

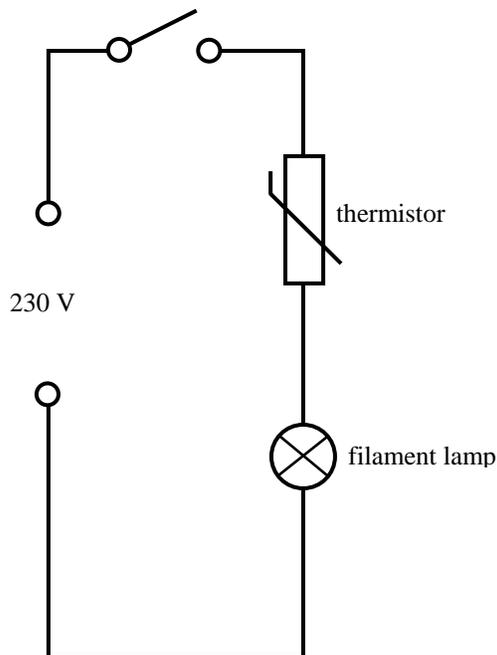
TAP110- 4: Filament lamp and thermistor in series

Before starting

Make sure you are familiar with the characteristic graphs of the filament lamp and the thermistor.

Surge current protection

1. Sketch graphs of current vs. potential difference for a filament lamp rated 230 V; 25 W. Explain the shape of the graph in terms of the effect of temperature on the conductance / resistance of the lamp.
2. Sketch graphs of current vs. potential difference for a thermistor whose resistance decreases with temperature. Explain the shape of the graph in terms of the effect of temperature on the conductance / resistance of the thermistor.
3. This circuit contains a filament lamp and thermistor in series with a 230 V supply. When the switch is closed, the lamp glows dimly at first, but then gets brighter and brighter until the lamp is lighting normally. Explain these observations.



4. How does connecting a filament lamp in series with a thermistor protect the components from a surge current?

Practical advice

This question can follow activities on electrical characteristics. The student is expected to remember the shape of the characteristics. It is important for students to relate the characteristics to the change in conductance / resistance with temperature. The observations in question 3 can be demonstrated using a torch bulb of high resistance connected to a low voltage supply. It is not wise, for safety reasons, to use the mains voltage for laboratory demonstrations of the effect. A pair of circuits, one with and one without a thermistor in series and switched on together, neatly shows the delay.

Social and human context

Many devices, from modern lighting systems to computers, need protection against surges in current, particularly when turning them on.

Answers and worked solutions

1. With current on the y -axis and pd on the x -axis, the graph should slope steeply for low currents (low resistance, high conductance), and then curve to become flatter at high currents (higher resistance, lower conductance).
2. With current on the y -axis and pd on the x -axis, the curve should have a small slope to begin with (high resistance, low conductance at small currents), and then start to rise more steeply (lower resistance, higher conductance, as the thermistor becomes hotter).
3. As the filament wire gets hot the conductance decreases and the resistance increases. As the thermistor gets hotter its conductance increases and the resistance decreases.
4. When the switch is closed both components are cold. The thermistor has a high resistance which limits the current. Most of the potential difference is across the thermistor and so most of the power is dissipated in the thermistor. This heats up the thermistor so its conductance increases and more of the potential difference is applied across the filament lamp. More power is dissipated by the lamp which now glows brighter. The bulb glows more and more strongly as the thermistor's conductance increases. As the filament gets hotter its resistance increases. Eventually the situation stabilises when the resistance of the filament is far greater than that of the thermistor, so that nearly all the power is dissipated by the lamp.
5. Surge currents often occur when circuits are turned on and this large initial current, although only lasting for a fraction of a second, can still overload a component. The high resistance of the lamp (when cold) limits the size of the surge current.

External references

This activity is taken from Advancing Physics Chapter 2, 280X