

Interactive TV - Why do I hear a loud "boing" when I turn on my TV set? I can't imagine which electronic component makes noises like this.

The "boing" is caused by the degaussing circuitry used in all colour TVs and monitors. The TV tube steers three electron beams to a fine pattern of phosphor dots in the three primary colours on the screen. Just before they hit the screen, they pass through a perforated metal mask that only lets the beams through if they are heading for the right colour phosphor. Any errors, and the beam hits the wrong-coloured phosphor, resulting in distorted colours on the screen.

Stray magnetic fields can divert the beams. Left to itself, the metalwork of the TV, especially the colour mask, becomes randomly magnetised. To prevent this, the TV has a large demagnetising coil which is operated each time you switch on. The circuitry sends a strong pulse of alternating current through the coil. The alternating field has to be quite strong to demagnetise the tube, and it rattles both the mask and any other ferrous metalwork in the TV, producing the "boing".

Network nightmare - How does a mobile phone network keep track of the whereabouts every individual's phone, so that an incoming call can be directed to the right one?

When a mobile phone is switched on, it takes a short time to be connected to the network. This is because the phone looks for the nearest base station, basically an antenna. When it finds it, the phone identifies itself by giving its number and other details. After the base station registers the phone's location with the network, calls can be routed to it from that base station.

As a user moves out of the area covered by a station the base that is "losing" the phone as its signal weakens sends a broadcast to adjacent stations. Whichever of these stations is picking up the phone's signal communicates with the other base, and a "hand-off" is produced, where the phone passes from one to the other. This is not noticeable to the user.

The Blue Room - Why is it that a room illuminated by a television appears blue to a person outside regardless of the colours that are being displayed on the screen?

Colour television pictures are produced by three different colours: red, green and blue. These combine to create a whitish light with a colour temperature close to that of daylight (5500 to 6500 kelvin).

Colour temperature is a way of describing the relative amounts of the different colours that make up the light from a particular source. It can be thought of roughly as the temperature an object would need to be heated to give off light with that mixture of wavelengths. At low temperatures, low-energy colours such as red and yellow predominate; at higher temperatures the proportions of green or blue increase.

For example, standard tungsten light bulbs have a colour temperature of 3200 K and are very yellow. Your eyes adjust to this light, making it appear whiter and more like daylight. At twilight or at night, anything with a higher colour temperature than tungsten lights, such as a television, appears distinctly blue.

The same effect is seen if you look out of a room lit by tungsten light. The twilight appears particularly blue, and yet if you were to go outside and look at the same scene, the eye would no longer compare it to the lit room and the colours would appear more neutral.

The converse is also true. Viewed from outside, the windows of houses lit by tungsten light sources look distinctly yellow. Fluorescent sources generally have a spectrum much closer to that of daylight and do not produce the same effect.

Forecourt fear - My mobile phone company insists that, for safety reasons, I should switch off my phone when I'm in a petrol filling station. What could happen if I forgot to do so and how real is the danger? Have any incidents actually been caused by mobile phones in filling stations?

There is a small but real danger in using a mobile phone at a petrol filling station. The batteries that are used in the phone can deliver enough power to ignite petrol, diesel or liquefied petroleum gas vapour and the ringer (usually a piezoelectric device) uses more than 100 volts for excitation. There is also a risk of the radio frequency signal inducing a current in any metal that may be nearby. Because a mobile phone emits a 5-watt signal, this really could ignite fuel vapour.

So in the worst-case scenario of a fuel spill soaking a customer and then the customer's phone ringing, a fire is possible. To avoid litigation in the unlikely event of this happening, it is in the best interests of phone companies and also petrol companies to say: "We told you so".

However, it might be worth considering that the probability of a fire being caused by static discharges (the sparks that give you a jolt when you touch a car after driving it on a dry day) is a few orders of magnitude higher than the mobile-phone scenario. Even so, mobile phones (and other transmitters) are banned from most petrochemical plants.

Sealed in light - When I am opening some types of self-sealing envelopes I notice that there is a purple fluorescent effect within the gum. It only lasts for a very short time, but can be repeated if I reseal the envelope and pull it apart again. What causes this effect?

The coloured glow is a form of chemiluminescence. Separating the gummed surfaces requires energy that breaks the attractive forces between the molecules of gum. Presumably, the act of pulling apart the surfaces supplies excess energy to the gum molecules that lifts them into an excited state. As they decay back to their normal state the energy is released in the form of visible light. The difference in energy between the excited and ground states defines the wavelength and hence the colour of the light produced; in this case purple.

This phenomenon is different from fluorescence, where light (often ultraviolet) is absorbed and then re-emitted at a longer wavelength (in the visible spectrum). Fluorescence gives rise to "Day-Glo" colours and the blue glow you might observe while drinking tonic water near one of the ultraviolet lamps often found in nightclubs.

Does my bum... - I recently remarked to a female friend of mine that a lot of the girls in Swindon wear black trousers and denim jackets. She told me it was because black trousers "make your bum look smaller". Is this true? Can it be scientifically proven?

Yes, your bum does look smaller when you dress in black, at least if viewed from behind. The reason is that we can only perceive shapes if what we see appears in different shades or colours. If one wore white trousers the shape of your behind could be inferred from the slight shadows cast by its contour. In black clothing, the shadows are invisible and the shape appears flat.

It is also the reason why facial features need to be greatly exaggerated on dark bronze sculptures.

Of course, your bottom will reveal its true size in profile, but black, especially matt, will save you a lot of exercise and dieting.

Lamp Light - One afternoon I turned on an incandescent lamp and noticed that an object's shadow was blue. I conducted some more experiments and found that the phenomenon only happened when sunlight was combined with the light from the incandescent lamp. I then tried lamps of many colours, with the results shown below. Why does the shadow change colour? Lamp's colour/Shadow's colour: Yellow/Blue, Red/Green, Pink/Green, Green/Purple, Blue/Red

Coloured shadows are a well-known optical phenomenon, although most people do not follow them up as carefully as your correspondent. Visible light covers a range of wavelengths between about 0.4 micrometres (violet) and 0.7 micrometres (red). The colours of the rainbow are created by all visible wavelengths, including that for violet and red. Most light sources have a broad spectrum that is, they emit a wide range of wavelengths. White light consists of a mixture of all the wavelengths in the right proportions.

The eye contains three kinds of colour photoreceptors, known as cones, which are sensitive to different wavelengths of visible light. The three types of cones have their highest sensitivity in the blue, green and red regions of the spectrum respectively. Each visible colour produces a unique combination of sensory signals from the different cones.

In addition, the brain does a lot of image processing, so the colour perceived depends not only on its actual wavelength spectrum, but also on its surroundings. In particular, if an area is illuminated with a broad range of wavelengths, the eye will tend to see the illumination as white.

Taking the example of the yellow incandescent lamp, if this is the only light source available, the eye and brain will tend to adjust to this colour and see it as white, especially since it is only slightly yellow. The shadow, of course, will be black.

If we now let in some daylight, the eye/brain will recalibrate to make the mixture of yellow and daylight appear white. The shadow still receives no light from the yellow lamp, but it is receiving daylight. Because the white of the daylight results from a different, less yellow combination of wavelengths, it appears bluer than the white of the surroundings.

If the daylight is directional, then there should be a second shadow, where the daylight is blocked and the only illumination is caused by the yellow light. This shadow should, of course, be yellow.

The other colours can be explained in the same way. The colour of the shadow corresponds to the complementary colour of the light, but the intensity of the colour is limited by the broad spectrum of daylight. To see the best collection of coloured shadows, you should shut out the sun and use several lamps of different colours instead. If you combine blue, green and red lamps, you can make a pretty good white illuminating light, and spectacular coloured shadows.

Goggle-eyed - It has always intrigued me that I can see clearly underwater if I wear goggles or a mask, yet if I don't everything is blurred. What is it about my eyes or the water that causes this effect?

The reason that you see this effect is the same reason a spoon looks bent when you immerse it in a glass of water. Light travels more slowly through water than it does through air. When light moves from one medium to another, it changes speed, and as a result the beam is bent, or refracted. The amount of bending depends on the ratio of the speed of light through each medium.

The human eye is delicately balanced to make sure that light coming in through the pupil is focused onto the retina at the back of the eye. But it is optimised for light coming from air and hitting the surface of the eye. The eye has evolved to take account of the refraction that takes place at the interface between air and eye, and gives a focused image on the retina.

However, when light comes directly from water to the eye, the light is bent by a different amount, so the light is not correctly focused. Goggles restore the air/eye interface and normal sight is resumed.

This phenomenon of light bending when it goes through different media is used to our advantage in spectacles, where lenses bend the light to correct imperfect vision.