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

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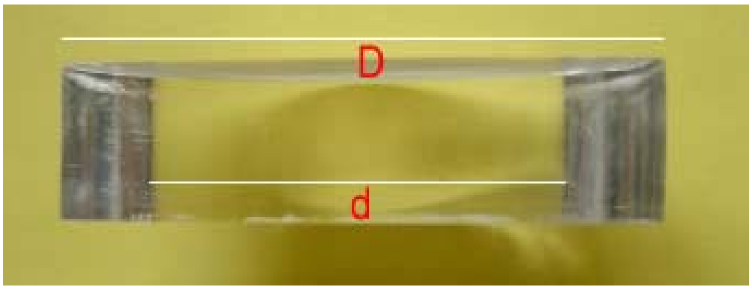
Experiment:

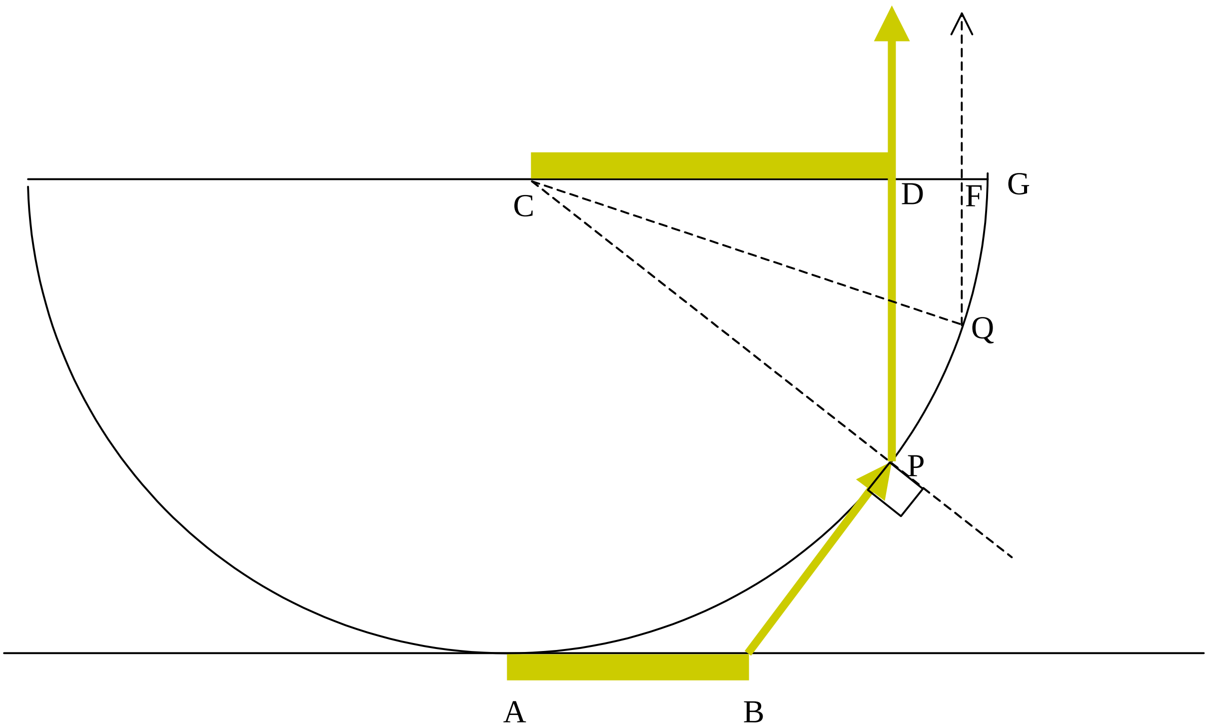
Stand a transparent semi-circular block upright with its curved surface downwards on a coloured paper. When viewed from the top, the two ends of the upper surface of the block will not show any images of the bottom paper.

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 at a far distance, the rays reaching the eye will be approximately vertical (the right photograph shown above is taken at a long object –camera distance).
2. In the above diagram, $\angle CPD$ is the critical angle.
3. It is obviously that $\angle CQF$ is larger than $\angle CPD$. So it is impossible for a light beam emitting from the bottom and emerging to the outside vertically at F. In other words, we cannot sees any images within the region DG .
4. Index of refraction of the semi-circular glass block $n = \dfrac{1}{\sin\angle CPD} = \dfrac{CP}{CD} = \dfrac{CG}{CD}$
5. From the above picture, we measure

   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 easily.