Energy-saving bulbs – not such a bright idea?

Stuart St John

The recent blackouts in California are a reminder to us that making efficient use of electricity is not unimportant. GCSE science teaches children about the need to find renewable energy resources, and perhaps as an extension to this we ought to discuss with pupils the ways in which we can become more energy efficient.

I have long had an interest in energy-saving light-bulbs – and more so in recent years since they have dropped to a sensible price. During the last few months I discovered that a well-known Swedish furniture store was selling them for £1.50 each and this coincided with the time in our AS physics course when we were due to look at the characteristics of various sensing devices, including thermistors and light-dependent resistors (LDRs). It struck me that a group of sixth-formers armed with LDRs might be an interesting way to test the manufacturer's claim that my 11 W energy-saving light-bulb (strictly speaking, a compact fluorescent lamp, although this isn't what the general public calls them!) has the same light output as a 60 W incandescent bulb.

Procedure

The degree of help given to a particular group of students could vary, but I chose to throw mine in at the deep end to begin with. The challenge was presented, as were the materials available to them. The group were then encouraged to discuss possible ways forward amongst themselves with the occasional prompt to keep them thinking along sensible lines. The use of potential dividers (also part of the 'Electrons & Photons' module in OCR A-level Specification A, Module 2822, 5.2.2(l)) was thrown into the discussion, as were the issues of test conditions and the possible use of the darkroom. It was generally agreed that we didn't actually need to use a darkroom, so long as we could be certain that the ambient lighting was kept the same. After all, we weren't going to be measuring any absolute values – rather a comparison between the two types of light-bulb. A range of commonly available incandescent bulbs (25, 40, 60 and 100 watt) was then tested to produce a calibration curve (Figure 2). The beauty of

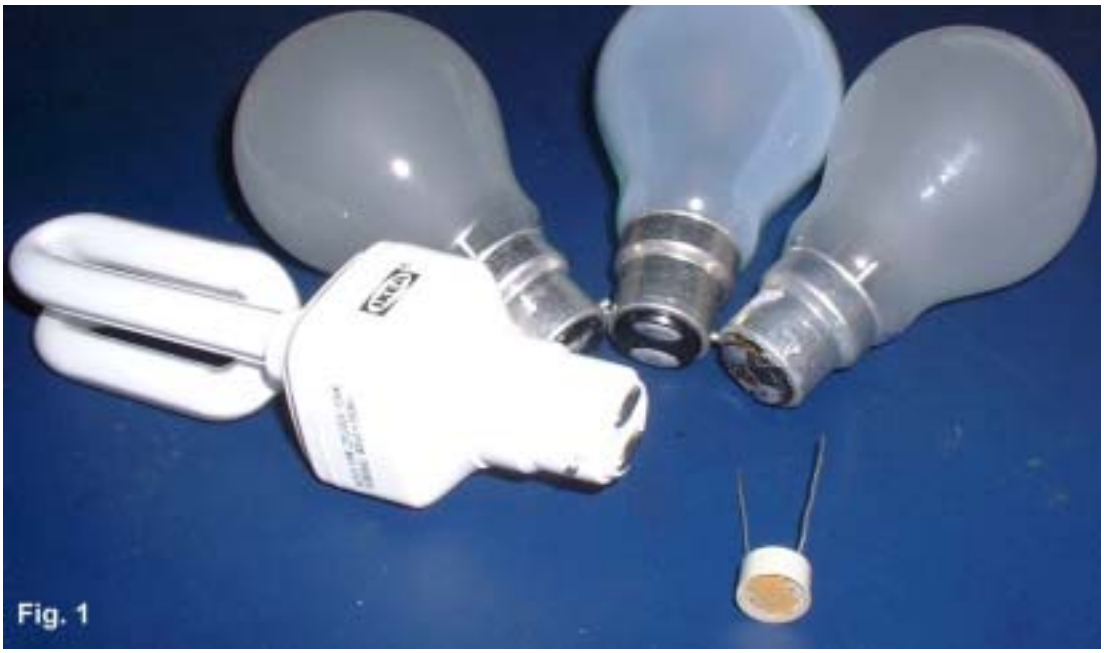

Figure 1 Materials needed.

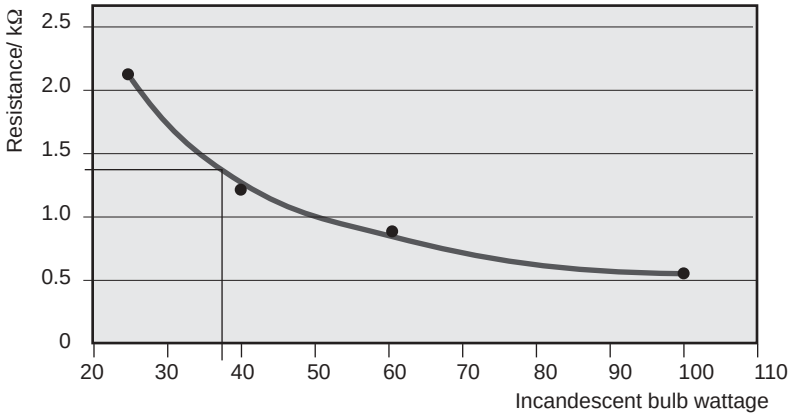

Figure 2 Graph of LDR resistance against incandescent bulb wattage, with reading for energy-saving bulb added.

this approach was that a direct relationship between LDR resistance and conventional light-bulb wattage could be drawn up. The precise distance of the light from the LDR was not vital, so long as all the bulbs were kept at the same distance. (We used a desk lamp with a parabolic reflector, and the distance was taken between the sensor and the nearest point on the bulb.) In this way useful data could be obtained without resorting to complex calculations or so much as mentioning candelas, lumens or lux!

Results

One of the first things we noticed (and this may be well known by those who use energy-saving bulbs in their homes) was that energy-saving bulbs seem to be quite a lot dimmer when you first switch them on. In the past I had wondered if it might be due to my eyes adjusting, but seeing the needle on the meter moving convinced me that they take between 3 and 5 minutes to start emitting their full light output. Obviously this raised a number of questions about fair testing which would reinforce some of the ideas introduced at GCSE quite nicely. The somewhat disturbing discovery, once the needle had stopped moving, was that my so-called '60 watt equivalent' bulb only equated to a 37 watt incandescent bulb according to our calibration chart!

Further investigation

A group of students who really took to the investigation would soon come up with a multitude of further investigations, given suitable prompting. For instance, the question 'Do paintings and photographs look the same under fluorescent light as they do under incandescent light' might lead to them looking into how the light spectra produced by the two methods (white hot filament versus fluorescent coating) differ, and whether the composition of the 'white' light emitted affects an LDR differently. With any group there is certainly the potential to put some 'key skills' to good use and write to the bulb manufacturers requesting information on how they came by their own definition of '60 watt equivalence'.

Presented to a group of post-16 students in the form of a challenge, this investigation could prove to be quite a fruitful teaching tool across a number of subject areas (e.g. experimental method, calibration, modelling and interpreting data graphically), not just the potential dividers/LDR investigation I originally planned.

As yet I haven't contacted trading standards ...

Stuart St John wrote this article during his second term as a PGCE physics student at Birmingham University School of Education.