The Goethe Prism

Colours are the deeds and sufferings of light. J.W. von Goethe

Johann Wolfgang von Goethe, one of the greatest German poets, is less known as a natural scientist, although he himself considered his Theory of Colours to be more important than all his poetical works. He developed his own method to gain insights in the nature of colours: He always started from the phenomenon as it represented itself to the observer, who thus became an integral part of the experiment.

The beginning of his research into the nature of colours can be dated to May 17 1791, when he was about to send back a prism he had borrowed from a friend and cast a last glace through it onto a sunlit wall in his room. According to his knowledge of Newton's theory of colours he expected to see colours there, but didn't see any. Only when he looked at the border of an adjoining dark space could he see impressive coloured edges.

This experience of colours occurring at the border between a bright and a dark space, and thus from an encounter of light and darkness, led him to a concept of colour which was in contradiction to Newton who had taught that all colours were contained in sunlight, which was then decomposed into its components by the prism. From this day on Goethe tried to prove Newton to be wrong.

Goethe spent decades of his life on his colour theory, but in the end he had to acknowledge that most scientists of his time, though not all, rejected his new ideas and supported Newton's. Today it has become clearer that Goethe's and Newton's approaches not only differed in their methods but also in their objectives and therefore can be seen as complementing each other. Not a few people today hold Goethe's colour theory in high esteem, especially in the fields of arts and colour psychology. All this makes it very interesting to reenact some of Goethe's experiments with a prism.

When do colours emerge from the apparently colourless sunlight?

Everybody knows the rainbow which turns sunlight into colours, but also when falling on a thin film of oil, or onto a coloured surface, or through a coloured filter "white" or rather colourless light changes into coloured light. The blue of the sky is the result of sunlight refracted when entering the earth's atmosphere. Without an atmosphere we would have a black sky 24 hours a day. And, last not least, colours appear when light passes a prism.

Try the following experiments with your Goethe-Prism and let yourself be surprised:

1. Hold the prism horizontally before your eye and look through one of the long sides. Besides a picture obviously caused by reflection and without any special colour effects, you will also see another one with coloured rims. Here the path of your view is deflected.

In which direction is it deflected? Towards the edge of the prism or away from it?

2. Turn the prism very slowly around its longitudinal axis.

When do the coloured rims become strongest and best visible?

3. Place some black and white pieces of paper or some other material on top of each other in such a way as to form the figures A, B and C (see below).

Which colours do you see at the borders between black and white and white and black?
What happens with the coloured rims when you first look at figure A, then figures B and C?
Can you find a difference between the left and the right halves of the figures?

4. The colours made visible by the prism are called a spectrum. In experiment 3 you found the spectrum on the left side getting more and more sharply determined, but also weaker. On the right side you also found a spectrum, but it showed the complementary (opposite) colours. Now look again at these spectrums using different sources of light: daylight, incandescent light bulbs, energy saving (fluorescent) lamps, bluish white street lighting (mercury vapour lamps), yellowish street lighting (sodium discharge lamp), light diodes of different colours.

Which light source produces the strongest spectral colours?
Which light sources produce smooth transitions between the spectral colours and which sharp limitations without transitions?

5. Let sunlight shine through the prism and look out for the place where a spectrum appears. This is easier if the room where the spectrum is to appear is dark, and will help much if you close the curtains or the shutters almost completely, leaving only a small opening for a ray of light.

Which colour observation can you make?
Do the colours change when you turn the prism slowly around its axis?
Which way does the light take through the prism when the spectral colours are strongest?

6. Put a sheet of white paper where the prism appears in step 5.

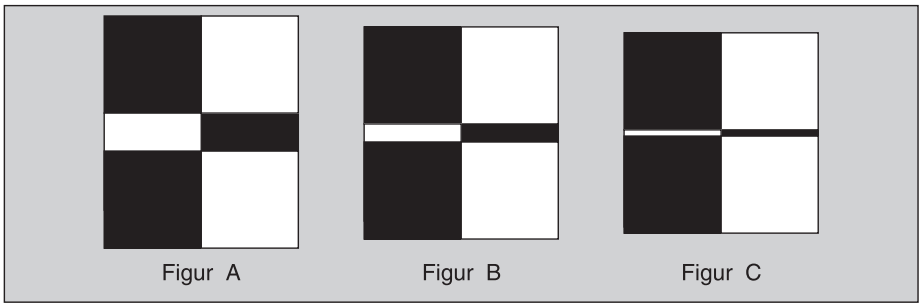
Does the spectrum change when you change the distance between paper and prism?
Which colours do you see when the paper is very close behind the prism?
Does the spectrum change when you let it shine on a coloured piece of paper instead of a white one?

We wish you a lot of fun playing and experimenting with your Goethe-prism!

AstroMedia

Hands-on Science Series

www.astromedia-verlag.de
Article No 573.GPR



Figur A Figur B Figur C