Exploring wave motion
Diffraction of light

Commentary
So what about light? Does light spread out after passing through an aperture? Well, here's an aperture. And if I put this piece of card up here, and we look at the shadow cast by this aperture, then it doesn't seem to be causing much diffraction of the light. This nice sharp outline seems to imply that light travels in straight lines. So does it propagate like a wave or not? Well, light does propagate like a wave, and it does get diffracted. However, the wavelength is very small and this aperture is far too large to cause any appreciable diffraction. Remember how the diffraction of the water waves became less apparent as I made the aperture much bigger than the wavelength. To demonstrate diffraction with light waves I need to use much smaller apertures. I also need to use a different light source, one with a very narrow beam and a very narrow range of wavelengths. And in order to achieve that I'll be using this laser beam and, of course, I'll be taking care not to look directly into the beam. Now this slide contains the apertures I'll be using and in fact the first one is just 60 micrometres wide, or 60 microns for short. That's about one-sixteenth of a millimetre. So, if I place this slide in front of the laser beam, you'll see the diffraction pattern on the screen over there. The aperture's aligned vertically and that sharp spot of light has clearly been spread out, or diffracted, in a horizontal direction by the small aperture. You can see that the diffraction pattern consists of a series of dark and bright regions spaced regularly either side of the centre. The image appears bright in regions of so-called constructive interference, where light waves from different parts of the aperture combine to reinforce each other, and dark in regions of destructive interference where light waves combine in such a way that they cancel each other out. The double-headed arrow indicates the width of the central bright region. This spreading of the laser beam shows that light does indeed propagate like a wave. Now if you remember with the water waves, you saw that changing the aperture changed the amount of diffraction. So again here, if I use a smaller aperture, you should see that the diffraction pattern spreads out more. This next aperture's just 30 microns wide. Again, the double-headed arrow indicates the separation of the first dark regions on each side of the centre. And if I swap again to an aperture that's 120 microns wide, you can see that the diffraction pattern becomes less spread out. So this is exactly the same effect we saw with the water waves, the spread of the diffraction pattern increases with a narrower aperture, and decreases with a wider one. Now I'm going to use a different laser. This one produces green laser light and I've already put the 60 micron aperture in front of it, so let's have a look at the diffraction pattern produced in this case. Well, if you compare this pattern with the one produced by red light passing through the same aperture, you should be able to see that the green pattern is less spread out than the red one. So, how can you explain this result? Well, since I've used the same aperture, it must be something to do with the light. And, in fact, it's the wavelength. Now if you remember, there was less spreading of the water waves by the aperture when their wavelength was reduced and so the conclusion is that the green laser light must have a smaller wavelength than the red laser light. The different colours of visible light are simply the way our eyes interpret the different wavelengths. And outside the range of visible light are other forms of electromagnetic radiation which also show all the properties of waves. And within the visible range, the familiar rainbow of colours, red light has the longest wavelength and blue light the shortest. As for all waves, the frequency multiplied by the wavelength is the speed of the wave, which for light has the value of three times ten to the power eight metres per second, and is given the special symbol 'c'.