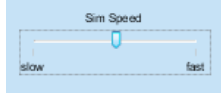**PhET Tips for Teachers**   **Bending Light**

Tips for controls:
- The tools and features are very easy to use according to our interviews.
- Tools and objects can be dragged out of the "tool box" and then returned.
- The objects in the **Prism Break** tab can be rotated by dragging the handle
- In the **Prism Break** tab, the protractor rotates and the laser translates.
- All the tools work in both **Ray** and **Wave** mode, but some are easier to use in **Wave** mode because the region where the tool can read is larger.
- Try all the different tabs at the top of the simulation. The tabs are designed to help teachers scaffold lessons or make lessons age appropriate by using only some tabs.
- In the Intro and More Tools tabs, the waves speed may make understanding difficult: you can **Pause** the sim and then use **Step** to incrementally analyze. Also, the sim speed tool allows the time increment of the simulation to be decreased, but the speed tool still functions to provide appropriate measurements.

Important modeling notes / simplifications:
- Snell's Law was used to determine angles and wavelengths.
- Intensities are calculated assuming a parallel polarized incident beam:
  - Reflected: $R_{\parallel} = \left(\frac{n_i\, cos\theta_t - n_t cos\theta_i}{n_i\, cos\theta_t + n_t cos\theta_i} \right)^2$
  - Transmitted: $T_{\parallel} = \frac{4\, n_i\, n_t\, cos\theta_i\, cos\theta_t}{(n_i\, cos\theta_t + n_t\, cos\theta_i)^2}$
- There are many types of Glass; we used an index of 1.50.

Insights into student use / thinking:
- Students explored lots of features. They may need guidance to relate the bending of light to the indices of refraction and also how light wavelength effects index.

Suggestions for sim use:
- For tips on using PhET sims with your students see: **Guidelines for Inquiry Contributions** and **Using PhET Sims**
- The simulations have been used successfully with homework, lectures, in-class activities, or lab activities. Use them for introduction to concepts, learning new concepts, reinforcement of concepts, as visual aids for interactive demonstrations, or with in-class clicker questions. To read more, see **Teaching Physics using PhET Simulations**
- For activities and lesson plans written by the PhET team and other teachers, see: **Teacher Ideas & Activities**