REFRACTION IN A GLASS OF WATER

05/03/2015

MATERIAL

- Curved glasses
- Water
- Cardboards
- Camera

PROCEDURE

Put a cardboard with a drawn or printed illustration behind a glass filled with water. Observe, photography and try to understand the resulting image.

The glass and the water will disturb the illustration in several aspect. For example, cylindrical shape of glass causes that system operates as a water converging lens.

This phenomena can also be observed in the nature, for example, during warm days, you can see on the road "water" even when it is dry. It is an optical illusion, due to differences in air temperature. Different warm air layers are having a different refractive index, and thus changes the direction of passing light beams. What we see is actually a picture of the sky, which your brain interprets as water on the road surface.

TIPS:

- instead of cardboard background you can use three glasses with different colored water assembled in a triangle
- try to look through a glass of water a building
- you can dip pen in glass of water and watch her top and side
- behind a glass of water place the paper with an arrow
- you can fill a glass from half with water and half oil and observe the difference of refraction between two environments simultaneously
- enter your best picture in the MILSET Science Photo Contest on http://spc.milset.org
- download some backgrounds like

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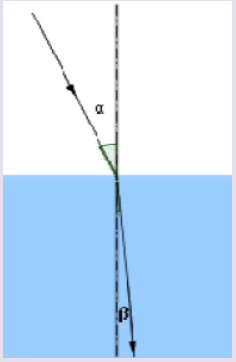
WHY DOES IT HAPPEN?



The refraction occurs at the interface between two medias, where light penetrates from one environment to second. The angle of incidence α is the angle between a ray incident on a surface and the line perpendicular to the surface at the point of incidence. Angle β formed between the refracted ray with vertical impact is the angle of refraction.

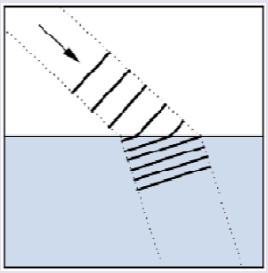
Refraction was first described by Ptolemy, who made a table of angles of refraction of light beam at certain angles at the interface of air and water. Quite similar table was also compiled by Snell fourteen centuries later.

Willebrord Snell formulated low of refraction as follows: The ratio of sines of the angles of incidence and refraction is equivalent to the ratio of phase velocities in the two media, or equivalent to the reciprocal of the ratio of the indices of refraction:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

with each θ as the angle measured from the normal oaf the boundary, v as the velocity of light in the respective medium (SI units are meters per second, or m/s) and n as the refractive index (which is unitless) of the respective medium.

Scientists have managed to produce material with a negative refractive index. If on such material falls beam of light from the air, it doesn't refract as other materials. The passage of the light beam is totally unusual.



Materials with negative refractive index are not found in the nature, they have to be produced artificially. These so-called photonic crystals can be composed for example of thin wires and loops arranged in a grid from dielectric material. Meanwhile we are able to produce materials having a negative refractive index in microwaves, but we are previewing soon their extension to the visible radiation.

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EXEMPLES OR EXPERIENCE FROM CZECH REPUBLIC









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INSPIRATION

Triple Glass Refraction - AlexSaberi

jmeyer - Photography Tips

Rajasekar Alamanda

pinterest.com

Credits
http://www.debrujar.cz/