Concept:

The law of reflection states that the angles of incident and reflected rays are equal. The law of refraction states that the ratio of the angle of incidence to the angle of refraction is related to the ratio of indexes of refraction of the media containing the incident and refracted rays. In general, as a light ray travels from rarer to denser media, it is bent towards the normal to the interface between the two media.

Equipment:

- Nakamura Refraction Tank
- 6V AC Power Supply
- 1 Gallon Water
- Funnel
- Paper Towels

Procedure:

1. Fill Nakamura Refraction Tank with water to 90-degree horizontal line.
2. Plug in power supply and banana clips.
3. Turn on power supply switch and verify that red LED (on power supply) and white light (on Nakamura Tank) come on.
4. Adjust the tank light arm and slit cover so beam lines up with 0-degree vertical line.
5. Swing tank light arm through various angles noticing verification of both the law of reflection and the law of refraction. Note that total internal reflection occurs at about 49 deg (see Notes and Extras).

Notes and Extras:

- [Video Link](#)
- Total Internal Reflection occurs at the critical angle: $\theta_c = sin^{-1} \dfrac{n_2}{n_1} \; for \; n_1 > n_2$

- When Medium 1 is water and Medium 2 is air, we have: $\theta_c = sin^{-1} \dfrac{1.00}{1.33} = 49^o$

- Both the law of reflection and refraction can be understood as a consequence of Fermat's principle of least time. See the [Feynman Lectures, Vol. I, p. 26-3](#).