



## Weird & Wireless: How can light have temperature?



*Welcome again to the wonderful but sometimes weird world of wireless comms, written by Joel Young, [CTO of Digi International](#).*

When I go to buy a light bulb, the packages seem to indicate light or colour temperature in something called Kelvin. What is this and how can light have temperature?

For me this is a really fun topic because it connects a label on the packaging of common consumer product, i.e. light bulbs, to some of the cool properties of thermal radiation, worked on by such physics legends as Max Planck and Albert Einstein.

In fact, these very properties helped disprove many of the commonly held notions surrounding classical physics, replacing them with the modern notion of Quantum mechanics.

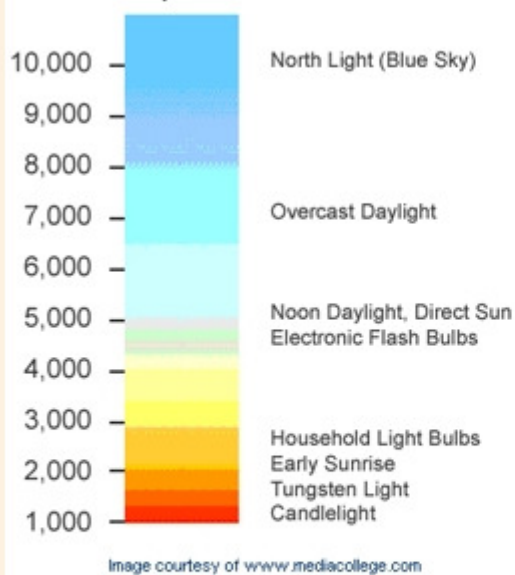
Don't worry, for those of you that have a fear of upper level physics and quantum mechanics, I'm going to keep it simple and perhaps point out a little bit of irony along the way.

To begin, if you want to keep it simple and don't care about the true meaning of the units Kelvin, just note that the colour temperature provides, in easy terms, the amount of blue or red you perceive in the light.

Effectively, the lower the number, the more reddish the light appears. The higher the number, the bluer the light appears. One point of irony for me is that we often say that a light source is "warmer" when it has more red, but a "warmer" light actually has a lower colour temperature.

The following figure illustrates the scale of colour temperature that I found at [www.mediacollege.com](http://www.mediacollege.com).

### Colour Temperatures in the Kelvin Scale



Note that somewhere in the middle, around say 4000 to 5000 Kelvin, the light looks pretty "white".

This means that the spread of visible light covers close to an even mix of light frequencies. So when you are replacing your old incandescent bulbs, be it tungsten or halogen, if you want the lights to look the same, look for a colour temperature in the 4000 or lower range. You can find CFLs in this range, but all of the LEDs I've found tend to be much bluer.

Note that this is because they are actually more efficient light sources and that low temperature CFLs are effectively "cheating" a bit by filtering out some of the blue light.

For those of you that don't care about the true meaning of Kelvin, you can stop reading, others can read on. To understand colour temperature and Kelvin, you need to really know two things.

First, the unit Kelvin is the scientific scale for measuring temperature where 0 is absolute zero - effectively as cold as anything in the universe can get, and the size of one Kelvin degree is the same as 1 Celsius degree. This means 0 Kelvins equals -273 Celsius, room temperature is close to 300 Kelvins and the boiling point of water is 373 Kelvins.

Next it is important to note that objects, as they get warmer spew electromagnetic radiation. The problem is that most objects also absorb and reflect electromagnetic radiation as well.

So, what if we could find an object that didn't reflect any radiation, but absorbed it all? In physics we call this a "black body" because it looks black no matter how much light you throw at it.

Now, it turns out that because all incoming electromagnetic radiation is absorbed (not reflected or scattered), the electromagnetic radiation emitted from a black body is directly related to its temperature. So, if you could heat a black body to say 1,000 Kelvin, it would glow like a candle. If you could heat it to 10,000 Kelvin then it would glow a bright blue.

While we don't have any real black bodies on earth, we have all probably seen a pretty good approximation.

Take a hot iron in a blacksmith's shop for example. When it is really hot, just pulled from the fire, it might glow white and we might call it "white hot". As it cools, it goes to orange and then red. Our man Lord Kelvin discovered this when looking at the colours of hot coals.

For those of you puzzled by this phenomenon, remember that the energy increases with frequency - so it is natural that a higher temperature would cause a shift in radiated output to higher frequency light. Also remember that it doesn't stop with visible light spectrum - as we get to higher energy, the peak shift to ultra violet and all of those nasty cancer causers.

Just remember - what we call warm is really cold and what we call cold is really warm.

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