LEDs – Lights of the Future?

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What are LEDs?

(1)

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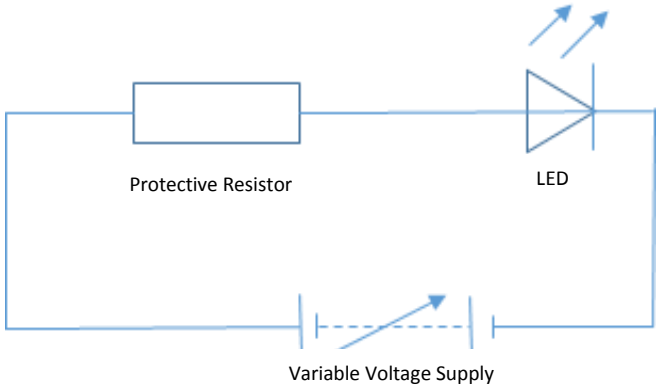
LEDs – How Good Are They?

Interview with Mr R Gray (Physics Teacher)

LED stands for 'Light-emitting diode'. They are made by creating a junction of two special materials known as semiconductors. When there is an electric current in the junction, electrical energy is transformed into light.
However, care is required as too high a voltage across (or too high a current through) the junction will destroy it.
Therefore a protective resistor must be connected in series with the LED as shown in the circuit diagram.



Notice that the LED will not light if the connections from the supply are reversed. Increasing the voltage (p.d.) across the LED results in increased brightness. The LED will light with only a small current.

LEDs do not get hot when in operation – in contrast with many other light sources. It is possible to buy LEDs that emit red, green, yellow, blue and white light. (2)

So How Common Are LEDs?
The answer is – very common indeed! LEDs are very tiny light bulbs so they are VERY useful for lots of different jobs. They form the numbers on digital clocks, they transmit information from remote controls, and tell you when your appliances are turned on. Large numbers of LEDs can form images on a jumbo television screen. (3)

LED's – How Good Are They?

An interview with Mr R Gray, Physics Teacher at Banchory Academy

Q: Mr Gray, can you tell us a little about your interest in light bulbs?

A: Well, we use light bulbs every day and for loads of uses. Sometimes it's to light up a room, sometimes it's to tell us that a piece of equipment is switched on. So it's important that we choose the best light bulb for the job.

Q: The S4 classes have done an experiment to measure the brightness of an LED bulb as the distance away from the bulb increases. We found that the brightness decreases rapidly over the first few centimetres and then decreases more slowly. Can you tell us if other light bulbs show the same behaviour?

A: Ah, that's interesting. The Physics teachers here did their own experiment. It was exactly the same as yours except that we measured the brightness of an LED bulb, a halogen bulb and a fluorescent bulb. The results are shown in the graphs on the next page.

Q: So it looks like the halogen bulb is brightest and the LED bulb least bright when you're right up close?

A: Yes, that's right. But in real life it's unlikely that you would be that close to a bulb. You'd be a few centimetres away. Look a little more closely at the light intensity readings for all three bulbs at 5cm. The scale on the graph is difficult, but you could read off the intensities at 5cm and compare them and that might be interesting.

Q: Did you use the same measurement technique for all the bulbs?

A: Yes, exactly the same setup that you used and have written up in your investigation jotters.

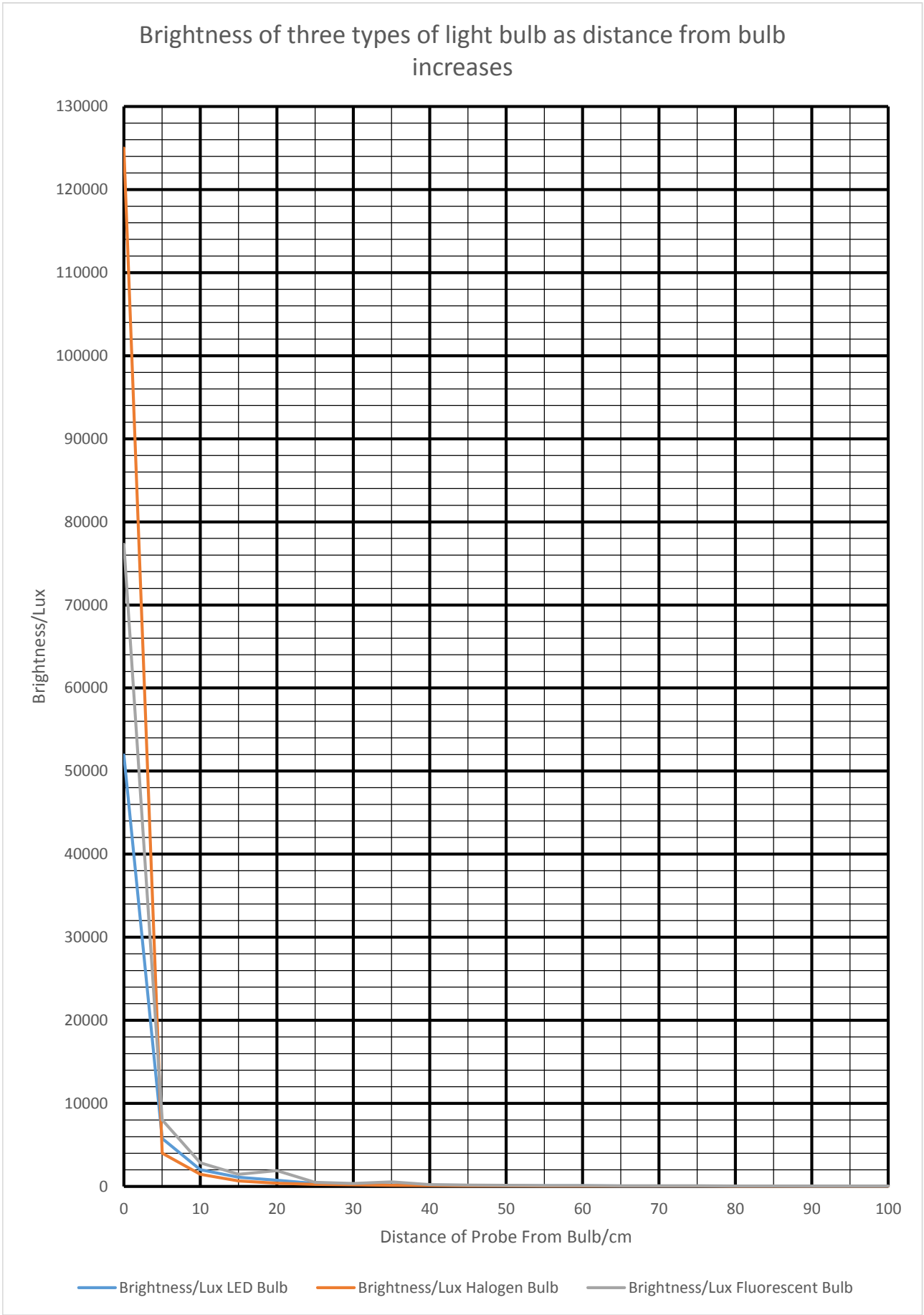
Q: What about the light sensor?

A: Yes, it was the same light sensor & data logger set up, reading in lux, that you used.

Q: Did you find out anything else about these bulbs that might be helpful?

A: Yes, we looked at the specifications of the bulbs and made a table of the data that we found.

Type of Bulb	Power Consumption (W)	Light Production (lumen)	Expected Lifetime (h)
TCP LED Energy Saver	5	330	25 000
TCP Halogen Saver	18	210	2 000
Eveready Micro Spiral Fluorescent	9	450	10 000


Brightness of three types of light bulb as distance from bulb increases
Brightness/Lux
130000
120000
110000
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
0
10
20
30
40
50
60
70
80
90
100
Distance of Probe From Bulb/cm
Brightness/Lux LED Bulb
Brightness/Lux Halogen Bulb
Brightness/Lux Fluorescent Bulb

(4)

Q: What does 'lumen' mean?

A: It measures the light intensity over an area. So 1 lumen is equivalent to 1 lux per square metre. The light sensor that we used for the experiment measured the light intensity at a point so the units of lux were more appropriate.

Q: There's a lot of data here. How could we use it to help us decide which light bulb is best for lighting at home?

A: I think it would be important to know the amount of light production per unit power consumption – lumens per watt. Then you could decide which bulb was the most efficient, compared to its lifetime.

Q: Thank you Mr Gray. That was very interesting!

A: No problem!

References

(1) House of Orange (2010), *LED 101 – Pt 2*. Available at: http://www.houseoforange.co.uk/articles/Blog/LED_101_-_Pt_2_550.html (Date accessed: 29th January 2016)

(2) National 5 Physics with Answers (page 19) by Arthur Baillie, pub Hodder Gibson

(3) Tom Harris & Wesley Fenlon (2002) "How Light Emitting Diodes Work". Available at: HowStuffWorks.com. http://electronics.howstuffworks.com/led.htm (Date accessed: 29th January 2016)

(4) Experiment to compare light output (lux) as a function of distance from bulb for an LED bulb, a halogen bulb and a fluorescent bulb, carried out by Physics Teachers, Banchory Academy.

(5) Data acquired from packaging of the light bulbs studied.