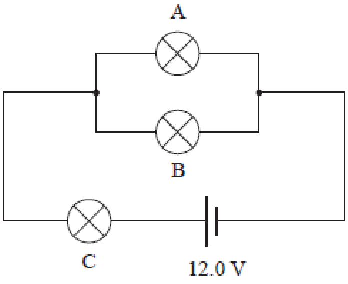
ELECTRICITY: CIRCUIT QUESTIONS

CIRCUITS (2022;2)

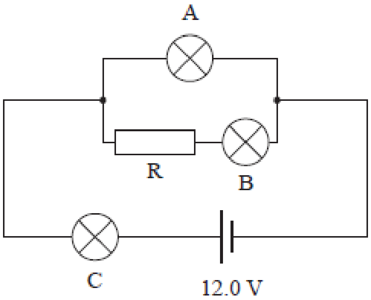
A student finds some car headlamps that are labelled 12.0 V, 55.0 W.

(a) Show the resistance of a single headlamp is 2.62 Ω.



(b) The student connects two of these headlamps (labelled A and B), and another lamp (C), which is used to light up the number plate in the circuit shown. The resistance of lamp C is 1.22 Ω. Calculate the total resistance of this circuit.

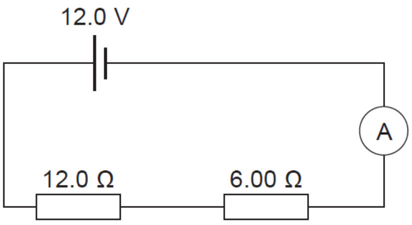
The student connects a radio with resistance R to the circuit.



(c) Use physics principles to describe the effect adding the radio would have on the brightness of lamp A. Assume the radio and lamps are all operating. Start by describing what effect adding the radio would have on the circuit resistance.

(d) Give at least three reasons why the circuit in part (c) would not be a good way to connect the 12 V headlamps in a car.

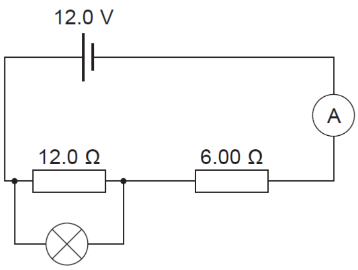
CIRCUITS (2021;1)



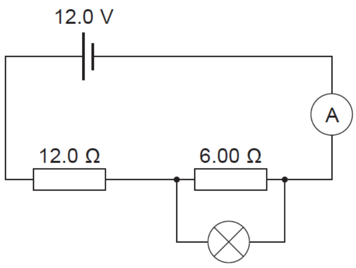
Bob is investigating circuits in the laboratory and starts with the circuit shown. The voltage across the 12.0 Ω resistor is 8.00 V.

(a) Calculate the current in the circuit.

(b) Calculate the amount of energy converted to heat in one hour in the 6.00 Ω resistor.



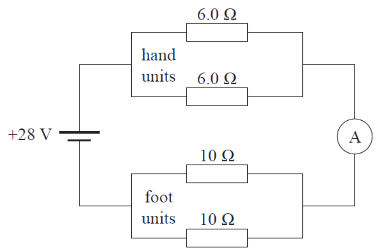
(c) Bob has a lamp that operates normally only when connected to 8.00 V. He connects it in parallel with the 12.0 Ω resistor. Without further calculation, explain why Bob's lamp will not operate normally when connected this way.



(d) Bob finds another lamp that has resistance of 4.57 Ω. He connects this lamp in the original circuit in parallel with the 6.00 Ω resistor. Calculate the voltage across this lamp.

FIRST CLASS CABINS (2020;1)

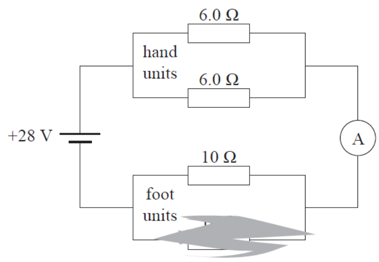
In a first-class cabin, the seats are fitted with four heating units: two for the hands, and two for the feet. The hand units have a resistance of 6.0 Ω, and the foot units 10 Ω. The heating circuit is connected to the 28 V supply.



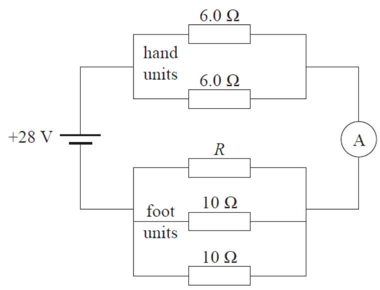
(a) Show the combined resistance of the hand units is 3.0 Ω.

(b) Calculate the current flowing through the ammeter.

(c) One of the foot units stops working. Explain what effect this would have on the current through a single hand unit.

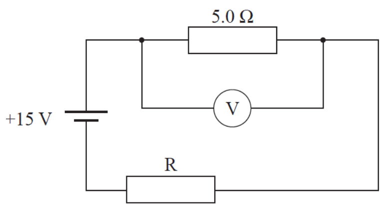


(d) As an upgrade, the airline adds an additional heating unit (labelled R) to the seat. When the new heating unit is added, the power output from the supply is 120 W. What is the value of the resistance, R, of the new heating unit?



THE BICYCLE LAMP (2019;1)

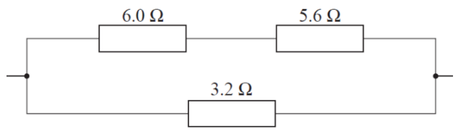
Jason needs to buy a lamp for his bike. When he pulls apart an old lamp, he finds some circuits. A simplified version of a circuit found in Jason's bike lamp is shown below.



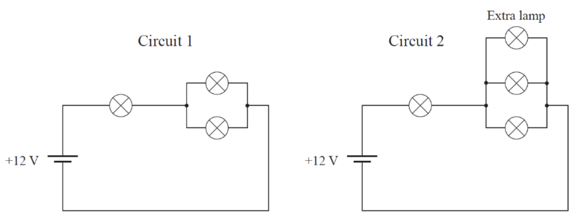
(a) The voltmeter reads 4.0 V. Show that the circuit current is 0.80 A.

(b) Calculate the heat energy dissipated in 2 minutes by the resistor marked R.

(c) Another part of a circuit in the lamp is shown. Calculate the total resistance of this circuit.

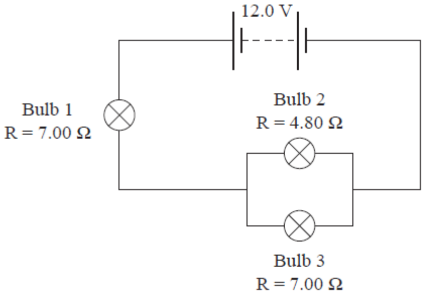


(d) Jason's friend Deborah designs the following lighting circuits, and Jason wonders which circuit would give out the most light. All lamps are identical. Circuit 2 has an extra lamp. By considering the combined brightness of all the lamps in the circuit, give a comprehensive explanation comparing the total brightness of Circuit 1 to Circuit 2.



CIRCUITS (2018;3)

Use the following circuit diagram to answer the questions below.

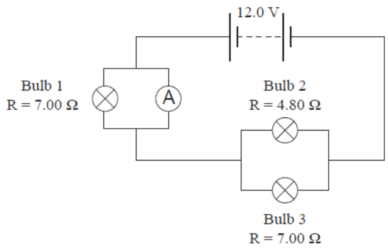


(a) Show that the total resistance of the circuit is approximately 10 Ω.

(b) Calculate the voltages across bulb 1 and bulb 2.

(c) Bulbs 2 and 3 are not the same brightness. Discuss which bulb is brighter, and why.

(d) An ideal ammeter (with negligible resistance) is added to the previous circuit as shown below. Discuss the effect adding the ammeter has on the current, the voltage, and hence the brightness of each bulb.

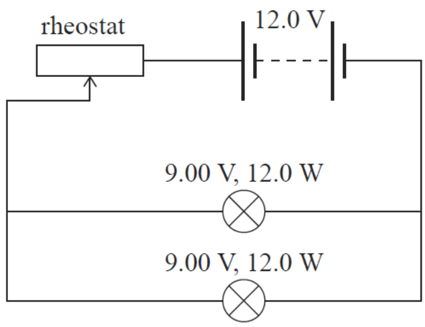


Light bulbs (2017;2)

Sam is using a light bulb rated as 9.00 V, 12.0 W.

(a) Calculate the current flowing through the bulb when it is working at the stated voltage of 9.00 V.

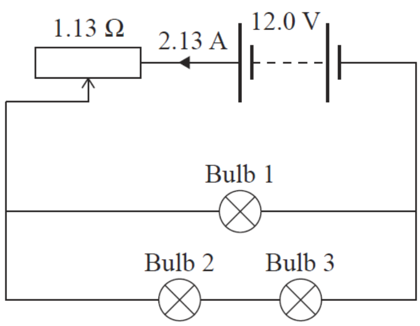
Sam then connects two identical 9.00 V, 12.0 W bulbs, a 12.0 V battery, and a rheostat (variable resistor) as shown below:



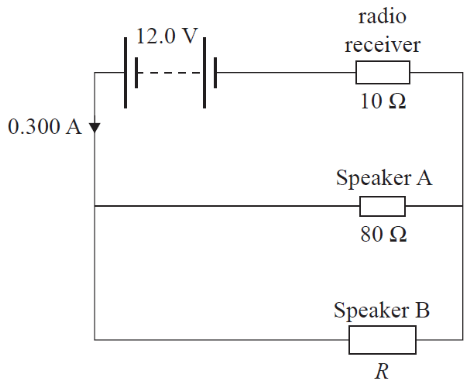
(b) Explain how increasing the resistance of the rheostat affects the voltage across each bulb.

(c) Show that the resistance of the rheostat must be 1.13 Ω, in order for each bulb to be operating at 9.00 V.

(d) Sometime later Sam modifies the circuit in part (a) by adding one more identical bulb. A current of 2.13 A is drawn from the battery when the circuit is connected. Explain how the addition of Bulb 3 affects the brightness of Bulb 1. In your answer, explain if any of the bulbs are now more likely to 'blow'.



DC (2016;1)



A car radio can be modelled by the use of resistors. One resistor can be used to model the radio receiver. Two different-sized resistors can be used to model two different-sized speakers. The circuit is shown below. The resistance of the radio receiver is 10 Ω, and the resistance of the small speaker is 80 Ω. The current from the car battery is 0.300 A.

(a) Calculate the voltage across the radio receiver

(b) Calculate the current passing through Speaker A

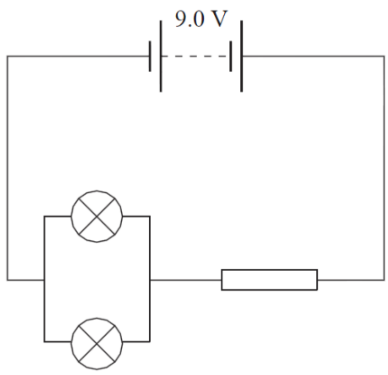
(c) Speaker B uses more power than Speaker A. Compare the resistance of Speaker B with the resistance of Speaker A. No calculations are required.

(d) The 12 V car battery can be connected to a car's headlight. One of the bulbs in the car's headlight is rated 12 V, 60 W. A normal household bulb is rated 240 V, 60 W, and is connected to the 240 V household supply.

(i) Carry out calculations to explain which bulb (the car's headlight bulb or a normal household bulb) has more current passing through it.

(ii) Discuss how the brightness of the car's headlight bulb compares with that of the normal household bulb. Assume both bulbs are the same type.

Circuits (2015;4)

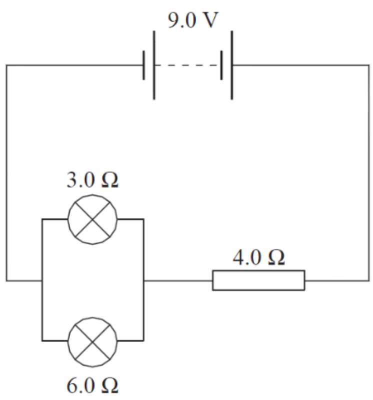


Kahu has two identical lamps marked 6.0 V, 2.0 W. He wants to connect them to a 9.0 V battery. He realises that he will have to connect a resistor to reduce the voltage across the lamps. He connects the circuit as shown.

(a) Calculate the current in each lamp when it is operating at its normal brightness.

(b) Calculate the resistance of the resistor that he should use so that the lamps are at their normal brightness.

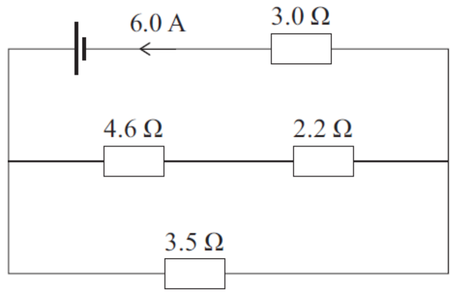
(c) What will happen to the current in the resistor if one lamp "blows"? Explain your answer.



Kahu sets up a new circuit with different lamps and resistor, as shown in the diagram.

(d) Calculate the voltage across the 4.0 Ω resistor.

Resistors in a DC circuit (2014;2)



Sandra is investigating electrical circuits in the lab. She connects various resistors in combination. The current drawn from the supply is 6.0 A.

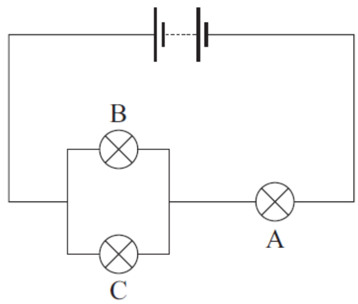
(a) Calculate the effective resistance of the circuit.

(b) Calculate the size of the voltage across the 3.5 Ω resistor.

(c) Express your answer to Question Two (b) to the correct number of significant figures. Give a reason for your choice of significant figures.

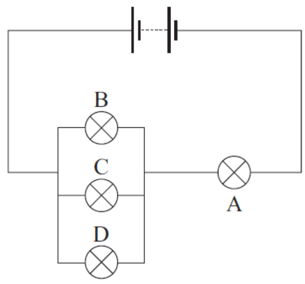
(d) Explain which resistor, the 4.6 Ω or the 2.2 Ω resistor, would convert the greater amount of energy per second into heat.

Lamps and resistors in a DC circuit (2014;3)



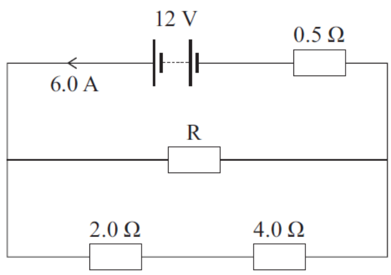
Stephen connects identical lamps, as shown in the diagram,

(a) Lamp B blows. State what happens to the brightness of lamp A.



(b) Stephen replaces lamp B with a new one. Explain what would happen to the voltage across lamp B and the voltage across lamp A if another identical lamp, D, was added in parallel, as shown in the diagram.

Stephen then takes a selection of resistors and connects them as shown in the diagram.

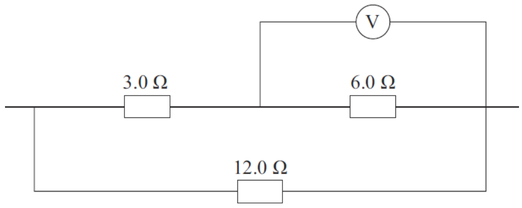


(c) Calculate the voltage across the 0.5 Ω resistor.

(d) Calculate the resistance of resistor R. Begin your answer by calculating the voltage across each branch.

Circuits (2013;2)

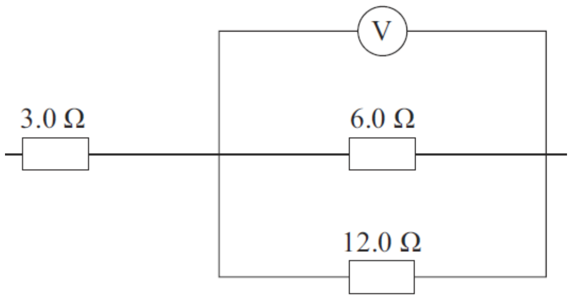
Tavita is working on the power supply for the X-ray tube. The diagram shows part of the circuit that Tavita is testing.



(a) The voltmeter reads 18.0 Volts. Calculate the size of the current through the 6.0 Ω resistor. Write your answer with the correct number of significant figures.

(b) Explain what happens to the power output of the 6.0 Ω resistor if the voltage across it doubles.

Tavita reconnects the three resistors as shown.



(c) The circuit is changed so that the current through the 6.0 Ω resistor is now 2.0 A. Calculate the power output of the 3.0 Ω resistor.

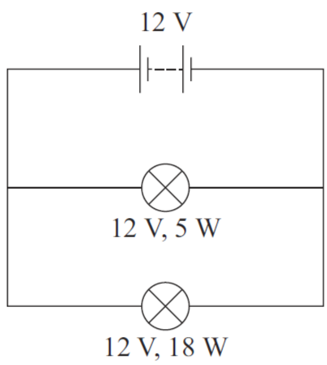
(d) Explain what would happen to the voltage across the 3.0 Ω resistor if the 12.0 Ω resistor is removed, but the total voltage remains the same.

12 V Lamps (2012;1)

The photograph alongside is of two lamps. The label on one of the lamps reads 12 V 5 W.

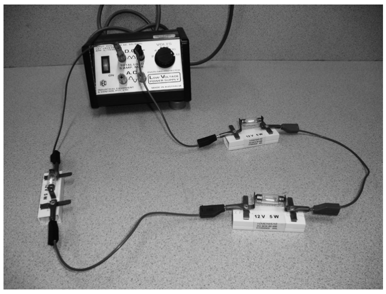
(a) State what 12 V 5 W means.

The label on the second lamp reads 12 V 18 W. The two lamps are connected in parallel to a 12 V power supply, as shown below.



(b) State which of the two lamps will be brighter. Give reasons for your answer.
(c) Calculate the effective resistance of the circuit.
(d) With reference to the circuit diagram calculate the energy transferred by the 18 W lamp if it is left on for 3 minutes

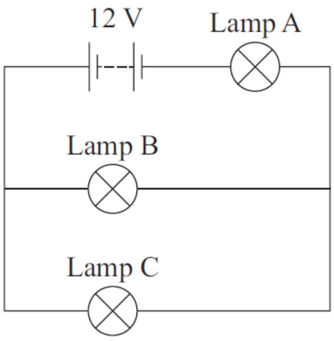
More 12 V Lamps (2012;2)

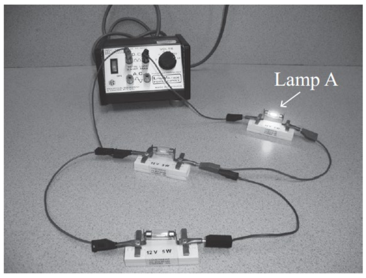


Jason connects three identical (12 V, 5 W) lamps in series to a 12 V power supply. He notices that all three of them glow with the same brightness.

(a) Explain why the lamps all glow with the same brightness.

Jason then reconnects the circuit, as shown in the diagram and photograph below.





(b) Calculate the **current drawn** from the power source when the circuit is connected as shown in the diagram (Lamp A in series with the source, Lamp B and Lamp C parallel to each other). Begin your answer by calculating the resistance of each lamp.

(c) Jason notices that the three lamps no longer all glow with the same brightness. Lamp A is brighter than Lamp B and Lamp C. Discuss why Lamp A is **brighter** than Lamps B and C, even though they are all identical lamps (12 V, 5 W). You may use calculations to justify your answer.

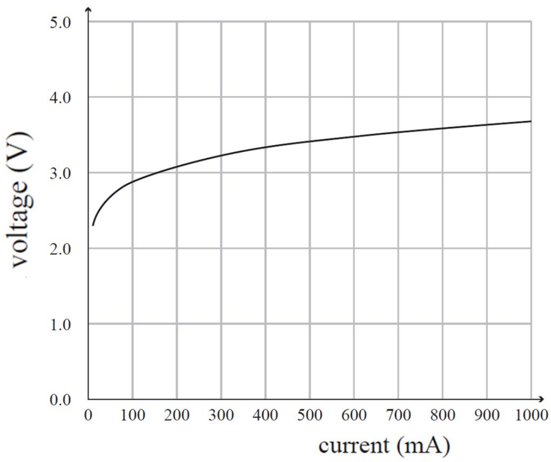
Claire's car lights (2011;3)

Claire has a light bulb inside her car. The light bulb is labelled "12 V 5 W", and it is connected to the car's 12 V battery.

(a) Describe what the label means.

(b) Calculate the size of the current in the light bulb when it is switched on.

The graph shows the voltage current characteristics for an LED.

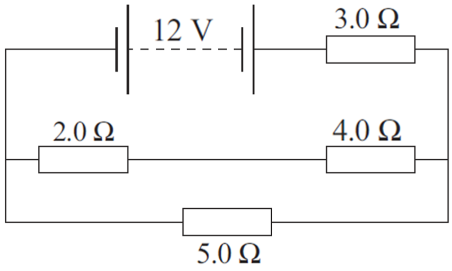


(f) Calculate the resistance when the current is 700 mA.

(g) Describe how the resistance changes when the current increases.

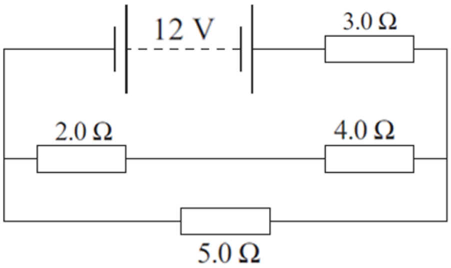
DC Electricity (2010;2)

Frank is out camping. He has just one 12 V battery with him. He connects various low voltage devices to this battery, as shown in the diagram.

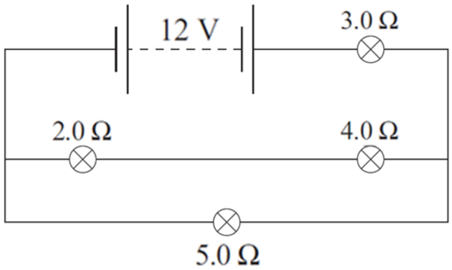


(a) Calculate the effective resistance of the circuit.
(b) Calculate the current through the 3.0 Ω resistor.
(c) Calculate the current through the 5.0 Ω resistor.

As it grows dark, Frank replaces all the devices with lamps of resistances similar to those of his low voltage devices at that temperature.



Old circuit

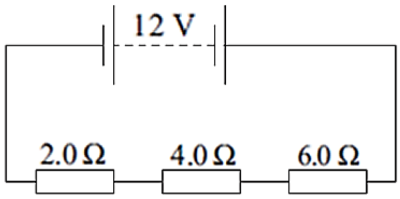


New circuit

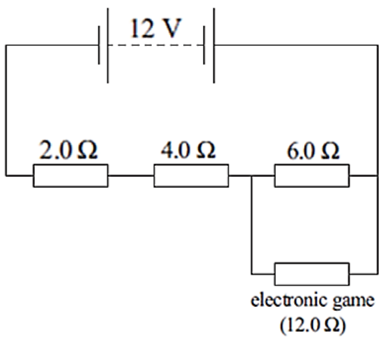
(d) Discuss which of the TWO lamps (3.0 Ω lamp or the 4.0 Ω lamp) in the circuit will be brighter. You may use calculations to support your answer.

Electric circuits (2009;2)

Sean has a yacht with a 12 V power supply. He has various low voltage devices that he wants to run off the power supply. He connects three resistors in series with the power supply as shown in the diagram.

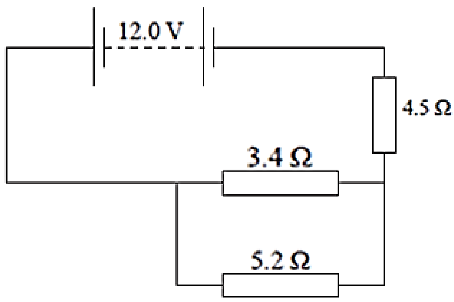


(a) Calculate the current through the circuit.
(b) Sean connects an electronic game with a resistance of 12.0 Ω in parallel with the 6.0 Ω resistor. Calculate the voltage across the electronic game.
(c) Sean switches the electronic game to "standby mode". This causes the resistance of the electronic game to increase. Explain how this affects the voltage across the 4.0 Ω resistor.



DC Electricity (2008;2)

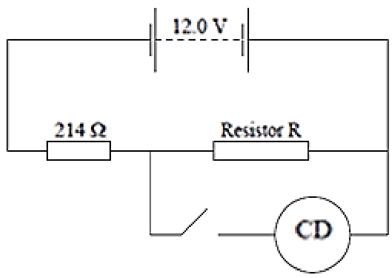
Martha and Mere connected the following circuit using several resistors and a power supply.



(a) How much energy does the battery give to each Coulomb of charge?
(b) Show that the total resistance in this circuit is 6.56 Ω.
(c) Calculate the current through the 4.5 Ω resistor.
(d) Show that the voltage across the 3.4 Ω resistor is 3.8 V.
(e) State the voltage across the 5.2 Ω resistor. Give reasons for your answer.

Electric circuits (2007;2)

Ella has a battery-operated CD player that she wants to connect to her car battery. The voltage of her car battery is 12.0 V and her CD player is marked "4.5 V, 25 mA". She knows she cannot connect it directly to the car battery, so she decides to connect it in a circuit as shown in the diagram. The switch is initially closed.



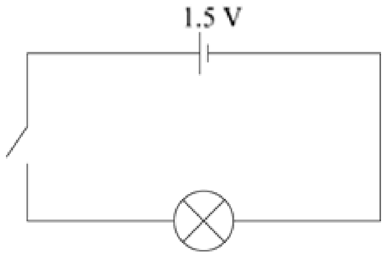
(a) Calculate the resistance of the CD player.
(b) Calculate the voltage across the 214 Ω resistor if the CD player has the correct voltage across it when the switch is closed.
(c) Show that the appropriate value of resistor R is 450 Ω.

Ella now opens the switch.

(d) Explain what happens to the voltage across the 214 Ω resistor when she opens the switch.
(e) The switch remains open. Explain which resistor produces more heat in a given time.
(f) Ella does not have a 450 Ω resistor, but she does have three 300 Ω resistors. Draw a diagram to show how she could connect the three 300 Ω resistors to give a total of 450 Ω.

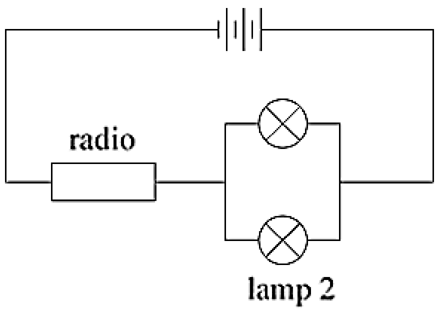
DC Electricity (2006;1)

Tom was out camping one weekend. He had taken some spare 1.5 volt cells with him. The diagram shows the circuit diagram for Tom's torch.



(a) When the cell is switched on, the resistance of the lamp is 5.00 Ω. Calculate the current flowing through the lamp.
(b) How many joules of energy does the cell supply to each coulomb of charge that flows out of the cell?
(c) State the meaning of the term **resistance** in terms of electron flow.
(d) The torch was used for 3 minutes. Calculate the number of coulombs of charge that flowed through the lamp in 3 minutes.

Three 1.5 V cells are connected as shown.

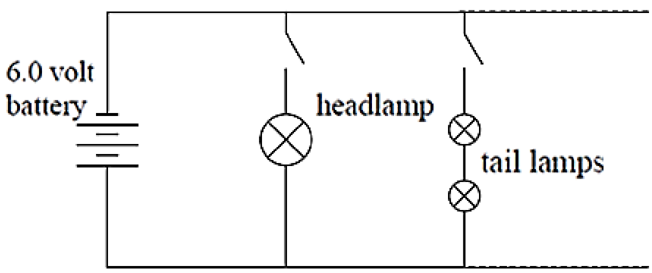


(e) Calculate the total voltage supplied by the cells.

The resistance of each of these lamps is 4.00 Ω and the resistance of the radio is 14.0 Ω.
(f) Calculate the total resistance of the circuit. Express your answer to the correct number of significant figures.
(g) Calculate the voltage across lamp 2.

Mike's motorbike (2005;2)

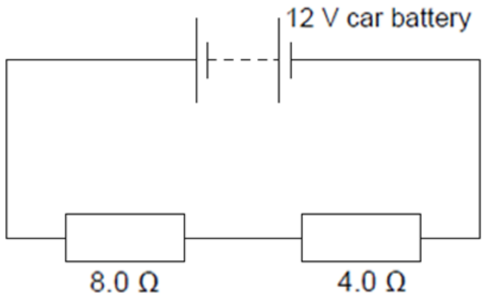
Mike is restoring an old motorbike. The wiring is damaged, and he decides to replace it. His sister Moana designs a lighting circuit and draws a wiring diagram. Part of it is shown. Mike then connects the lighting circuit on the motorbike.
All the lamps are designed to operate at 6.0 V.



(a) The headlamp has a resistance of 1.2 Ω when it is switched on. Show that the electric current through the headlamp is 5.0 A.
(b) Calculate the power output of the headlamp when it is operating normally. Give the correct unit with your answer.
(c) Explain clearly what will happen to the current in the headlamp in the short time after its switch is first closed.
(d) The battery is producing 6.0 A when both switches are closed. Calculate the resistance of each tail lamp, assuming that they are identical.

THE CD PLAYER (2004;1)

Amelia has a CD player that requires a 4.0 V DC power supply. To save the expense of buying new batteries, she decides to operate her CD player from her car's battery.
Her friend Shona suggests using a voltage divider and designs the following circuit.

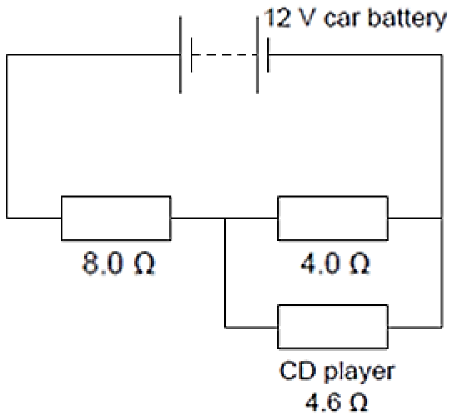


(a) Calculate the total resistance of the circuit.
(b) Calculate the current that would flow from the battery.
(c) Calculate the voltage across the 4.0 Ω resistor.
(d) Shona examines the CD player. The label states:

4.0 V	3.5 W

Show that the CD player's resistance is 4.6 Ω.

The CD player has a resistance of 4.6 Ω.
Shona hopes that by connecting it in parallel with the 4.0 Ω resistor, it will have 4.0 V across it and will work normally. When she tries it, she finds it does not work properly.



(e) Calculate the total resistance of the new circuit.
(f) Explain what happens to the voltage across the 8.0 Ω resistor when the CD player is put in the circuit.
(g) Show that the current through the 8.0 Ω resistor is 1.2 A.
(h) Calculate the voltage across the CD player.

Shona could only find two 2.0 Ω resistors and two 16.0 Ω resistors to use to make the voltage divider.

(i) Draw two diagrams to show how she could make a 4.0 Ω resistor and an 8.0 Ω resistor from the ones available