Pfund's method: using total internal reflection to measure index of refraction

Snell's Law,

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

can give an interesting result when light travels from a more dense to a less dense medium. ($n_1 > n_2$) In this case, there is some critical angle θ_c for which the exiting beam would come out at an angle of 90°. In this case

$$\sin\theta_c = \frac{n_2}{n_1}$$

and for any angle greater than θ_c the light is totally internally reflected. We can use this phenomenon to accurately measure the index of refraction of a transparent material.

Place a piece of paper on a flat surface and mount a laser above it, pointing down onto the paper. Carefully note what you see. Now put a plate of transparent material on the paper, so that the laser shines onto the paper directly below the plate. Again note what you see. Is the pattern you see on the top of the plate, on the bottom of the plate, or on the paper? How would you confirm your answer? Finally, adjust the transparent material so that the laser shines onto the paint on the bottom of the plate. What do you see now?

Figure out exactly what is going on. How do you explain the patterns you see? What causes any differences you observe in the patterns for paper versus for paint?

Make careful measurements, including estimates of your measurement uncertainty, and use your measurements to calculate the index of refraction, with its uncertainty, for the acrylic and glass samples provided. Measure the index of at least one other material using this method. Material suggestions might include Jello, rock candy, adult variations on Jello,[1] various liquids, etc.

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[1] 21 years and older only, and don't even *think* of eating your samples on campus.