Part 1: Ohm's law

The following questions are based on Ohm's law, V = I R.

1. An energy-efficient light globe that you have just installed in your 240 V study lamp draws a current of 0.20 A. What is the resistance of the globe when the lamp is operating normally?

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2. A solar cell powers a 12 V garden light with a resistance of 6 Ω. What current does the solar cell need to produce to light the lamp?

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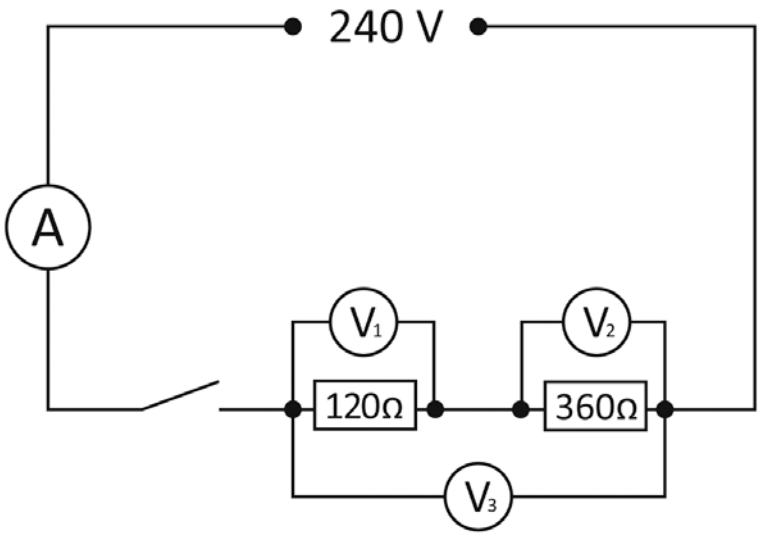
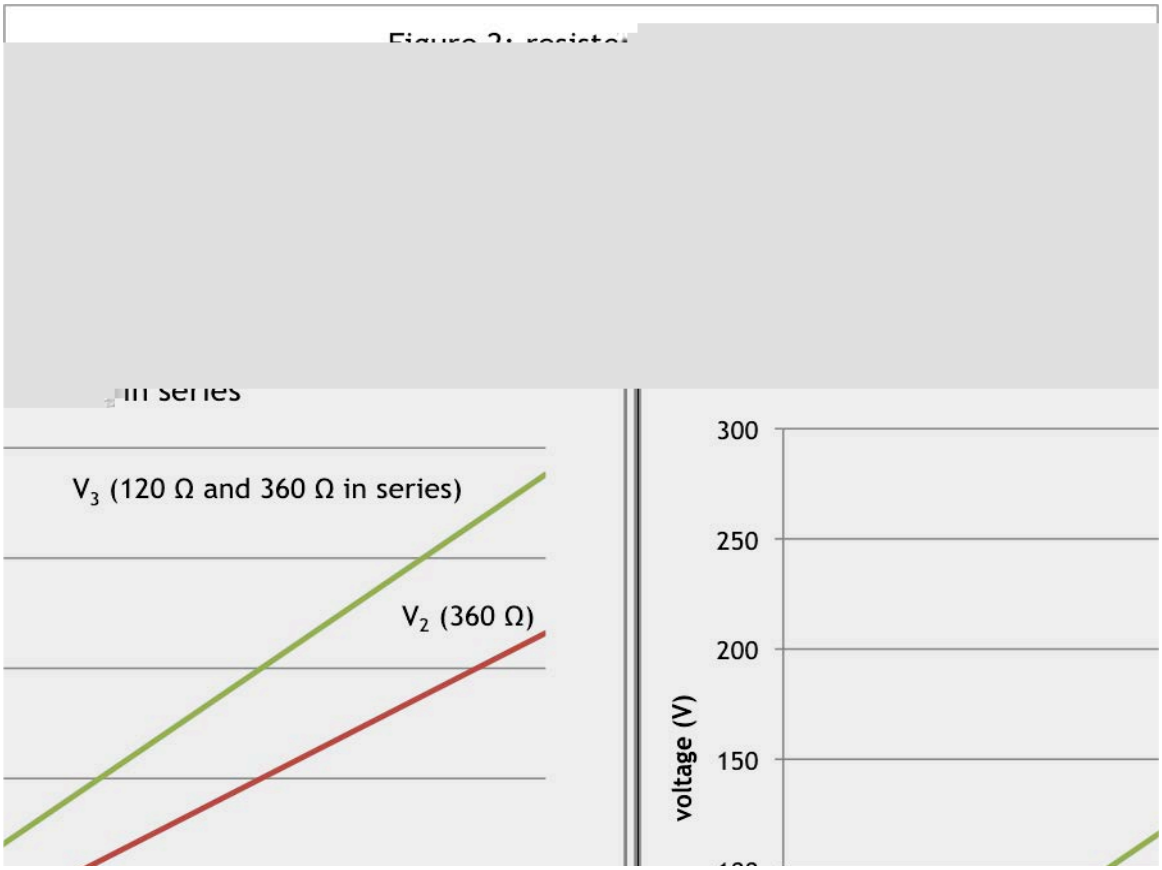
- The circuit diagram below (Figure 1) shows two resistors of 120 Ω and 360 Ω, in an electric blanket, connected in series. When tested with meters, a graph of results is produced (Figure 2) showing the voltage and current relationship for individual resistors (V_1 and V_2). The current and voltage relationship for the combined resistors (120 + 360 = 480 Ω, V_3) is also shown in this graph.

Figure 1: resistance in series





- Use the graph in Figure 2 to answer the following questions:

3. What quantity does each of the three lines on the graph represent?

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4. If a current of 0.5 A is measured in the ammeter, what is the voltage across each of the resistors?

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5. Is the graph line that represents the combined resistance of 480 Ω consistent with answers you calculated in question 4? Explain your response.

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6. What would be the voltage across each resistor if measured current was 0.25 A?

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7. Using the results from questions 4 and 6, suggest a relationship between total voltage and individual voltages across resistors in series.

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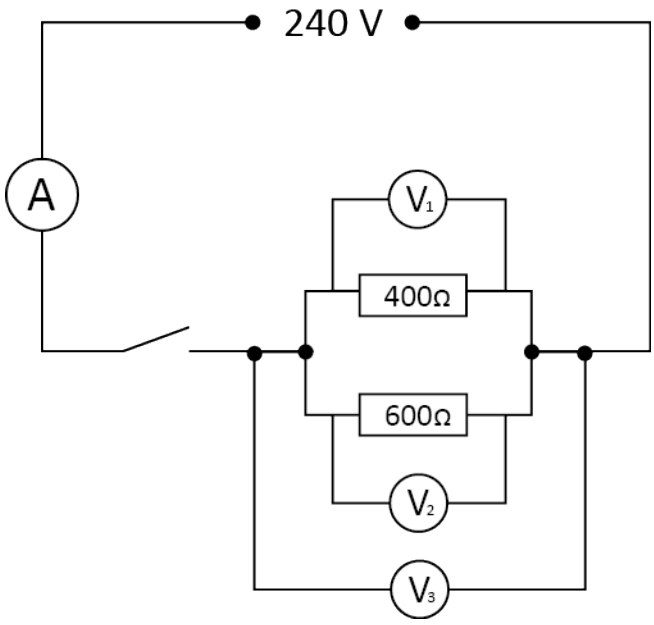
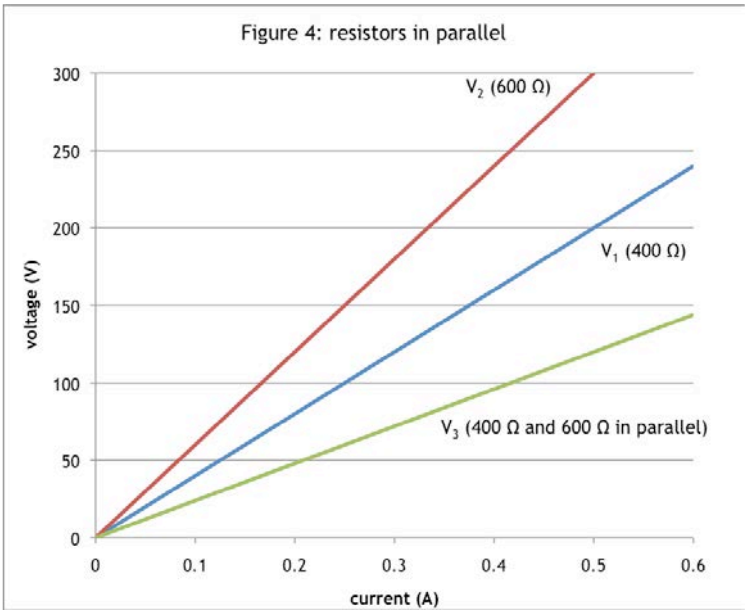
- A differently designed electric blanket has a circuit (Figure 3) that allows resistors to be turned on in parallel. This circuit is tested for current and corresponding voltage, and results graphed for each resistor (Figure 4). The current and voltage relationship is also shown when both resistors are turned on.

Figure 3: resistance in parallel





- Use the graph in Figure 4 to answer the following questions:

8. What quantity does each graph line represent?

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9. When a voltage of 120 V is measured across both resistors, what is the current in each of the two resistors?

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10. Is the graph line that represents the combined resistance of the two resistors in parallel, consistent with answers you calculated in question 9? Explain your response.

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11. Repeat calculations for a voltage of 60 V to find the current in each resistor.

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12. Using the results from questions 9 and 10, suggest a relationship between total current in the circuit and individual currents in each resistor in parallel.

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Part 2: Calculating current

Owners of caravans and camper trailers rely on batteries to supply energy to appliances such as portable fridges, microwave ovens, televisions and other devices that make life on the road comfortable. Batteries they use are rated in amp–hours (A h). For example, a battery rated at 80 A h is capable of delivering 80 amps for one hour or, more realistically, 4 amps for 20 hours.

As current is defined in terms of quantity of charge delivered per unit of time, there is a relationship between charge, current and time, given by: $q = I\,t$ (or $I = q/t$), where:

- q is the charge measured in coulombs (C),
- I is the current measured in amps (A), and
- t is the time measured in seconds (s).

A coulomb is the amount of charge transferred by a current of one amp flowing for one second, so 1 A h is equivalent to 3600 C.

It is important for users to know how much charge a battery is capable of delivering before it requires recharging. If the original capacity of a battery, the current delivered by it, and the time interval it has been delivering this current are all known, then the quantity of electricity capable of being delivered before the battery goes 'flat' can be calculated.

- Before setting out on a camping trip the owner of a caravan fully charges the caravan's battery.

13. How much charge passes through the battery if a current of 2 A is used for 4 hours?

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14. If a fully-charged battery is rated 80 A h, how long will it run a portable fridge that draws a 4 A current?

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15. The owner of a camper trailer installs two fully-charged 80 A h batteries in parallel to run the trailer's fridge, which draws an average of 4 A. How long will the batteries operate the fridge before the capacity of each battery falls below 10 A h and they need recharging?

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16. The owner of the camper trailer discovers that the batteries actually run the fridge for less time than calculated. Suggest a reason for the discrepancy between calculated and actual times.

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17. Careless handling of batteries causes a short circuit spark between the batteries and metal trailer. A current of 10 A flows for 30 minutes before it is detected. How much battery discharge time is lost?

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