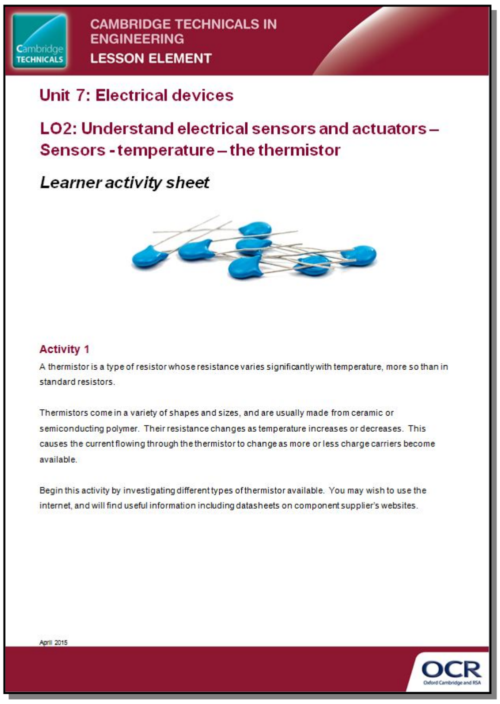
Unit 7: Electrical devices

LO2: Understand electrical sensors and actuators

Sensors – temperature – the thermistor

Instructions and answers for teachers

These instructions should accompany the OCR resource 'LO2: Understand electrical sensors and actuators – Sensors – temperature – the thermistor' *activity which supports Cambridge Technicals in Engineering Level 3.*


CAMBRIDGE TECHNICALS IN ENGINEERING
LESSON ELEMENT

Unit 7: Electrical devices

LO2: Understand electrical sensors and actuators – Sensors - temperature – the thermistor

Learner activity sheet

Activity 1

A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors.

Thermistors come in a variety of shapes and sizes, and are usually made from ceramic or semiconducting polymer. Their resistance changes as temperature increases or decreases. This causes the current flowing through the thermistor to change as more or less charge carriers become available.

Begin this activity by investigating different types of thermistor available. You may wish to use the internet, and will find useful information including datasheets on component supplier's websites.

The Activity:

In this task the students are tasked with familiarising themselves with DC networks.

This activity offers an opportunity for English skills development.

This activity offers an opportunity for maths skills development.

Suggested timings:

2 hours

Activity 1

For Activity 1 learners have been tasked to investigate the thermistor before performing an experiment using it.

A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors.

Learners may use the internet or other sources of material to complete their investigation.

Manufacturer data sheets might also prove a useful source of information.

Answers to questions:

1. **What is a NTC thermistor and how does it work?**

   The NTC thermistor has a negative temperature coefficient – meaning that the resistance of the device decreases as the temperature is raised.

   The thermistor consists of semiconductor material in which the amount of active charge carriers increases as the temperature is raised.

   For the NTC type of thermistor, the device is manufactured in order to have an approximately linear relationship between resistance and temperature over part of its operating range.

2. **What is a PTC thermistor and how does it work?**

   The PTC thermistor works on a similar principle to the NTC type – except that the resistance of the device increases as temperature rises.

   The PTC type is often termed the 'switching' type of thermistor meaning that their resistance suddenly increases at some critical temperature. However, some PTC thermistors with a linear 'resistance vs. temperature' characteristic do exist.

3. **What applications are thermistors used for?**

   Typical applications of the thermistor include:

   - Temperature control (as a temperature sensor)
   - Circuit protection
   - As an input sensor

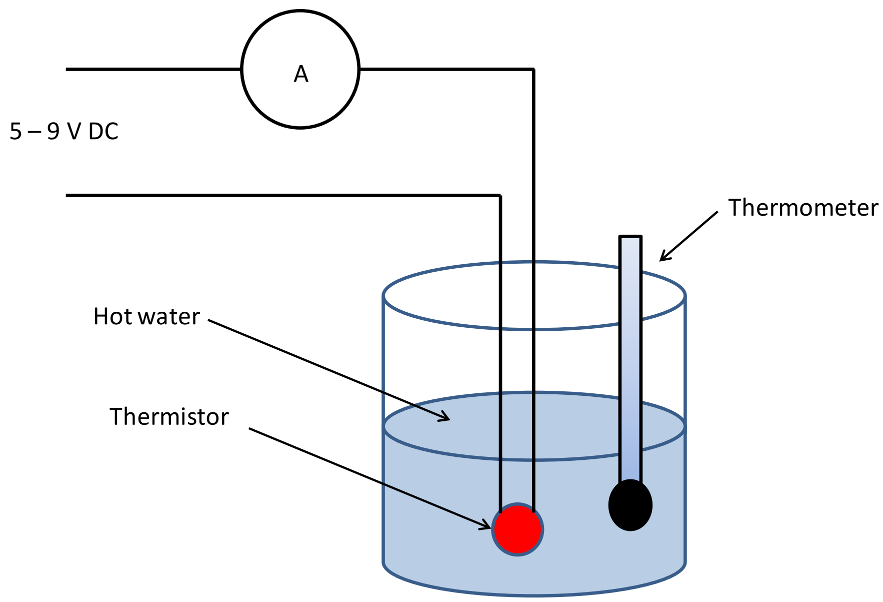
Activity 2

For Activity 2 learners are required to perform an experiment using a thermistor and hot water in order to determine its characteristics.

Teachers should select a suitable thermistor of the NTC type.

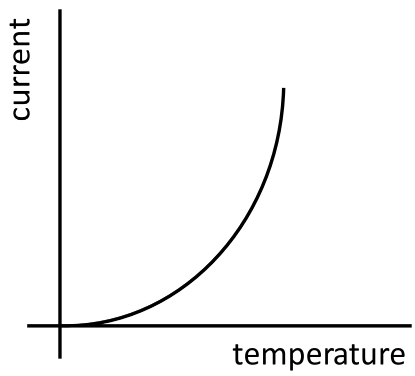
The equipment list for the experiment is shown below.

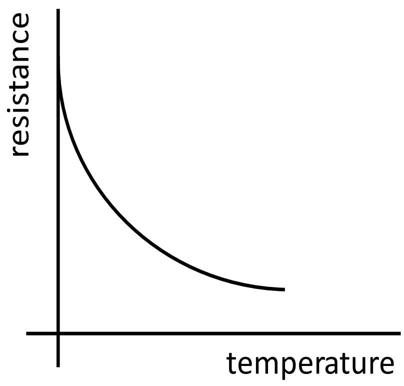
Equipment you will need:
Thermistor (an NTC type with 100Ω at 25°C is suitable)
Power supply (regulated, fixed voltage, DC)
Ammeter (A) (you could use the ammeter function in a multi-meter)
Connecting wires
Timer or stopwatch
Thermometer
Beaker
Heat resistant mat
Supply of hot water (from a kettle)



Learners should tabulate and plot their results from the experiment. In order to determine resistance of the device, learners could use Ohm's Law.

Typical graphs are shown below for current vs. temperature and resistance vs. temperature, but the shapes of the graphs will be determined by the thermistor used in the experiment. The graphs might also have a linear region.





Answers to questions:

1. **What do you notice about the shape of the graphs?**

The current vs. temperature graph shows that the thermistor allows more current to flow as temperature increases.

2. **What is happening to the resistance of the thermistor?**

Conversely resistance of the device falls with increasing temperature.

This demonstrates the increase in charge carriers within the semiconductor material as temperature rises.

3. **If you have access to the datasheet for the thermistor being used, do your results agree with the current vs. temperature and/or resistance vs. temperature graphs in the data? If not, explain why you think it does not match.**

> Learners should comment on the shape of the graphs by comparing with the datasheet for the thermistor, if available.
>
> The thermistor may have a linear region on the graph.
>
> Typical error and discrepancies will most likely be due to experimental error (e.g. misreading or errors caused by lead resistance etc) or tolerance errors within the device itself. These errors are usually corrected using calibration of the thermistor circuit.

Learners could repeat the activity using a thermocouple. The thermocouple produces a voltage output that changes with temperature, but may require more complex circuitry to perform a measurement.