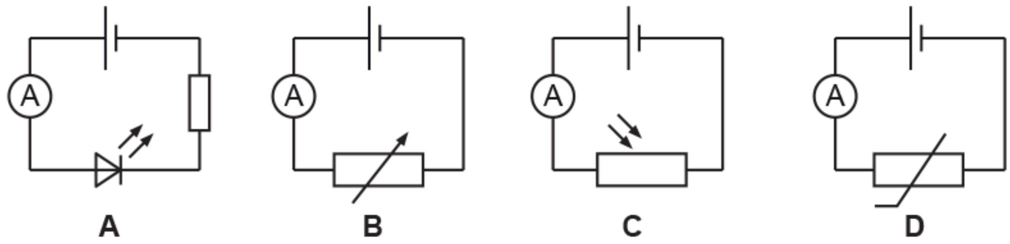
Energy, Power and Resistance Circuit symbols

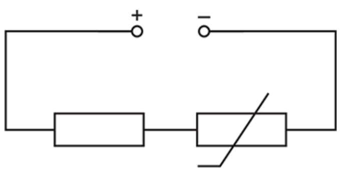
1. Which circuit below can be used to monitor the variation of light intensity in a room?



Your answer

[1]

2. A circuit with a thermistor is shown below.



The resistance of the resistor is *R* and the resistance of the thermistor is 2.5*R*.
The potential difference (p.d.) across the thermistor is 5.0 V.

What is the total p.d. across both components?

A 2.0 V
B 7.0 V
C 12.5 V
D 17.5 V

Your answer

[1]

3. The power rating of a toaster is given as 2000 W. Which of the following is **not** an equivalent power rating?

A. 2×10^{-9} TW
B. 2000 N m s^{-1}
C. 2 kJ s^{-1}
D. 2000 mJ s^{-1}

Your answer

[1]

4. This question is about investigations involving an electromagnetic wave.

A vertical transmitter aerial emits a **vertically polarised** electromagnetic wave which travels towards a vertical receiver aerial. The wavelength of the wave is 0.60 m.

Fig. 5.1 shows a short section of the oscillating electric field of the electromagnetic wave.

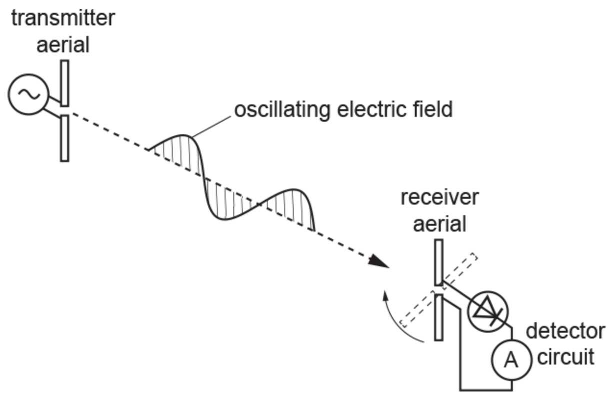


Fig. 5.1

Suggest why the diode in **Fig. 5.1** is necessary for an ammeter to detect a signal at the receiver aerial.

[1]

5. The circuit diagram shows a battery of e.m.f. E and internal resistance r connected to a variable resistor R.

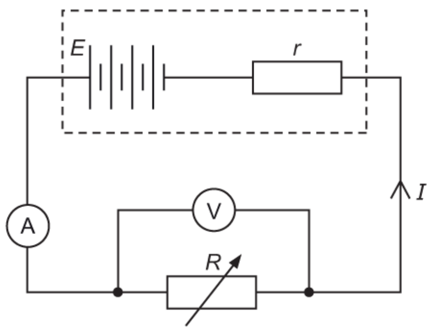


Fig. 5.1

The current I in the variable resistor is measured using an ammeter and the potential difference V across the variable resistor is measured using a voltmeter.

Use Kirchhoff's second law to show that $V = E - Ir$.

[2]

6. A student is given a chemical cell, an ammeter, a voltmeter, a variable resistor and a number of connecting wires.

Design a laboratory experiment to determine the internal resistance *r* of the chemical cell using a graph. Start with a circuit diagram.

In your description pay particular attention to

- the circuit used
- the measurements taken
- how the data is analysed using a graph.

----

[4]

7. This question is about two identical filament lamps. Fig. 23.2 shows the *I-V* characteristic of each lamp.

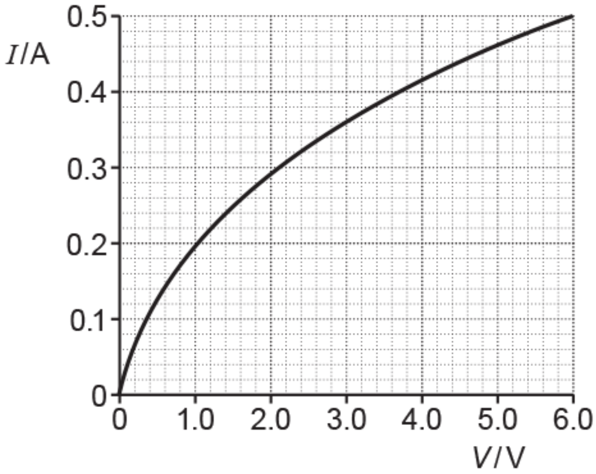


Fig. 23.2

The lamps are connected to a 6.0 V supply of negligible internal resistance in **series**, as shown in Fig. 23.3, and then in **parallel**, as shown in Fig. 23.4.

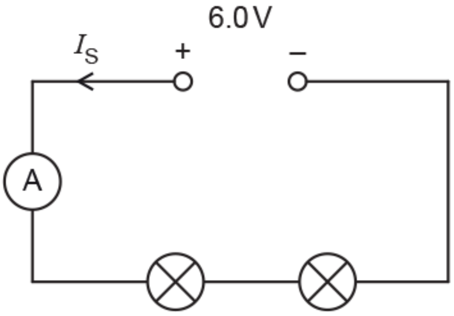


Fig. 23.3

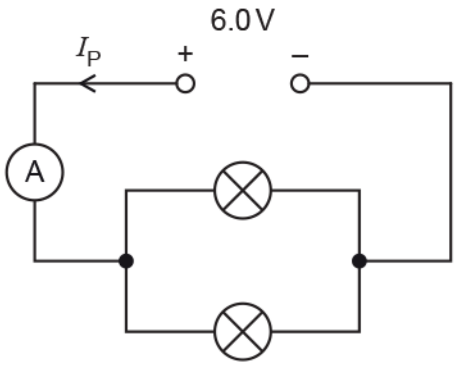


Fig. 23.4

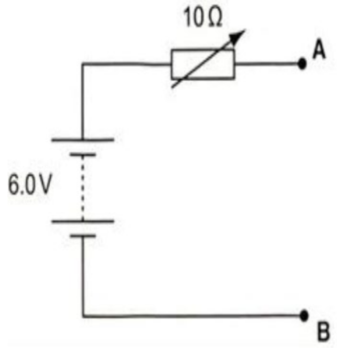
The current from the supply in the series circuit is I_S and the current from the supply in the parallel circuit is I_P.
I_P is found to be almost 3 times greater than I_S.

Use Fig. 23.2 to explain why I_P is almost 3 times greater than I_S.
Show any calculations and your reasoning below.

Fig. 23.3 | Fig. 23.4

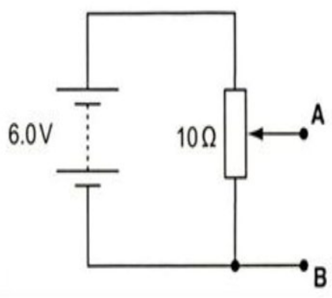
[4]

8. *In order to determine the *I-V* characteristic for an LED, one student connects to the incomplete circuit **X** shown in **Fig. 4.2(a)** and a second student connects to the incomplete circuit **Y** shown in **Fig. 4.2(b).** Each adds an LED with a resistor in series and suitable meters to take the measurements between terminals **A** and **B**.



Incomplete circuit X

Fig. 4.2(a)



Incomplete circuit Y

Fig. 4.2(b)

Only one of these circuits is suitable to carry out the task.
Draw an LED with a 100 Ω resistor in series and suitable meters to complete the correct circuit on **Fig. 4.2(a)** or **4.2(b)**.

Explain why only one of the circuits is suitable to carry out the task and why the 100 Ω resistor has been included.

----

[6]

9. A student monitors the temperature in a room by using a potential divider circuit containing a negative temperature coefficient (NTC) thermistor. The student sets up the circuit shown in Fig. 4.2.

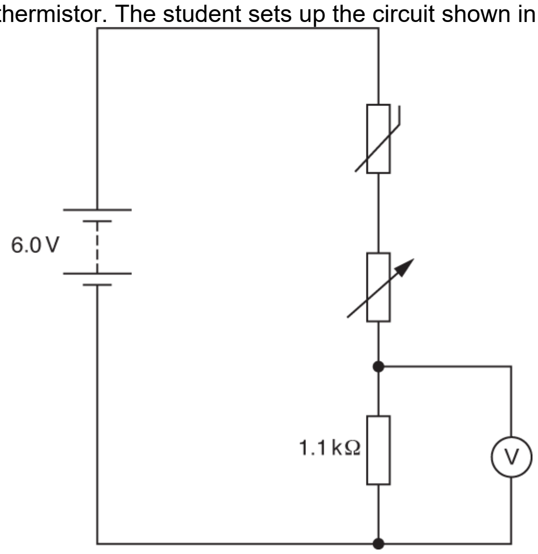


Fig. 4.2

The battery has an e.m.f. of 6.0 V and negligible internal resistance.

i. When the temperature of the thermistor is 12 °C the thermistor has a resistance of 6.8 kΩ.
The resistance of the variable resistor is set to a value of 1.4 kΩ.
Calculate the reading *V* on the voltmeter.

V = ... V **[2]**

ii. Explain how the reading on the voltmeter will change when the temperature of the thermistor increases.

-- **[4]**

10. A light-dependent resistor (LDR) is connected between points **X** and **Y** in the circuit of Fig. 4.2. The circuit is used to switch on a lamp during the hours of darkness.

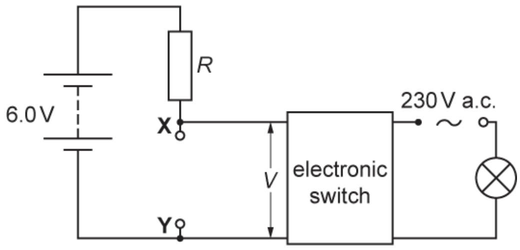


Fig. 4.2

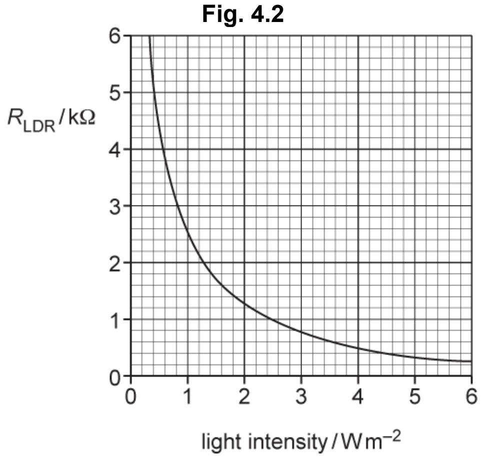


Fig. 4.3

i. Draw the symbol for an LDR on Fig. 4.2 between **X** and **Y**.

[1]

ii. Fig. 4.3 shows how the resistance of the LDR varies with light intensity. The electronic switch closes when
V across **XY** is 4.0 V and opens when *V* across **XY** is 2.4 V. The electronic switch draws a negligible current.

Calculate

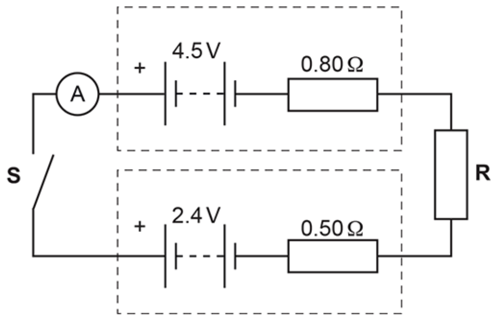
1 the resistance *R* of the resistor for the lamp to switch on at a light intensity of 0.80 W m^{-2}

R = ... Ω **[3]**

2 the light intensity of the surroundings at which the lamp switches off.

light intensity = ... W m^{-2} **[2]**

11. The circuit diagram of an electrical circuit is shown below.



The positive terminals of the batteries are connected together.
One battery has electromotive force (e.m.f.) 4.5 V and internal resistance 0.80 Ω.
The other battery has e.m.f. 2.4 V and internal resistance 0.50 Ω.
R is a coil of insulated wire of resistance 1.2 Ω at room temperature.

The switch **S** is closed.

i. On the diagram, draw an arrow to show the direction of the conventional current.

[1]

ii. Calculate the current *I* shown by the ammeter.

I = ... A **[3]**

iii. The insulated wire has diameter 4.6×10^{-4}m.
The number density of charge carriers in **R** is 4.2×10^{28} m^{-3}

Calculate the mean drift velocity v of the charge carriers in **R**.

v = ... m s^{-1} **[2]**

iv. The current measured by the ammeter is smaller than that calculated in **(ii)**. This is because the temperature of **R** increased due to heating by the current.

Without any changes to the circuit itself, state and explain what practically can be done to make the measured current the same as the calculated current.

----

[2]

12(a). Fig. 4 shows a circuit with five identical 60 Ω resistors. The battery has electromotive force (e.m.f.) 9.0 V and negligible internal resistance.

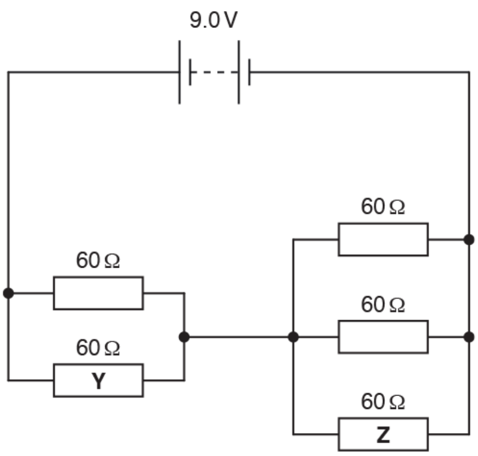


Fig. 4

i. Show that the total resistance in the circuit is 50 Ω.
Make your reasoning clear.

[2]

ii. Calculate the potential difference *V* across resistor **Y**.

V = ... V **[2]**

iii. Calculate the charge *Q* passing through resistor **Y** in two minutes (include an appropriate unit).

Q = ... unit: .... **[3]**

iv. Calculate the energy *W* dissipated in resistor **Y** in two minutes.

W = ... J **[1]**

(b). Explain how the mean drift velocity of electrons in resistor **Y** compares with the mean drift velocity of electrons in resistor **Z**.

---

[3]

13. A filament lamp **X** is part of an electrical circuit. The circuit has a battery of electromotive force (e.m.f.) 6.0 V and negligible internal resistance. The potential difference across the lamp can be increased **continuously** from 0 to 6.0 V. This potential difference is measured using a voltmeter.
The lamp glows brightly at 6.0 V.

i. Draw a circuit diagram for this electrical arrangement.

[2]

ii. Describe and explain the variation of the resistance of this lamp as the potential difference across it is changed from 0 to 6.0 V.

---

[4]

iii. The filament lamp **X** is now connected in a different circuit as shown in Fig. 16.

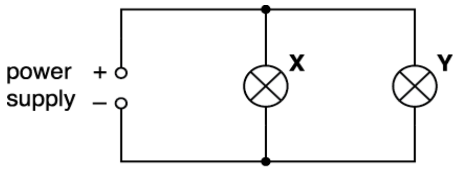


Fig. 16

The power dissipated in **X** is three times more than the power dissipated in the filamentlamp **Y**. The filament wire of lamp **X** has a diameter half that of lamp **Y**.
The filament wires of **X** and **Y** are made of the same material and are at the same temperature.

Calculate the ratio

$$\frac{\text{mean drift velocity of charge carriers in lamp } \mathbf{X}}{\text{mean drift velocity of charge carriers in lamp } \mathbf{Y}}.$$

ratio = ... **[3]**

END OF QUESTION PAPER