Blue Moon

I have a clear memory from when I was a child in Guildford, Surrey, in the early 1960s. One evening I saw a moon which was distinctly blue. Sadly, I recall no other details such as time or year, but I know I was outdoors. Could this memory be correct? Is a blue moon possible and if so, what atmospheric conditions are necessary and how often could it happen? There must be something in the saying "once in a blue moon".

The questioner's memory is quite reliable: the Moon can indeed appear blue on rare occasions, and so can the Sun. This is caused by anomalous scattering of the moonlight or sunlight by fine particles of ash or dust such as those produced during volcanic eruptions or large forest fires. Blue moons and suns were widely observed after the eruption of Krakatoa in 1883.

More recently, in a paper published in 1951 (**Monthly Notices of the Royal Astronomical Society**, vol 111, p 477), R. Wilson reported a "blue sun" which was observed over Edinburgh on the afternoon of 26 September 1950 (see below for a first-hand account). The Sun "was observed to be a deep indigo blue" from 3pm, when it was first noticed, until sunset. The following day, the Sun's colour had returned to normal.

Wilson, who worked at the Royal Observatory, had the presence of mind to take a spectrogram of the blue sun. This shows a marked extinction of the red part of the solar spectrum when compared to a spectrogram of the "normal" Sun, so the effect was not a product of the observer's imagination.

Wilson noted that extensive forest fires had been burning in Alberta, Canada, on 23 September. The smoke clouds had reached eastern Canada on 24 September, when they were thick enough to blot out the Sun. When the Sun did become visible again, it was purple or blue. From Atlantic weather charts, Wilson calculated that the smoke would have reached Scotland by 26 September.

Normally, blue light is scattered more strongly than red light by dust in the atmosphere. This is why the Sun appears red at sunrise and sunset. However, when the particles have a mean radius between 0.4 and 0.9 micrometres and an almost uniform size distribution, they scatter longer wavelengths (red light) more strongly, giving rise to blue moons and blue suns.

According to Bohren and Huffman in **Absorption and Scattering of Light by Small Particles** published by John Wiley and Sons, the uniform size distribution is a key factor in anomalous scattering. Few processes in nature give rise to such a size distribution, which is why blue moons and blue suns are so rare.

As for the old expression "blue moon", it is at least five hundred years old. Philip Hoscock has written an entertaining article about both its history and its folklore which can be found at www. griffithobs.org/IPSBlueMoon.html.

Insular electrons

A relative was given an electric toothbrush as a Christmas present which, sadly, began a family argument. The bottom of the toothbrush is plastic and the cradle of the recharging device is also plastic. None of us could work out how the electrons were able to move from recharger to toothbrush through an insulating material.

Electrons do not have to move directly from the recharger to the toothbrush. As you correctly observe, there are no electrical contacts. It works because there is a coil in the bottom of the toothbrush and another in the recharger just beneath where the toothbrush sits. When the toothbrush rests on the recharger the two coils sit very close together and effectively form a conventional electrical transformer. The recharger coil draws current from the mains to produce an alternating magnetic field. This field then induces an alternating current in the coil of the toothbrush, and this is converted into direct current to charge the battery.

To increase the efficiency of the process, the recharger often has a vertical spigot which fits into a hole in the bottom of the toothbrush. Not only does this secure the toothbrush in its holder, but it is filled with a magnetic material, such as iron, to form a core that concentrates the alternating magnetic field.

This method of recharging removes the need for contacts, which would have to be kept clean and would get wet and become contaminated with toothpaste.

The answer is electromagnetic induction. As Michael Faraday famously discovered, if you vary the electric current in a coil of wire, it produces a varying magnetic field that can induce a current in a secondary coil placed nearby.

In at least one electric toothbrush system, the primary coil is in the charger, while the secondary is in the toothbrush, both well insulated by the supporting plastic. To make such small coils work satisfactorily, the charger first converts the 50-hertz mains supply into a much higher-frequency alternating current of around 20 kilohertz.

During a nocturnal walk in the woods of the Belgian Ardennes, I found a piece of rotten wood. To my surprise, I saw a soft glow inside. As I write this, after 24 hours in darkness, the wood is still glowing. What causes this?

This type of glow was noted by Aristotle more than 2000 years ago. It is a bioluminescence caused by a wood-rotting fungus and is kin to the light of the glow-worm, firefly and lantern fish. The mechanism is the oxidation of luciferin, a light-emitting compound, mediated by the enzyme luciferase.

Many microorganisms luminesce, including the vegetative filaments of fungi. One of the most common and spectacular is the honey fungus toadstool (*Armillaria mellea*). It is a serious and destructive parasite of many trees and is probably what the questioner saw. The infested wood, and the strap-like strands which spread the fungus beneath the bark, glow with a greenish light. A closely related North American toadstool (*Clitocybe illudens*) is named Jack-o'-lantern for the same reason.