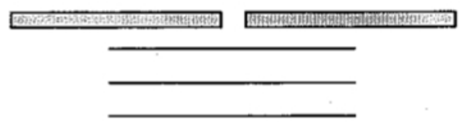
Diffraction of Waves in Two-Dimensions

When a wave passes around a barrier or through an opening, it will bend. This bending is called **diffraction**. We say the wave has **diffracted**. The amount of diffraction depends on the wavelength of the wave and the size of the opening.

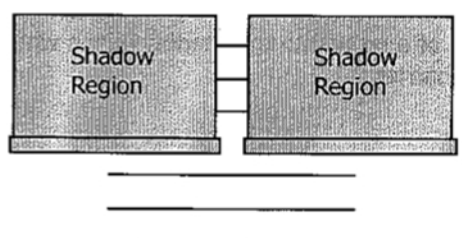
Diffraction and refraction have something in common: they both involve waves changing their direction of travel. Unlike refraction, however, diffraction occurs in a single medium.

Diffraction Through Openings

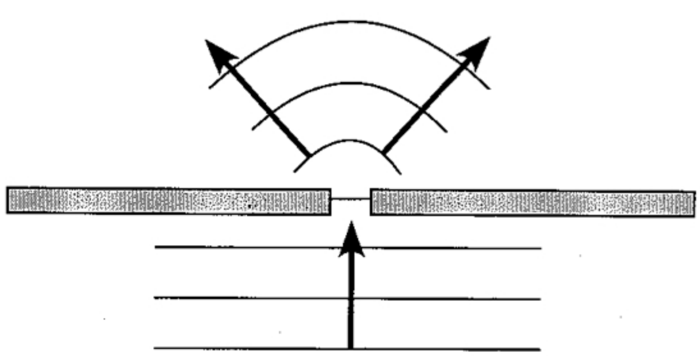
The diagram below shows waves that are incident on a barrier with a small opening in its center.



When the waves pass through the opening in the barrier, most people expect the result to look something like this:

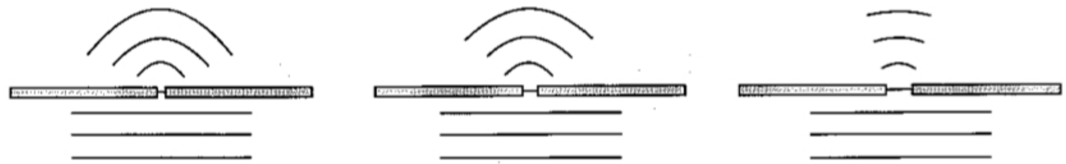


However, what actually happens is more interesting: the wave spreads out somewhat as it passes through the opening. This spreading out is known as diffraction. The next diagram shows this effect.



It is clear from this picture that when a plane wave passes through the opening, it diffracts as a circular wave. As it turns out, the smaller the opening, the more the resulting wave will resemble the perfect circular waves from a point source.

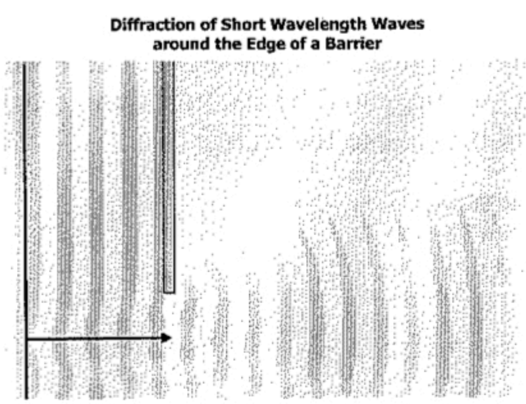
In general, a smaller opening will show more diffraction than a larger opening.

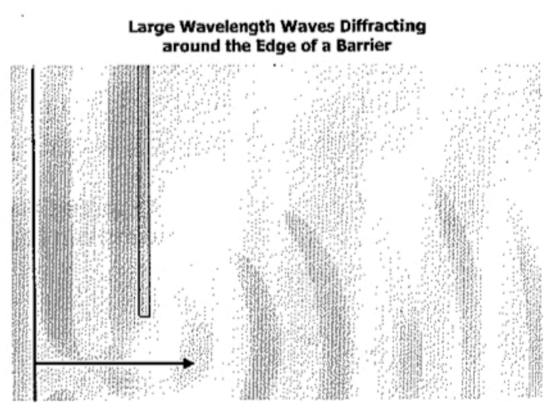


In addition, a wave with a larger wavelength will show more diffraction than a wave with a smaller wavelength.

Diffraction Around the Edges of a Barrier

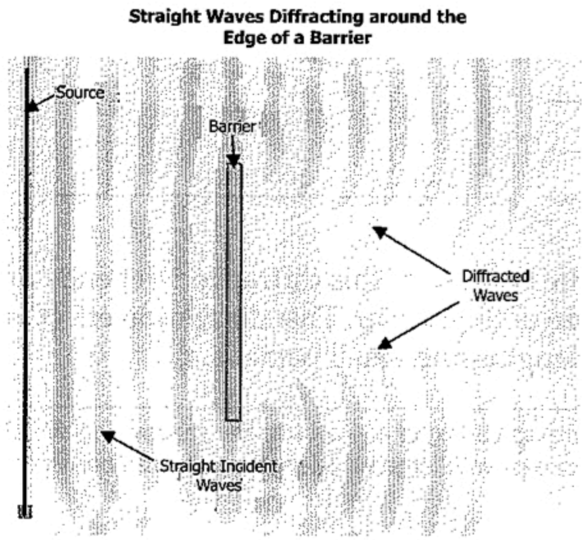
Waves also diffract when they pass by the edge of a barrier. The images below show this occurring for both short and long wavelengths.



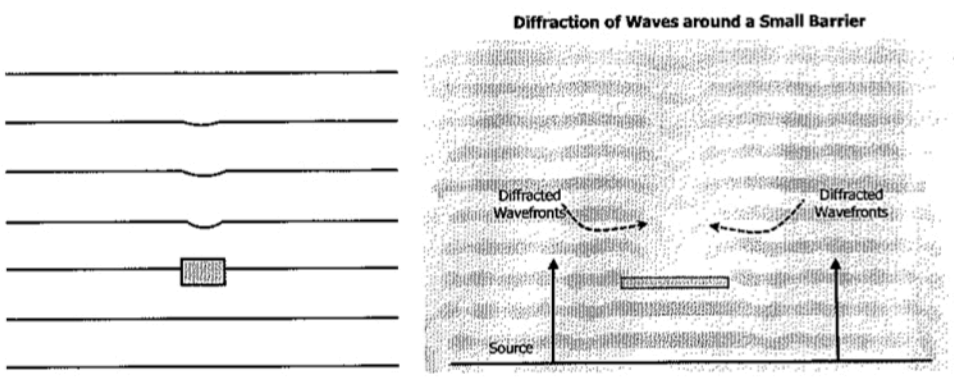


Notice that the longer wavelength results in more diffraction, just as it did for diffraction through an opening.

The size of the barrier also has an effect on the amount of diffraction. The image below shows the diffraction around a large barrier.



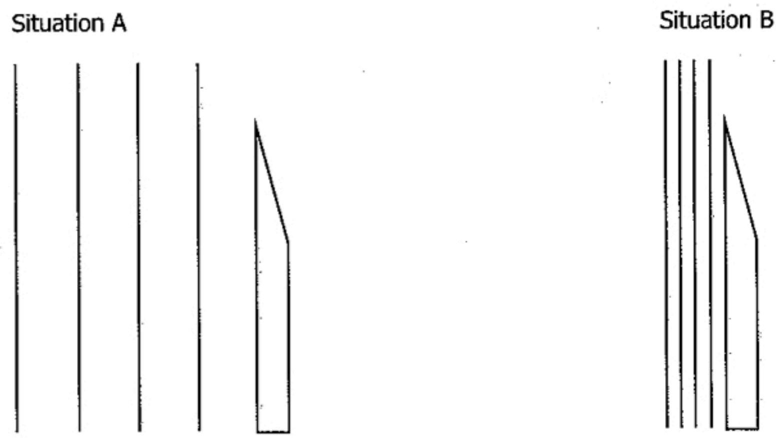
This final image shows diffraction around a small barrier.



Notice that the amount of diffraction is greater for the smaller barrier, just as it was for the smaller openings.

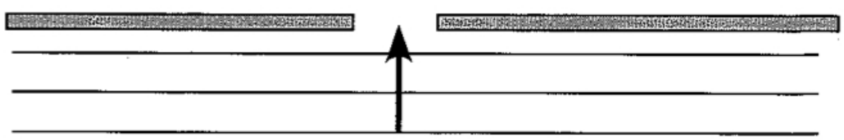
Waves Worksheet #7

1. The diagram below shows two different types of water waves approaching a sharp edge. Which type of wave will show the greatest diffraction: the waves in situation A or the waves in situation B?

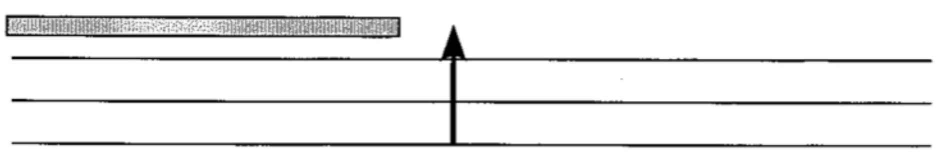


2. Draw the diffraction pattern for the following situations involving waves in a ripple tank:

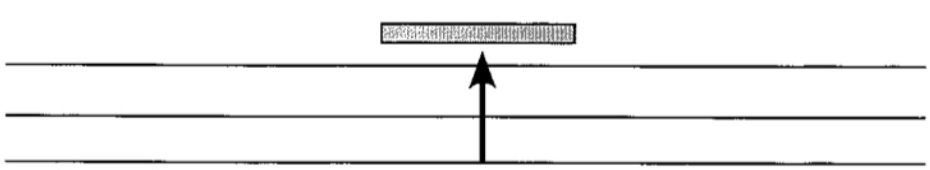
a)



b)



c)



3. Ocean waves are approaching an opening into a harbor. The opening is $100\ m$ wide. For which wavelength of ocean waves would there be the greater diffraction: those with wavelength of $50\ m$ or those with a wavelength of $200\ m$?

4. A D note in music has a frequency of $294\ Hz$. A G note has a frequency of $392\ Hz$. If music was playing in a hallway around the corner, what frequency of sound could you most clearly hear? (The speed of sound in air is $340\ m/s$.)

5. Light of wavelength $470\ nm$ is blue in color, and $610\ nm$ is orange. If these colors of light pass through a $500\ nm$ hole, which color of light will show the greatest diffraction?