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|  | Australian Curriculum Year 9 Science sample assessment ׀ Student booklet  Electric kettles |

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| To demonstrate understanding of energy transfer in electric circuits and to investigate factors that affect the transfer of energy. |
| You will:   * Use the particle model and the relationships between energy, power, voltage, current and resistance to demonstrate your understanding of energy transfer in electric circuits. * Investigate some of the factors that affect energy transfer in electric circuits. * Plan an investigation to check the power rating of an electric kettle. |

## Section 1. Explaining how heating elements in electric kettles work

1. Electric appliances transform energy from one form to another. Describe the principal energy transformation occurring in an electric kettle.

1. Electric kettles have a power rating measured in watts. Describe the relationship between power and energy.

1. Write the formula that shows how power, energy and time relate to each other (include units).

1. Write the formula for calculating the electrical power from the voltage applied to a heating element and the current flowing through it (include units).

1. Heating elements are made from metals that are electrical resistors. Ohm’s law shows how the current changes when the voltage across a resistor is changed.
2. Write the formula for Ohm’s law (include units)
3. Describe the relationship between current and voltage.

1. Use the formulas in questions 4 and 5 to give the formula for calculating power from resistance and voltage (include units and show all working).

1. With reference to the particles that make up a resistor, draw a labelled diagram to support an explanation of how electrical energy is transformed into heat when the resistor is connected in an electric circuit.

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## Section 2. Identifying factors that affect energy transfer in electric circuits

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| Nichrome wire is commonly used to make heating elements because it is a good electrical resistor. The size of the nichrome wire affects the properties of the electric circuit. |

### Question to be investigated

What effect does changing the thickness and length of a piece of nichrome wire have on the circuit measurements of voltage, current and resistance?

### Materials

* variable power supply (power pack)
* ammeter and voltmeter or 2 multimeters
* switch
* 6 connecting wires, with alligator clips
* heatproof mat
* 50 cm and 100 cm lengths of 20 swg (0.91 mm diameter) nichrome wire
* 50 cm and 100 cm lengths of 26 swg (0.46 mm diameter) nichrome wire

### Risk assessment

1. a. Identify potential safety risks for this investigation.
   1. Describe how to manage these safety risks.

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| **Risk** | **Management strategies** |
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### Method

* + - 1. Using the 50 cm coil of 20 swg nichrome wire as a resistor, set up the electric circuit shown in the diagram above. Make sure the ammeter is connected in series with the resistor, and the voltmeter is parallel across it.
      2. Place the circuit on the heatproof mat.
      3. Set the power pack to 2 volt DC.
      4. Close the switch, read the voltmeter and ammeter as quickly as possible, then open the switch.
      5. Record the voltage (V) and the current (I) in the results table below.
      6. Repeat steps 3–5 for 4 volts DC and 6 volts DC.
      7. Repeat the investigation using the 100 cm length of 20 swg nichrome wire as a resistor.
      8. Repeat the investigation using the 50 cm length of 26 swg nichrome wire as a resistor.
      9. Repeat the investigation using the 100 cm length of 26 swg nichrome wire as a resistor.

### Results

1. Once you have recorded the values for voltage (V) and current (I) collected during the investigation, complete the results table by:
   1. using Ohm’s law to calculate the resistance (R) for each trial
   2. calculating the average resistance for each circuit.

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| Length of wire (cm) | Thickness of wire (swg) | Voltage  (volts) | Current  (amps) | Resistance (ohms) | Average resistance (ohms) |
| 50 | 20  (0.91 mm) |  |  |  |  |
|  |  |  |
|  |  |  |
| 50 | 26  (0.46 mm) |  |  |  |  |
|  |  |  |
|  |  |  |
| 100 | 20  (0.91 mm) |  |  |  |  |
|  |  |  |
|  |  |  |
| 100 | 26  (0.46 mm) |  |  |  |  |
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### Data analysis

1. Use the data in the results table to identify the relationships in the table below.

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| Circuit measurement | Relationship to wire thickness | Relationship to wire length |
| **Resistance** |  |  |
| **Current** |  |  |
| **Voltage** |  |  |

### Discussion

1. Use the particle model to explain the relationships you identified in the data analysis table above.

## Section 3. Planning an investigation: Checking the power rating of a kettle

In Australia, most electrical appliances operate at 240 V and have a power rating stamped on them.

### Question to be investigated

Is the stated power rating of my kettle accurate?

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| **Important note:** 240 volts is a dangerously high voltage and must not be used in the planning and conducting of your investigation. The DC voltage range from a laboratory power supply should be sufficient.  **Hint:** You will need to determine the resistance of the kettle element. Refer to Sections 1 and 2 to decide what to measure to find the resistance and calculate the power of the kettle element. |

### Science report

Develop a plan for your investigation. Use the following checklist as a guide.

##### Introduction

* The aim of the investigation.
* Background information based on your ideas and findings in Section 1 and Section 2.
* Description and justification of variables to be controlled and measured.

##### Materials

* A list of everything you used in the investigation.

##### Method

* A risk assessment.
* Numbered steps detailing how you would carry out the investigation.
* A circuit diagram.

##### Results

* A data table with suitable headings and units of measurement.

##### Analysis of results

* Include any formulas used for calculations.

##### Discussion

* A description of the results and a discussion of the relationships and trends shown by the data.
* An explanation of identified relationships and trends, using scientific ideas from Section 1  
  and 2 and additional research, to justify conclusions.
* An evaluation of conclusions based on the reliability and validity of the method.
* A discussion of specific ways to improve the method so the quality of the data collected is improved.

##### Conclusion

* A summary of results relating to the investigation question.
* Suggestions of further investigations based on the findings.