

DC Circuits

Q1. In the circuit shown in **Figure 1**, the battery, of emf 6.0V, has negligible internal resistance.

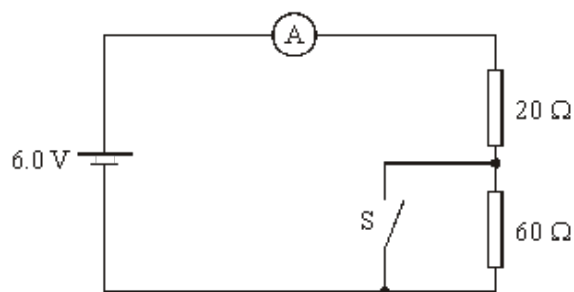


Figure 1

(a) Calculate the current through the ammeter when the switch S is

(i) open,

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(ii) closed.

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(3)

(b) The switch S is now replaced with a voltmeter of infinite resistance. Determine the reading on the voltmeter.

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(2)

(Total 5 marks)

- Q2.** (a) In the circuit in **Figure 1**, the battery, of emf 15 V and the negligible internal resistance, is connected in series with two lamps and a resistor. The three components each have a resistance of $12\ \Omega$.

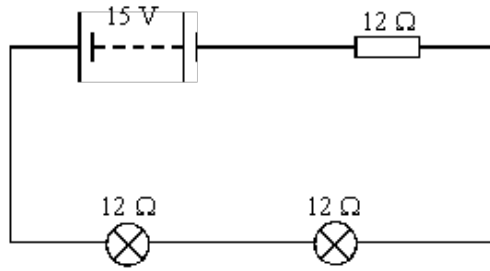


Figure 1

- (i) What is the voltage across each lamp?

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- (ii) Calculate the current through the lamps.

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(3)

- (b) The two lamps are now disconnected and reconnected in parallel as shown in **Figure 2**.

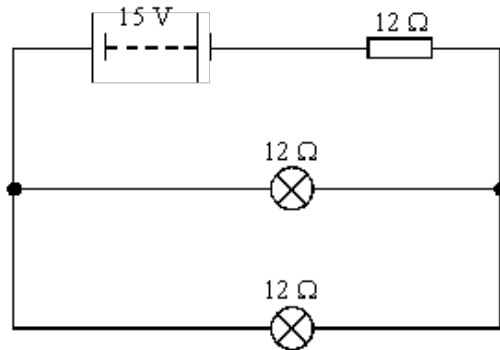


Figure 2

- (i) Show that the current supplied by the battery is 0.83 A.

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- (ii) Hence show that the current in each lamp is the same as the current in the lamps in the circuit in **Figure 1**.

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(3)

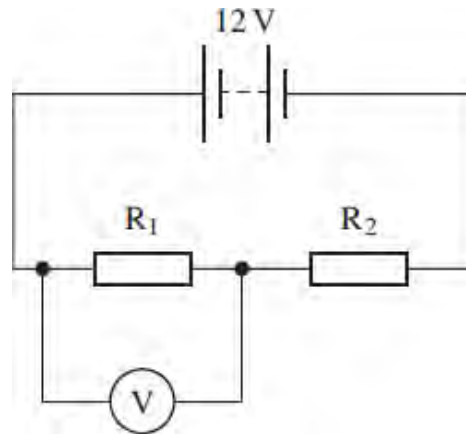
- (c) How does the brightness of the lamps in the circuit in **Figure 1** compare with the brightness of the lamps in the circuit in **Figure 2**?

Explain your answer.

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(2)
 (Total 8 marks)

- Q3.** The figure below shows two resistors, R_1 and R_2 , connected in series with a battery of emf 12 V and negligible internal resistance.



- (a) The reading on the voltmeter is 8.0 V and the resistance of R_2 is 60 Ω .
- (i) Calculate the current in the circuit.

answer = A

(2)

(ii) Calculate the resistance of R_1 .

answer = Ω

(1)

(iii) Calculate the charge passing through the battery in 2.0 minutes. Give an appropriate unit for your answer.

answer = unit =

(2)

(b) In the circuit shown in the figure above R_2 is replaced with a thermistor. State and explain what will happen to the reading on the voltmeter as the temperature of the thermistor increases.

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(3)

(Total 8 marks)

Q4. X and Y are two lamps. X is rated at 12 V 36 W and Y at 4.5 V 2.0 W.

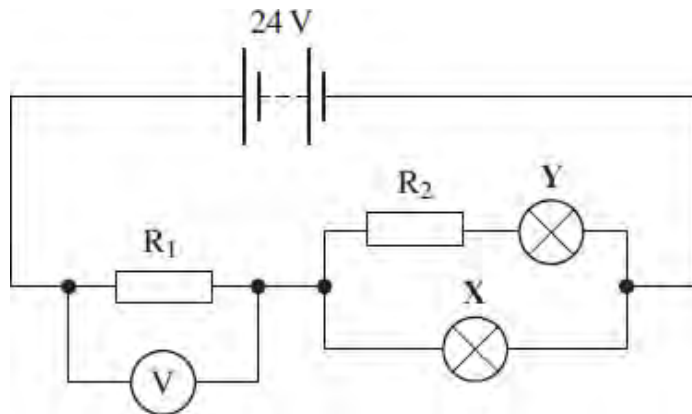
(a) Calculate the current in each lamp when it is operated at its correct working voltage.

X A

Y A

(2)

- (b) The two lamps are connected in the circuit shown in the figure below. The battery has an emf of 24 V and negligible internal resistance. The resistors, R_1 and R_2 are chosen so that the lamps are operating at their correct working voltage.



- (i) Calculate the pd across R_1 .

answer V

(1)

- (ii) Calculate the current in R_1 .

answer A

(1)

- (iii) Calculate the resistance of R_1 .

answer Ω

(1)

- (iv) Calculate the pd across R_2 .

answer V

(1)

- (v) Calculate the resistance of R_2 .

answer Ω

(1)

(c) The filament of the lamp in **X** breaks and the lamp no longer conducts. It is observed that the voltmeter reading decreases and lamp **Y** glows more brightly.

(i) Explain without calculation why the voltmeter reading decreases.

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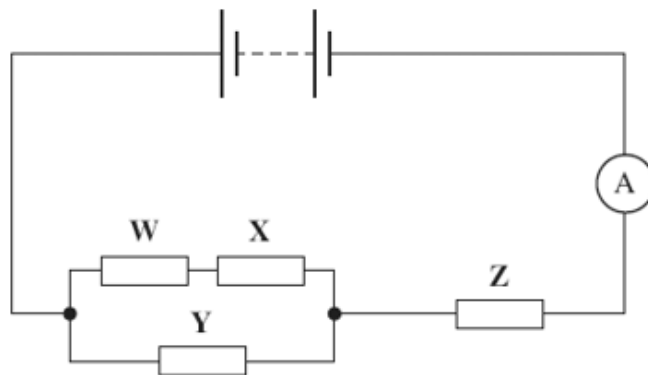
(2)

(ii) Explain without calculation why the lamp **Y** glows more brightly.

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(2)
 (Total 11 marks)

Q5. The circuit shown in the figure below shows an arrangement of resistors, **W**, **X**, **Y**, **Z**, connected to a battery of negligible internal resistance.



The emf of the battery is 10V and the reading on the ammeter is 2.0 A.

(a) (i) Calculate the total resistance of the circuit.

answer = Ω

(1)

- (ii) The resistors **W**, **X**, **Y**, and **Z** all have the same resistance. Show that your answer to part (a) (i) is consistent with the resistance of each resistor being 3.0Ω .

answer = Ω

(3)

- (b) (i) Calculate the current through resistor **Y**.

answer = A

(2)

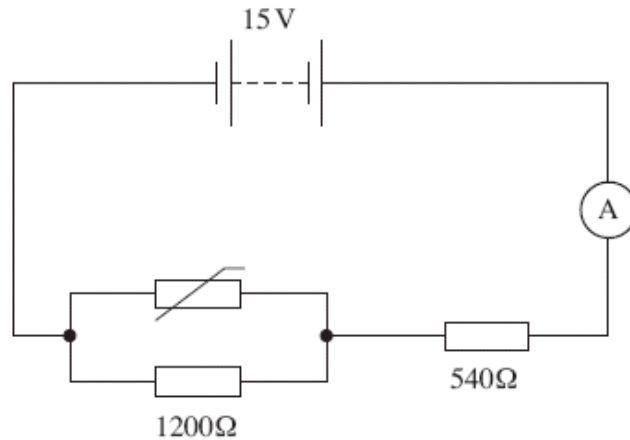
- (ii) Calculate the pd across resistor **W**.

answer = V

(2)

(Total 8 marks)

Q6. The circuit shown below shows a thermistor connected in a circuit with two resistors, an ammeter and a battery of emf 15V and negligible internal resistance.



(a) When the thermistor is at a certain temperature the current through the ammeter is 10.0 mA.

(i) Calculate the pd across the 540 Ω resistor.

answer = V

(1)

(ii) Calculate the pd across the 1200 Ω resistor.

answer = V

(1)

(iii) Calculate the resistance of the parallel combination of the resistor and the thermistor.

answer = Ω

(iv) Calculate the resistance of the thermistor.

answer = Ω

(2)

(b) The temperature of the thermistor is increased so that its resistance decreases. State and explain what happens to the pd across the 1200 Ω resistor.

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(3)

(Total 9 marks)

Q7. (a) A student wishes to investigate how the resistance of a thermistor changes with temperature.

(i) Draw a labelled diagram of a suitable circuit that would enable the student to measure the resistance of the thermistor.

(2)

- (ii) Describe the procedure the student would follow in order to obtain accurate and reliable measurements of the resistance of the thermistor at different temperatures.

The quality of your written communication will be assessed in this question.

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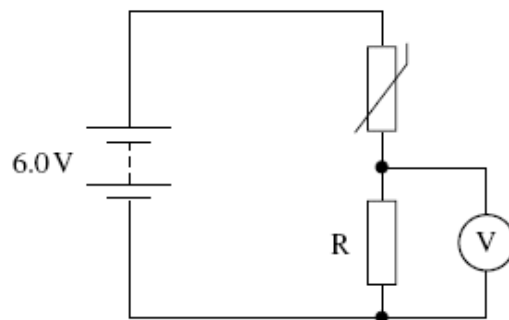
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(6)

- (b) The diagram below shows a thermistor connected in series with a resistor, R , and battery of emf 6.0 V and negligible internal resistance.



When the temperature is $50\text{ }^{\circ}\text{C}$ the resistance of the thermistor is $1.2\text{ k}\Omega$. The voltmeter connected across R reads 1.6 V .

- (i) Calculate the pd across the thermistor.

answer = V

(1)

(ii) Calculate the current in the circuit.

answer = A (1)

(iii) Calculate the resistance of R quoting your answer to an appropriate number of significant figures.

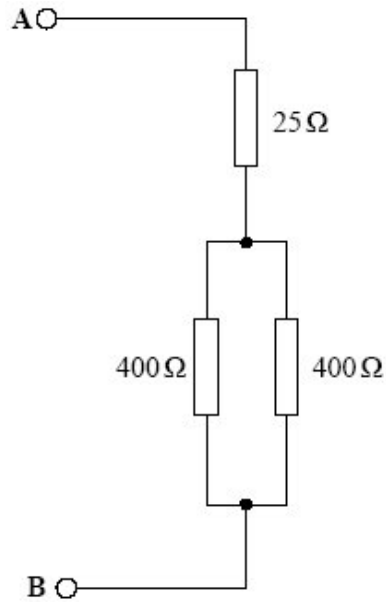
answer = Ω (2)

(c) State and explain the effect on the voltmeter reading if the internal resistance of the battery in the circuit in part (b) was not negligible.

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(2)
(Total 14 marks)

Q8. The diagram below shows an arrangement of resistors.



(a) Calculate the total resistance between terminals **A** and **B**.

answer = Ω

(2)

(b) A potential difference is applied between the two terminals, **A** and **B**, and the power dissipated in each of the $400\ \Omega$ resistors is $1.0\ \text{W}$.

(i) Calculate the potential difference across the $400\ \Omega$ resistors.

answer = V

(ii) Calculate the current through the $25\ \Omega$ resistor.

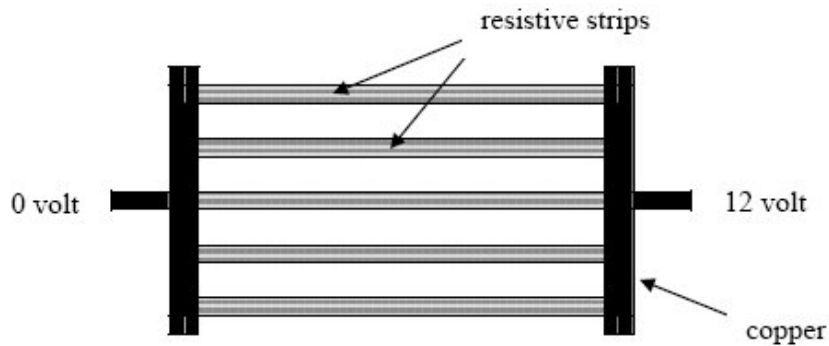
answer = A

- (iii) Calculate the potential difference applied to terminals **A** and **B**.

answer = V

(6)
(Total 8 marks)

- Q9.** A heating unit as used on the rear window of a car consists of five strips of resistive material joined at either end by strips of copper of negligible resistance, shown in the diagram below. Heat is generated at a rate of 45 W when the unit is connected to a 12 V car battery.



- (a) (i) Calculate the total resistance of the unit.

total resistance =

- (ii) Show that the resistance of each strip is about 16 Ω .

(4)

- (b) If each resistive strip is 2.5 mm wide and of length 0.80 m, determine the thickness of each strip.

Resistivity of the resistive material = $5.0 \times 10^{-5} \Omega\text{m}$.

thickness =

(3)

- (c) The rear window heater on a car is sometimes set to be switched off automatically after a period of time to prevent draining the battery.

If the charge stored in a fully charged battery is $1.44 \times 10^5 \text{ C}$, how long, in hours, would it take to fully drain the battery with the heater?

time =hours

(3)

(Total 10 marks)

- Q10.** (a) A set of decorative lights consists of a string of lamps. Each lamp is rated at 5.0 V, 0.40 W and is connected in series to a 230 V supply.

Calculate

- (i) the number of lamps in the set, so that each lamp operates at the correct rating,

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- (ii) the current in the circuit,

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(iii) the resistance of each lamp,

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(iv) the total electrical energy transferred by the set of lights in 2 hours.

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(5)

(b) When assembled at the factory, one set of lights inadvertently contains 10 lamps too many. All are connected in series. Assume that the resistance of each lamp is the same as that calculated in part (a) (iii).

(i) Calculate the current in this set of lights when connected to a 230 V supply.

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(ii) How would the brightness of each lamp in this set compare with the brightness of each lamp in the correct set?

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(3)

(Total 8 marks)

Q11. (a) A student is given three resistors of resistance 3.0 Ω , 4.0 Ω and 6.0 Ω respectively.

(i) Draw the arrangement, using all three resistors, which will give the largest resistance.

(ii) Calculate the resistance of the arrangement you have drawn.

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(iii) Draw the arrangement, using all three resistors, which will give the smallest resistance.

(iv) Calculate the resistance of the arrangement you have drawn.

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(5)

(b) The three resistors are now connected to a battery of emf 12 V and negligible internal resistance, as shown in **Figure 1**.

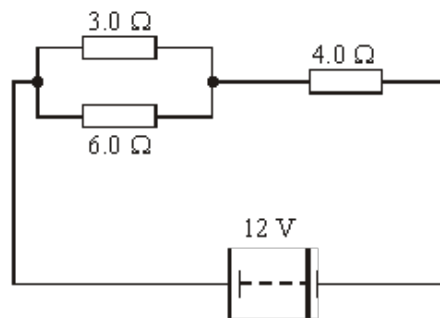


Figure 1

(i) Calculate the total resistance in the circuit.

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(ii) Calculate the voltage across the 6.0 Ω resistor.

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(4)
(Total 9 marks)