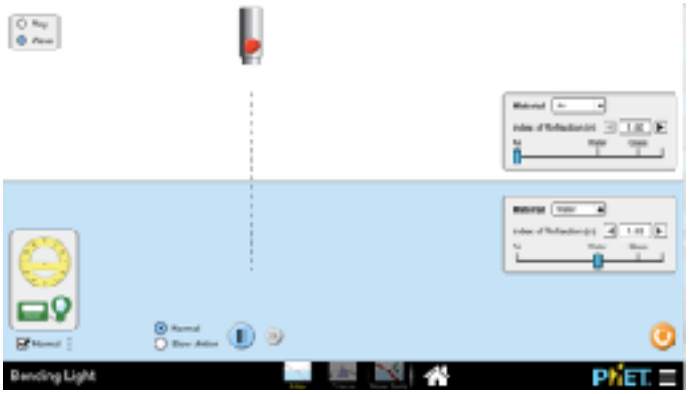
Wave Refraction

In this activity students will be exploring wave refraction of water and or light using the “Bending Light” PhET simulation.

Open the simulation by clicking on the link:

https://phet.colorado.edu/en/simulation/legacy/wave-interference

Take a look at the explanatory video via YouTube:
https://youtu.be/WJH7tAL_a9M



Learning Objectives

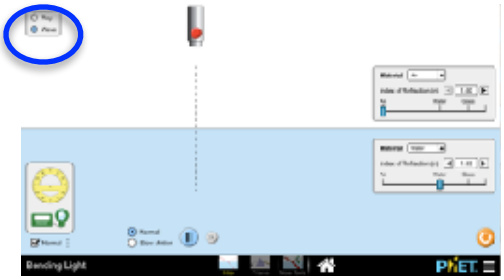
By the end of these activities it is hoped that students will have an acquired the following skills:

- Following explicit instructions to gain acquired knowledge
- Investigate how waves bend through as it enters an increasing denser media.
- Investigate how waves bend through as it enters an increasing denser media.
- Be able to draw the wave patterns as waves pass from a less dense to more dense media and vice versa

Author: Simon Lees 2017

Activity A: Investigating how waves react when entering a more dense media

- On opening the program click on the "**Intro**" page and click the waves button shown with the blue circle.



- Make sure you are going from AIR into WATER this is like going from less DENSE to MORE DENSE.
- Place the wave source in this case the light so it is running down the normal. SWITCH ON.
- Take a screenshot of what you observe and PASTE it in the space below.

Screenshot of waves passing down the normal

- **What do you notice has occurred and why?**

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- Switch to light source and add the protractor tool. Place light source so it shines at an angle of incidence of 45º. Now measure the refracted ray and then switch onto a wave form.
- Take a screenshot of this angle in a wave form and PASTE it in the space provided opposite.

Screenshot of waves passing into dense media at an angle of 45º.

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- **What do you notice about the angle of refraction in simple ray form and wave form?**

- **What do you notice happens to the wavelength of the refracted wave as it enters the denser media?**

- Remain on the wave setting and move the light source anticlockwise while remaining on. Observe what happens to the width of the beam and the angle of refraction.
- **State what happens to…..**
    1. **Width of the beam**

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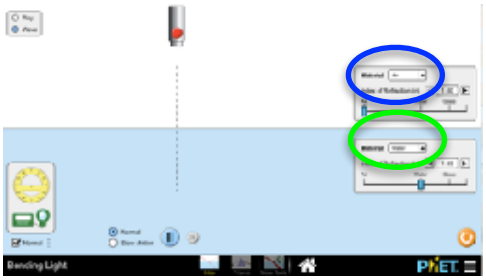
    2. **Angle of refraction as angle of incidence increase.**

Activity B: Investigating how waves react when entering a less dense media



- Now do the same but change the top layer and make it glass and bottom area make it AIR by clicking in the area shown with the blue and green circles.
- Take screen shots of the following and PASTE in the spaces provided:
    1. Light source running down NORMAL.
    2. Light source at 30º.
    3. Note wavelength changes
    4. How does refractive angle change as incident increases

Light source running down NORMAL	Light source at 30º angle of incidence.
Wavelength appearance of refracted wave	Angle of refraction change as incidence changes

- **What happens to the wavelength as the wave enters a less dense media?**

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- **What happens to the angle of refraction as the angle of incidence increases?**

- **What happens to the beam as you enter a less dense medium?**

- **The angles of refraction can also be calculated using Snell's Law**

$$n_i \sin\vartheta_i = n_r \sin\vartheta_r$$

Calculate the refractive angle for light as it travels from glass to air with an angle of incidence of 30°. What do you notice about the observed angle and calculated angle?

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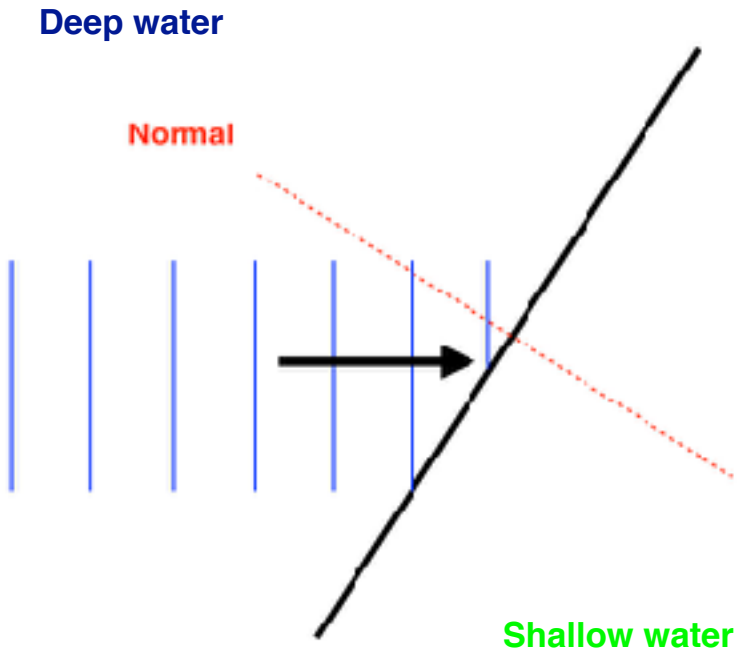
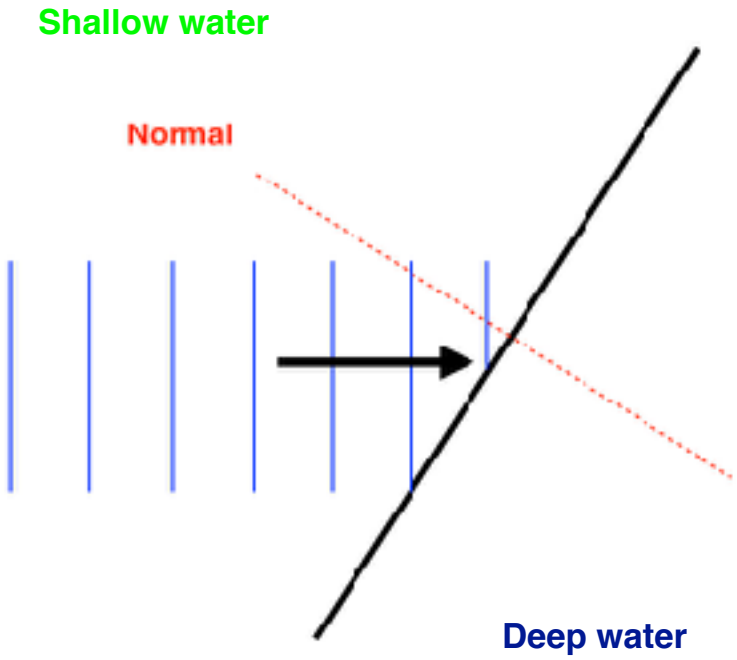
Activity C: Drawing wave refraction patterns

- Water is deemed to become less dense as it gets deeper and more dense as it gets shallower. It travels faster in the deep water and slower in shallower water.
- Use the knowledge you have derived during this investigation as to how waves interact as they enter more dense or less dense to complete the wave patterns formed in the two scenarios set up below:

Moving from deep water to shallower water in terms of angle and wavelength.



Moving from shallower water to deeper water in terms of angle and wavelength.



Summary:

- **As you move from deep water to shallow water the density gets…..**

- **As you move from shallow water to deep water the density gets…..**

- **As you move from deep water to shallow water the wave speed…..**

- **As you move from shallow water to deep water the wave speed…..**

- **As you move from deep water to shallow water the wavelength…..**

- **As you move from shallow water to deep water the wavelength…..**

- **As you move from deep water to shallow water the angle of refraction moves which way with respect to the NORMAL…..**

- **As you move from shallow water to deep water the angle of refraction moves which way with respect to the NORMAL…..**
