuit. The circuit contains a 6.0 V lamp.

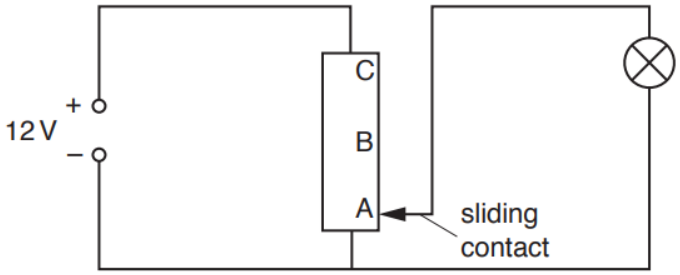


Fig. 10.2

(i) The sliding contact of this device is at position A, as shown in Fig. 10.2.

Describe and explain the brightness of the lamp when the sliding contact is in this position.

brightness of lamp .....

explanation .....

[2]

(ii) The teacher moves the sliding contact from position A to position B. Describe and explain what happens to the brightness of the lamp.

.....

..... [2]

(iii) The teacher moves the sliding contact from position B to position C. Suggest what happens to the lamp.

..... [1]

[Total: 6]

16 Fig. 10.1 shows an incomplete circuit diagram for two identical lamps arranged in parallel. The circuit contains an ammeter and a voltmeter.

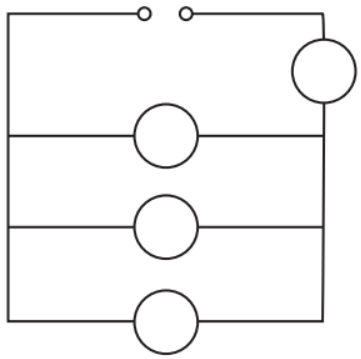


Fig. 10.1

(a) On Fig. 10.1, complete the symbols for two lamps, an ammeter and a voltmeter positioned correctly. [5]

(b) One of the lamps breaks.

State the effect, if any, this has on the brightness of the other lamp. Explain your answer.

effect .....

explanation .....

.....

[2]

[Total: 7]

17 **(a)** A student does an experiment to determine the resistance of a fixed resistor, R.

The student draws an incomplete diagram of the circuit, as shown in Fig. 10.1.

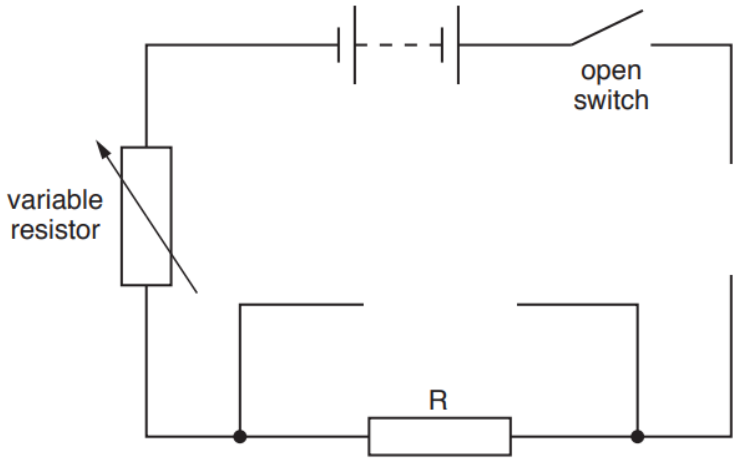


Fig. 10.1

(i) On Fig. 10.1, draw the missing circuit symbols. [3]

(ii) Describe how the student could use the circuit to determine a reliable value for the resistance of R.

.....

.....

.....

.....

.....

.....

.....

.....[4]

(b) Fig. 10.2 shows a 20 Ω resistor connected to a power supply.

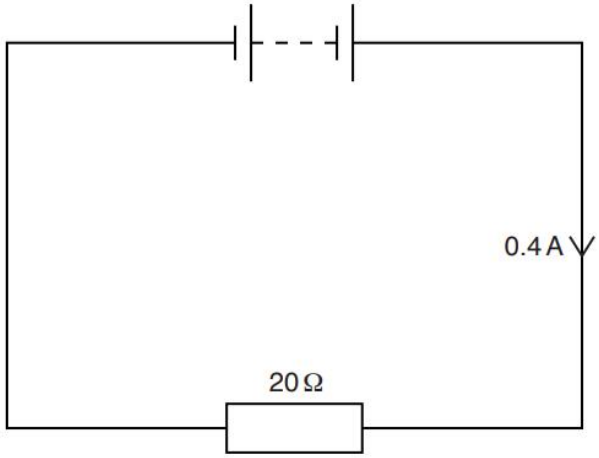


Fig. 10.2

A second 20 Ω resistor is connected in series with the first. State and explain how this affects the current in the circuit.

.....

.....

.....

.....[4]

[Total: 11]

18 **(a)** Fig. 9.1 shows a simple circuit.

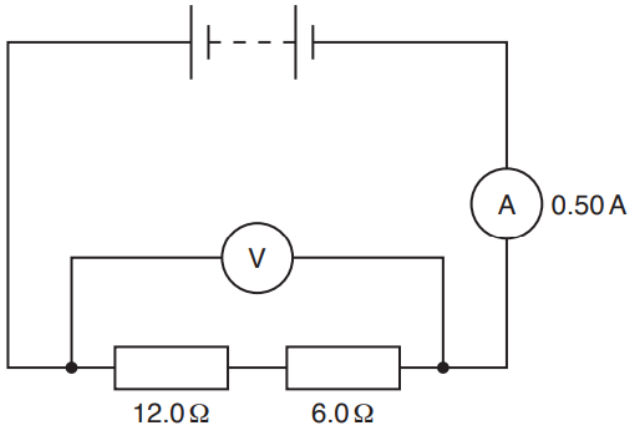


Fig. 9.1

(i) The current in the wires of the circuit is a flow of particles.
Indicate the name of these particles. Tick **one** box.

☐ electrons

☐ atoms

☐ protons [1]

(ii) Calculate the combined resistance of the two resistors.

resistance = ... Ω [1]

(iii) Calculate the potential difference (p.d.) reading that would be shown on the voltmeter.

potential difference (p.d.) = ... V [3]

(b) The circuit is changed.
The two resistors are connected in parallel.

Explain what happens, if anything, to the current reading on the ammeter.

.....

.....

.....[2]

[Total: 7]

19 A battery, a lamp L, a fixed resistor R and a switch S are connected as shown in Fig. 7.1.

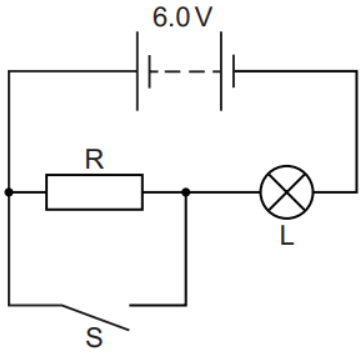


Fig. 7.1

(a) The potential difference (p.d.) across lamp L is 4.8 V and the current in lamp L is 0.40 A.

Calculate the resistance of lamp L.

resistance = ... Ω [3]

(b) State and explain how closing switch S affects the brightness of lamp L.

.....

.....

.....

..... [3]

20 A student connects three identical lamps J, K and L in a circuit, as shown in Fig. 10.1.

Switch S_1 is open and the current in ammeter A_1 = 0.2 A.

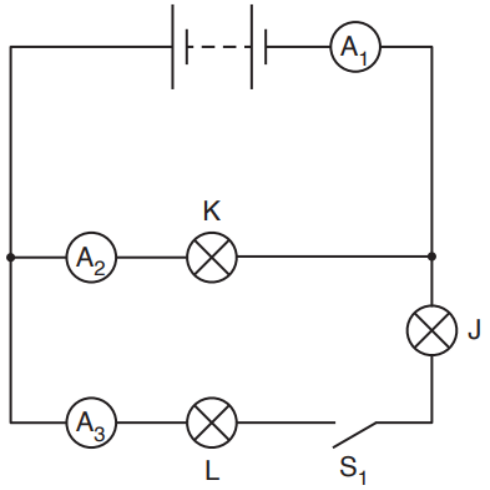


Fig. 10.1

Use words from the box to complete the sentences.

Each word may be used once, more than once, or not at all.

the same	increased	decreased

(a) The switch S_1 in Fig. 10.1 is closed. State and explain the effect on the circuit.

(i) The current in ammeter A_1 is ..... because the resistance of the whole circuit is ..... . [2]

(ii) The current in ammeter A_2 is ..... . [1]

(b) A student measures the potential difference (p.d.) across lamp J by using a voltmeter.

On Fig. 10.1, draw the correct electrical symbol for the voltmeter with the correct connections. [2]

(c) The p.d. across lamp J is 3.0 V and the current shown by ammeter A_3 is 0.15 A.

Calculate the resistance of lamp J. Include the unit in your answer.

resistance of lamp J = ... unit..... [4]

[Total: 9]

Paper 4

Questions are applicable for both core and extended candidates unless indicated in the question

21 A potential divider is made by connecting a light-dependent resistor (LDR) and a thermistor in series. Fig. 6.1 shows the potential divider, a voltmeter and a direct current (d.c.) power supply connected into a circuit.

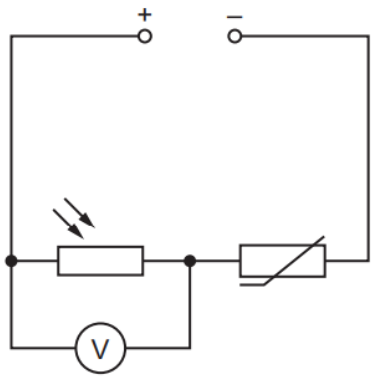


Fig. 6.1

The voltmeter measures the potential difference (p.d.) across the LDR.

(a) Define potential difference (p.d.).

.....

.....

..... [2]

(b) The electromotive force (e.m.f.) of the supply is *E*. **(extended only)**

Describe how the p.d. across the thermistor can be determined using the reading on the voltmeter.

.....

..... [1]

(c) The resistance of the LDR decreases and the resistance of the thermistor increases.

(i) State what has happened to the light intensity incident on the LDR and the temperature of the thermistor.

intensity of incident light on LDR: .....

temperature of thermistor: .....

[1]

(ii) Explain what happens to the reading on the voltmeter. **(extended only)**

.....

.....

.....

..... [3]

[Total: 7]

22 The electromotive force (e.m.f.) of a battery is 7.5 V.

(a) Define the term electromotive force.

.....

.....

..... [2]

(b) The battery is connected in series with a variable resistor and a 30 Ω resistor. The battery is made using 1.5 V cells.

(i) Draw a circuit diagram that shows all the 1.5 V cells connected to produce an e.m.f. of 7.5 V, the variable resistor and the 30 Ω resistor.

[3]

(ii) The resistance of the variable resistor can be varied from 0 Ω to a maximum resistance of 150 Ω.

Using the axes in Fig. 7.1, draw a graph to show how the current in the circuit varies with the resistance of the variable resistor as it increases from 0 Ω to 150 Ω.

Determine and label the value of the maximum current on the *y*-axis.

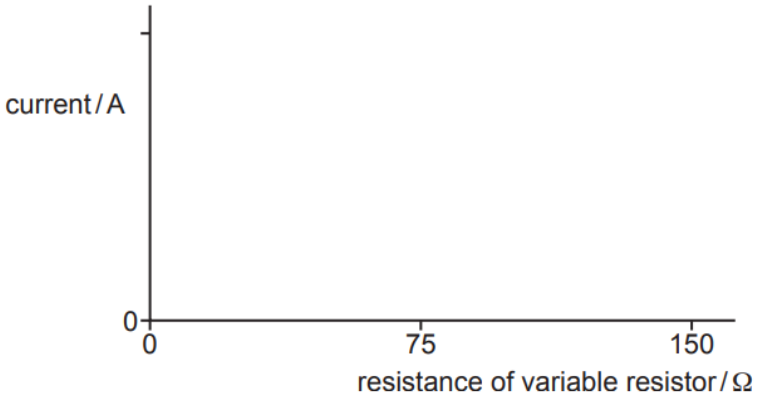


Fig. 7.1

[4]

[Total: 9]

23 **(a)** Fig. 8.1 shows a circuit. The circuit is designed to switch on a night light when the surroundings are dark.

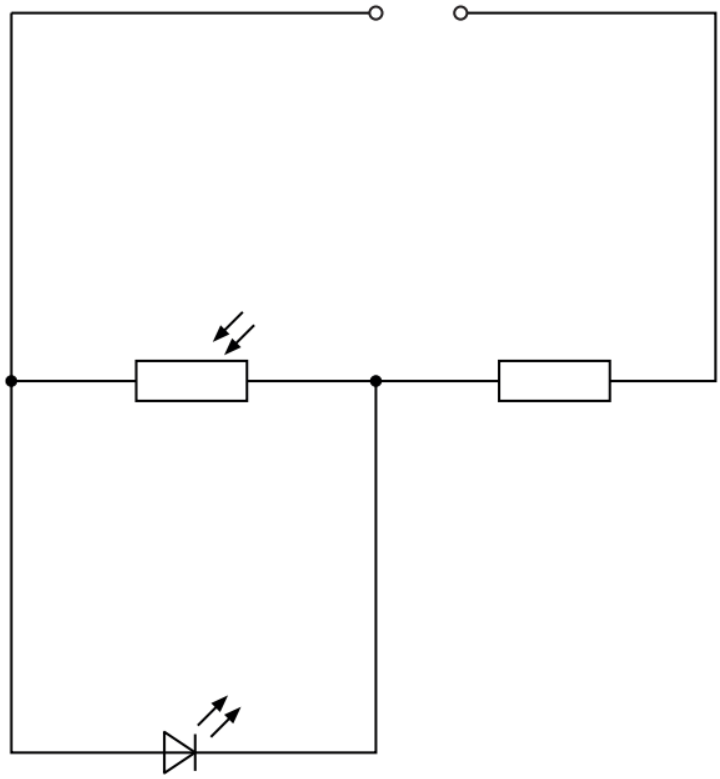


Fig. 8.1

(i) On Fig. 8.1, draw the circuit symbol for a voltmeter used to measure the potential difference (p.d.) across the light-dependent resistor (LDR). [1]

(ii) The surroundings change from light to dark.

1. State the effect of this change on the resistance of the LDR.

..... [1]

2. State and explain the effect of this change on the p.d. across the light-emitting diode (LED). **(extended only)**

.....

.....

..... [2]

(b) Fig. 8.2 shows another circuit. Lamps A and B are identical filament lamps. **(extended only)**

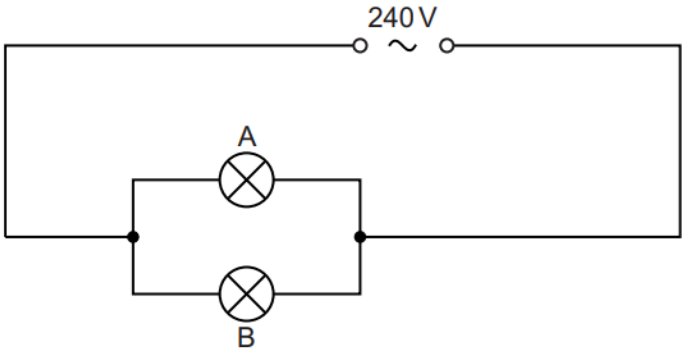


Fig. 8.2

The current supplied by the power supply is 0.50 A.

Calculate the resistance of lamp A.

resistance = ... [3]

[Total: 7]

24 Fig. 9.1 shows a circuit with a 3-position switch.

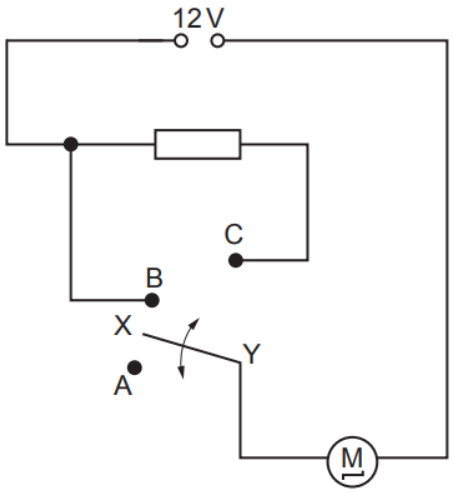


Fig. 9.1

The moving part of the switch is always connected to point Y around which it pivots. The other end of the moving part, labelled X, can be connected to one of the points A, B or C.

(a) The resistance of the motor is 2.0 Ω and the resistance of the resistor is 3.0 Ω.

Determine the current in the motor when the switch is connected to:

(i) point A

current = ... [1]

(ii) point B

current = ... [2]

(iii) point C.

current = ... [2]

(b) Two resistors of resistance 2.0 Ω and 3.0 Ω are connected in parallel. **(extended only)**

Calculate the combined resistance of the resistors in this arrangement.

resistance = ... [3]

[Total: 8]

25 **(a)** Fig. 9.1 shows a cell of electromotive force (e.m.f.) 1.5 V and a battery of e.m.f. 6.0 V connected in series.

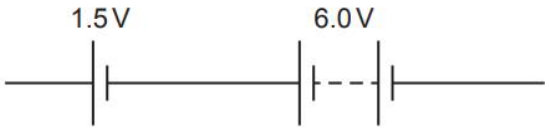


Fig. 9.1

Calculate the combined e.m.f. of the cell and the battery.

e.m.f. = ... [1]

(b) The combined resistance of the three resistors shown in Fig. 9.2 is 4.4 Ω.

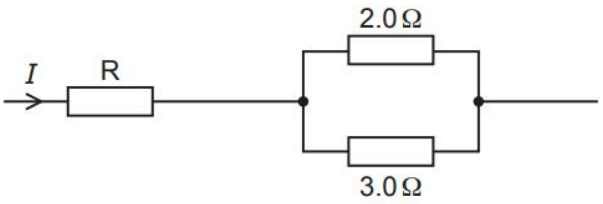


Fig. 9.2

(i) Calculate the resistance of resistor R. **(extended only)**

resistance = ... [3]

(ii) The current I in Fig. 9.2 is 0.94 A. **(extended only)**

Calculate the potential difference (p.d.) across the combination of resistors.

p.d. = ... [2]

[Total: 6]

26 A student sets up a circuit that includes a 12V battery, an 800Ω resistor, a voltmeter and a thermistor. Fig. 8.1 is an incomplete circuit diagram because the symbol for the thermistor is missing.

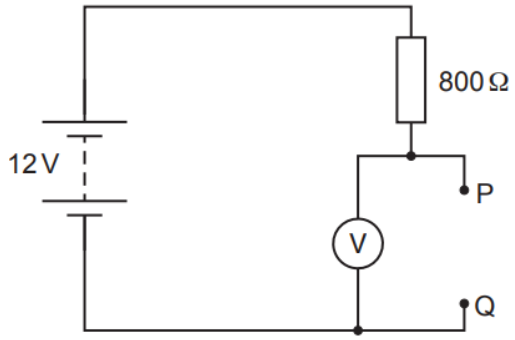


Fig. 8.1

The thermistor is connected between terminals P and Q.

(a) Complete Fig. 8.1 by drawing the symbol for a thermistor between terminals P and Q. [1]

(b) The 12V battery consists of eight identical cells connected in series.

Calculate the electromotive force (e.m.f.) of each cell.

e.m.f. = ... [1]

(c) The reading on the voltmeter is 8.0V.

(i) Determine the resistance of the thermistor. **(extended only)**

resistance = ... [3]

(ii) A few hours later, the student notices that the reading on the voltmeter is greater.

Explain what can be deduced from this observation. **(extended only)**

.....

.....

.....

..... [3]

[Total: 8]

27 Fig. 10.1 shows an incomplete electrical circuit.

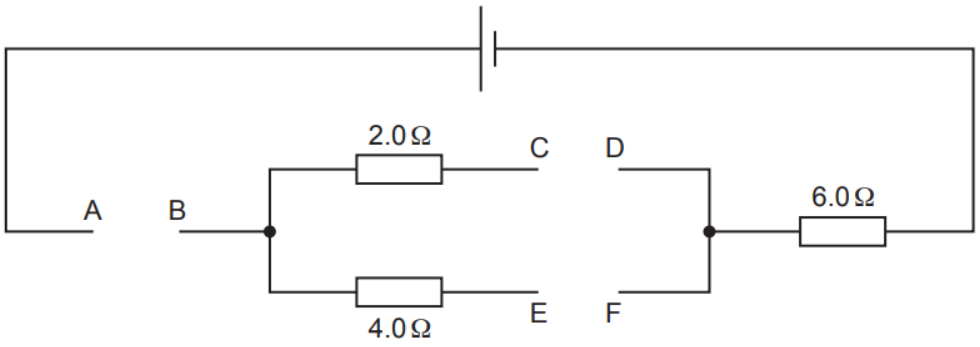


Fig. 10.1

(a) (i) A student completes the circuit and measures the current in the 6.0Ω resistor.

On Fig. 10.1, draw an ammeter symbol in one gap and straight lines to indicate wires in the other gaps to show how the student should do this. [1]

(ii) A voltmeter is connected to measure the potential difference (p.d.) across the 4.0Ω resistor.

On Fig. 10.1, draw a voltmeter symbol connected in the correct position. [2]

(iii) With the circuit completed, the current in the 2.0Ω resistor is 2.5A. **(extended only)**

Calculate the current in the 6.0Ω resistor.

current = ... [4]

(b) Fig. 10.2 shows the same electrical circuit with an alternating current (a.c.) power supply and a wire in the gap AB. **(extended only)**

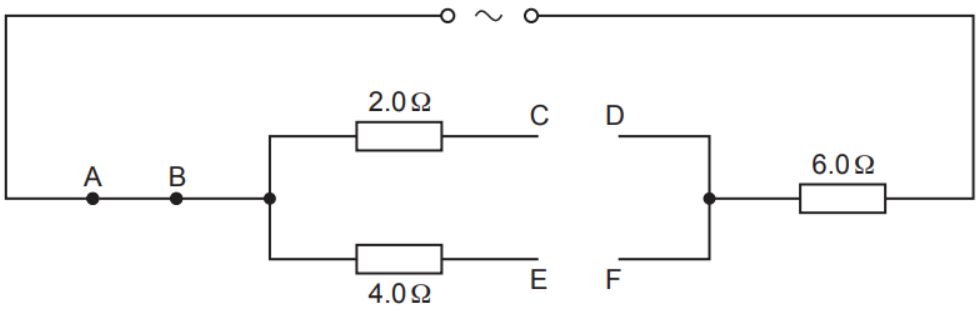


Fig. 10.2

On Fig. 10.2, draw a diode symbol in one gap and a straight line to indicate a wire in the other gap so that there is a current from right to left in the 4.0Ω resistor and an alternating current in the 2.0Ω resistor. [2]

[Total: 9]

28 Fig. 7.1 shows a circuit that contains a battery, a switch, a voltmeter and three 40 Ω resistors, R_1, R_2 and R_3.

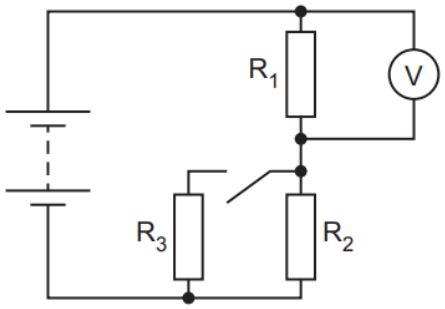


Fig. 7.1

The switch is open and resistors R_1 and R_2 form a potential divider.

(a) Describe what is meant by a potential divider. **(extended only)**

.....

.....

..... [2]

(b) The reading on the voltmeter is 7.5 V.

(i) Calculate the electromotive force (e.m.f.) of the battery. **(extended only)**

e.m.f. = ... [1]

(ii) The switch is closed. **(extended only)**

Calculate the resistance of the complete circuit.

resistance = ... [3]

(c) Calculate the reading on the voltmeter when the switch is closed. **(extended only)**

reading = ... [2]

[Total: 8]

29 **(c)** Fig. 8.2 shows a circuit.

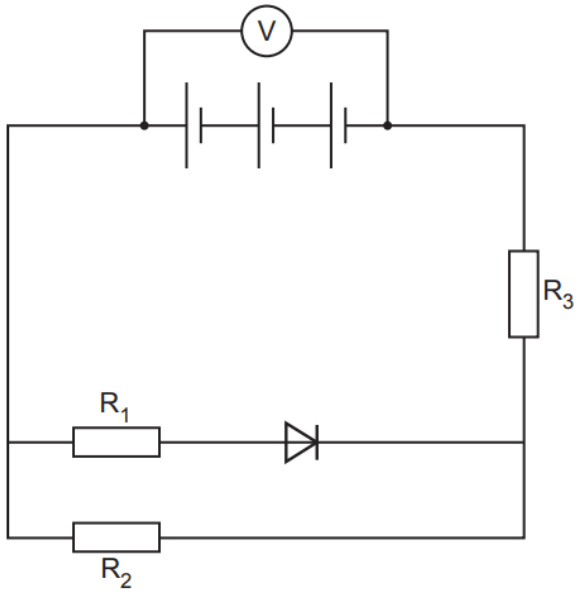


Fig. 8.2

The three cells are identical and have zero resistance.
The resistors R_1, R_2 and R_3 are identical.
The reading on the voltmeter is 6.0 V.
When the diode is conducting, it has zero resistance and zero potential difference (p.d.) across it.

(i) Determine the e.m.f. of one cell.

e.m.f. = ... [1]

(ii) Determine the ratio of the p.d. across R_2 to the p.d. across R_3. **(extended only)**

..... [1]

(iii) All the cells are reversed.

1. State and explain the change in current in R_1. **(extended only)**

.....

..... [1]

2. Determine the new value of the ratio of the p.d. across R_2 to the p.d. across R_3. **(extended only)**

..... [1]

[Total: 8]

30 The unit of the two electrical quantities electromotive force (e.m.f.) and potential difference (p.d.) is the volt (V).

(a) State **one** other similarity between e.m.f. and p.d.

.....

..... [1]

(b) State **one** difference between e.m.f. and p.d.

.....

..... [1]

(c) A battery consists of four cells, each of e.m.f. 1.2 V, in series.

(i) Calculate the e.m.f. of the battery.

e.m.f. = ... [1]

(ii) The battery is connected in a circuit with four 12 Ω resistors. Fig. 8.1 is the circuit diagram. **(extended only)**

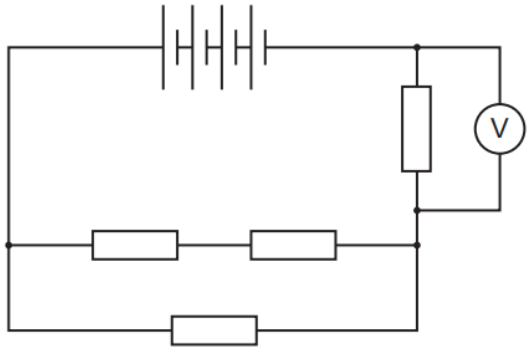


Fig. 8.1

Calculate the total resistance of this arrangement of resistors.

resistance = ... [3]

(iii) Calculate the reading on the voltmeter in Fig. 8.1. **(extended only)**

reading = ... [2]

[Total: 8]

31 A circuit contains two fixed resistors and a light-dependent resistor (LDR). Fig. 8.1 shows that the power supply is a 9.0 V battery.

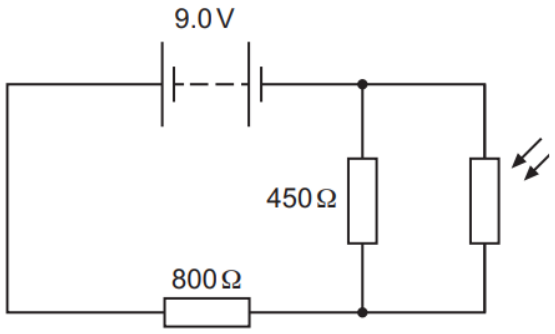


Fig. 8.1

The current in the 450 Ω resistor is 0.012 A.

(a) State what is meant by electric current. **(extended only)**

.....

..... [1]

(b) The current in the LDR is I_1 and the current in the 800 Ω resistor is I_2. **(extended only)**

Complete the equation that relates the current in the 450 Ω resistor to I_1 and I_2.

current in the 450 Ω resistor = ... [1]

(c) Calculate the power dissipated in the 800 Ω resistor. **(extended only)**

power = ... [4]

(d) The brightness of the light that is incident on the LDR increases. **(extended only)**

Explain what happens to the potential difference (p.d.) across the 450 Ω resistor.

.....

.....

.....

..... [3]

[Total: 9]

32 **(a)** Explain what is meant by *electromotive force* (*e.m.f.*).

.....

.....

..... [2]

(b) An electric heater contains two heating elements R_1 and R_2. An electric motor operates a fan. The fan blows cool air over the heating elements.

Fig. 8.1 shows the circuit.

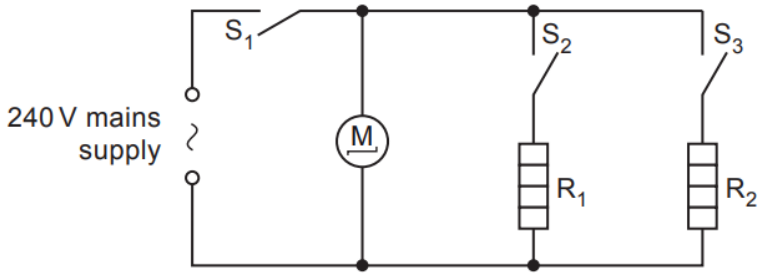


Fig. 8.1

The heater is powered by a mains supply of e.m.f. 240 V.

Switches S_1 and S_2 are closed. Heating element R_1 gets hot. The resistance of R_1 is 30 Ω.

(i) Calculate the current in heating element R_1. **(extended only)**

current = ... [1]

(ii) Calculate the power produced in heating element R_1. **(extended only)**

power = ... [2]

(iii) The resistance of heating element R_2 is 60 Ω. **(extended only)**

Switches S_1, S_2 and S_3 are closed.

1. State and explain how the current in R_2 compares with the current in R_1.

.....

.....

..... [2]

2. The current in the motor is 0.10A. The cable from the electric heater to the plug for the mains socket is safe when the current in it is less than 20A.

Suggest and explain a suitable fuse rating for this circuit.

.....

.....

.....

..... [2]

[Total: 9]

33 Fig. 7.1 shows a circuit diagram that includes component X.

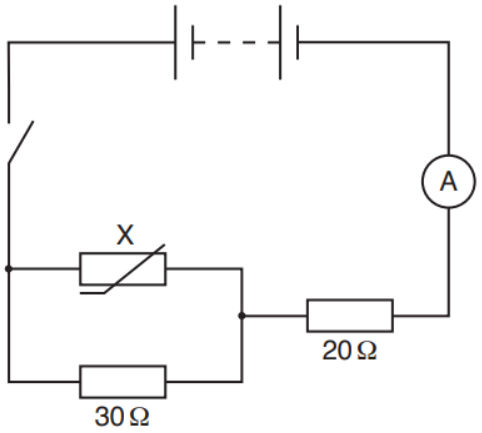


Fig. 7.1

(a) State the name of component X.

..... [1]

(b) The electromotive force (e.m.f.) of the battery is E. The switch is closed.

The potential difference (p.d.) across the 30 Ω resistor is V_{30}.
The p.d. across the 20 Ω resistor is V_{20}.
The p.d. across component X is V_X.

State an equation that relates V_X to:

(i) V_{30} **(extended only)**

..... [1]

(ii) E and V_{20}. **(extended only)**

..... [1]

(c) The e.m.f. of the battery is 6.0 V and the resistance of component X is 15 Ω.

Calculate:

(i) the total resistance of the circuit **(extended only)**

resistance = ... [3]

(ii) the ammeter reading. **(extended only)**

reading = ... [2]

(d) The temperature of component X increases. **(extended only)**

State and explain what happens to the ammeter reading.

.....

.....

..... [2]

[Total: 10]