**Measurement of the wavelength of light in water using a diffraction grating**

**Apparatus**:

A rectangular plastic container such as a transparent storage box about 35cm by 55cm if using the photonics explorer diffraction grating, a diffraction grating, a laser and water.

**Method**



**Figure 1**

Diffraction grating

Glass rod

laser

Attach the grating to the outside of the plastic container so it is half above and half below the water surface, see **figure 1**. Place a glass rod horizontally in the path of the laser beam, this causes the laser beam to form a vertical line. Direct the laser so the line of laser light is half above and half below the water and normal to the diffraction grating.

Place a sheet of white paper along the opposite side of the box, this is the screen on which the position of the zero and first order positions can be marked, see **figure 2**.



**Figure 2**

The line of laser light splits into two parts as a result of the section above the water being diffracted through a larger angle than the section below the water, see **figure 3**. This results from the fact that light travels slower in water than in air. The room will need to be darkened to see the diffracted light.



Figure 3

The photonic explorer grating will enable the first order diffraction line to be seen on the screen and its position is significantly different in water compared to air.

Theory

nλ = d Sinθ for light normally incident on a diffraction grating.

n is the order 0,1,2,3 etc,

λ is the wavelength of the light,

d is the grating spacing and

θ is the angle the light is diffracted at.

nwater sin θwater = nair sin θair

remembering λwater/ λair = nair/nwater

This gives sin θwater/sin θair = nair/nwater = λwater/ λair

This enables the refractive index of water and the wavelength of the light in water to be found.

Typical results:

Width of storage box = 35.0 ±0.1 cm

Distance from zero order to first order in water = 19.5 ±0.1 cm

Distance from zero order to first order in water = 29.5 ±0.1 cm

tan θwater =19.5/35.0

tan θair = 30.7/35.0

n water = sin θair/ sin θwater = 1.32 ± 0.01

It is good practice to plot a graph and this could be done by placing a white plastic ruler in the tank at different distances from the grating and parallel to the grating as this would give more data points. When doing this experiment with a plastic storage box check its width at the water’s surface. Some boxes change width by 2 cm.