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An easy method of finding the index of refraction of a transparent semi-circular block

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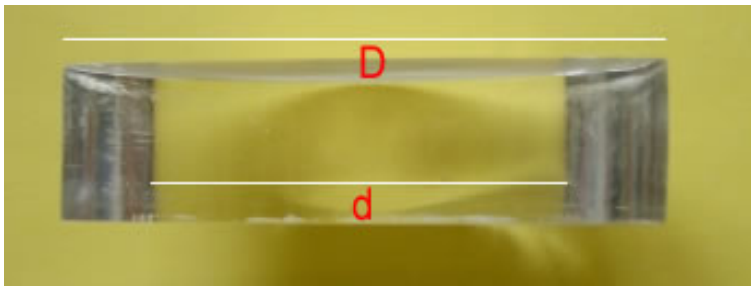
Experiment:

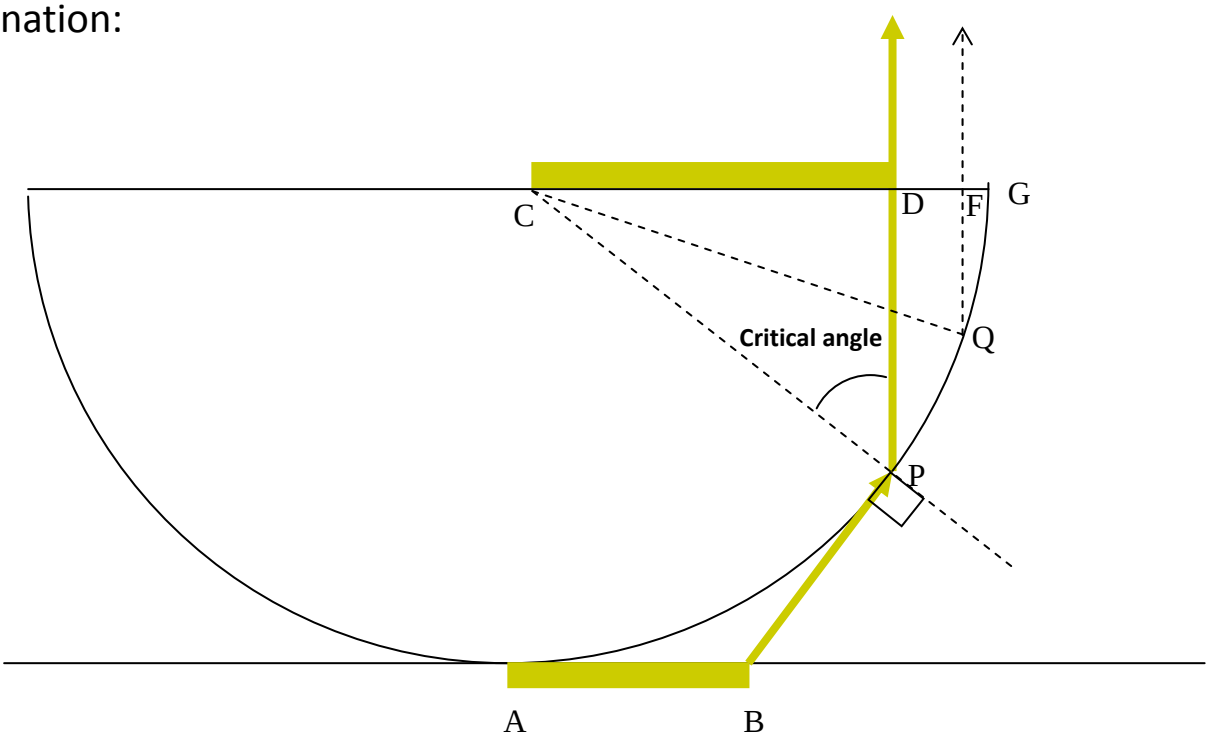
Stand a transparent semi-circular block upright with its curved surface downwards on a colored paper. When viewed from the top, the two ends of the upper surface of the block will not show any images of the bottom paper.

By measuring the diameter of the transparent semi-circular block (D) and the length of the middle image-seeing region (d), we can calculate the index of refraction of the material of the block.

The formula is $n = \frac{D}{d}$.



Explanation:



1. When the flat surface is viewed far away, the rays reaching an eye placed directly above A, the point where the glass block touches the bottom paper, will be nearly parallel and vertical.
2. In the above diagram, BP, a light ray from B reaches the semi-circular surface tangentially. It refracts into the semi-circular glass block with an angle of incidence equal to 90^0 and will finally leave the glass block in a vertical direction. We identify $\angle CPD$ as a critical angle of the material of the block.
3. Obviously, $\angle CQF$ is larger than $\angle CPD$. So it is impossible for any rays coming from the bottom paper to emerge vertically to the upper region at F. In other words, we cannot see any images of the bottom paper beyond D.
4. Finally, we get the index of refraction of the semi-circular glass block

$$n = \frac{1}{\sin \angle CPD} = \frac{CP}{CD} = \frac{CG}{CD}$$

From the above picture, we make the following measurements:

Diameter of the transparent semi-circular block (D) = 10.8 cm

Length of the middle yellow region (d) = 7.3 cm.

Hence, n = 10.8/7.3 = 1.48

This phenomenon can be observed as well by filling water in a transparent hemispherical bowl, an opaque ring around the water surface will be seen.
Hence, the method described here can be used to measure the index of refraction of a liquid.