

Wave Diffraction



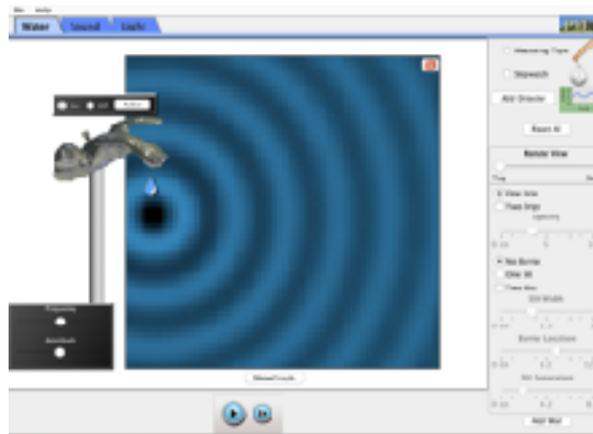
In this activity students will be exploring wave diffraction of water using the “Wave Interference” PhET simulation.

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/RyqSStaQXa4>



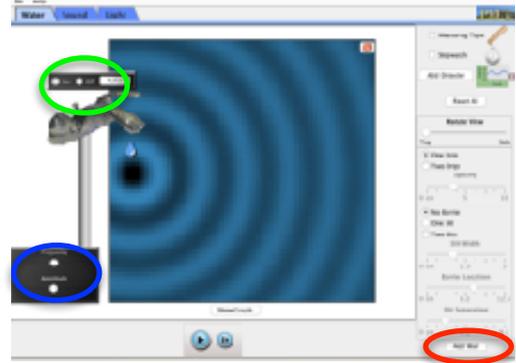
Learning Objectives

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

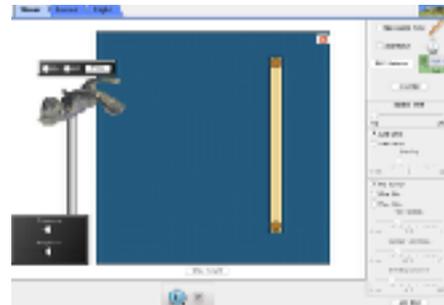
- Following explicit instructions to gain acquired knowledge
- Investigate how waves react when hitting barriers at high and low frequency.
- Investigate how waves react when passing through large and small barriers at high and low frequency.
- Investigate how waves react when passing around barriers that are wide and narrow at high and low frequency.
- Link some of these idea to white water kayaking.

Activity A: Investigating how waves react on hitting barriers

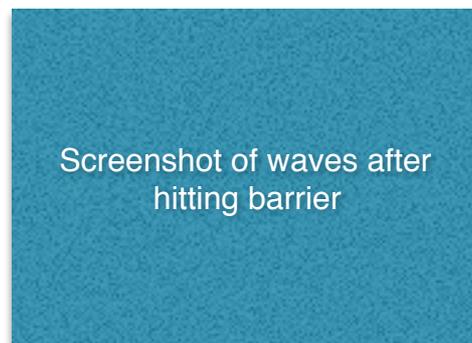
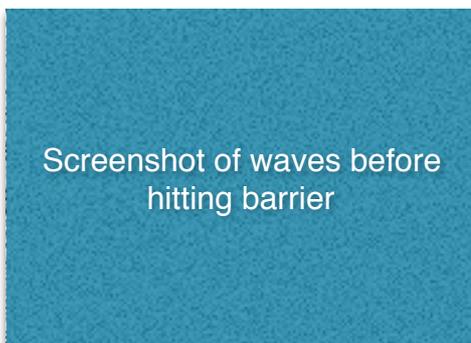
- Make sure you are using the water waves in this activity. You will only require a single drop.
- Turn the tap OFF clicking on the button in the green circle
- Move the frequency arrow, shown in the blue circle to approximately 50%.



- Now click on the “**Add a Wall**” button shown in the red circle.
- Straighten the wall so that it is vertical and it is 3/4 away from the tap. This will give you a good pattern. Click and drag the tap to the left so the drop is by the edge.



- Turn the tap ON and allow the waves to form.
- Before they hit the wall pause the animation and take a screenshot and paste it in the space provided below.



- Now click on the measuring tape and measure the wavelength from one crest to the next or one trough to the next. Write your answer in **table 1**.
- Allow the animation to resume and the waves to hit the barrier. Take a screenshot of the pattern and PASTE it in the space provided above.
- Turn the tap off until all you have is are the reflected waves on the screen and PAUSE the animation. Now using you measuring tape measure the wavelength again and write your answer in **table 1**.

- Now do the same but increase the amplitude to 75%

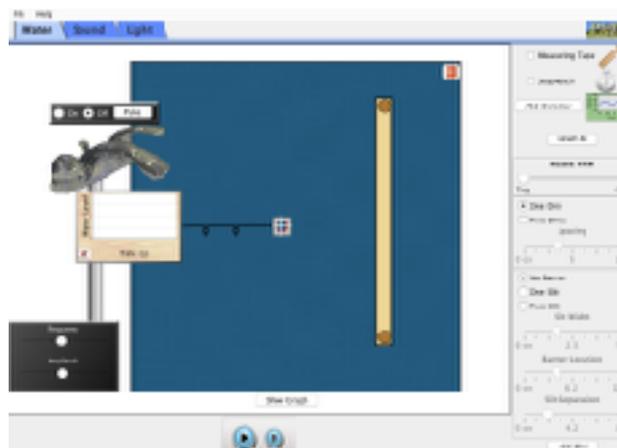
Table 1:

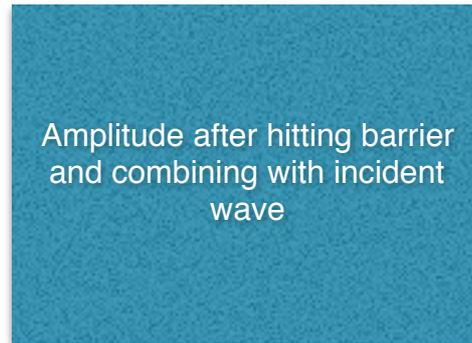
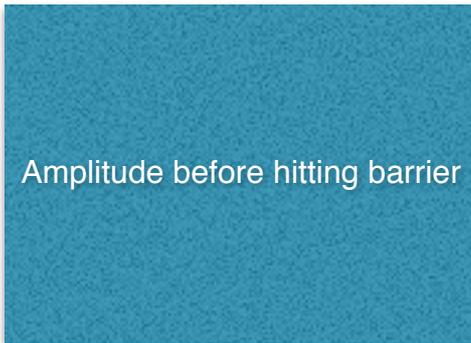
Wave Measured	Distance (cm)
Wavelength of waves (Incident) 50% frequency	
Wavelength of waves (Reflected) 50% frequency	
Wavelength of waves (Incident) 75% frequency	
Wavelength of waves (Reflected) 75% frequency	

- What do you notice about the two wavelengths for each situation after they hit the barrier.

- What law do you think is applying here?

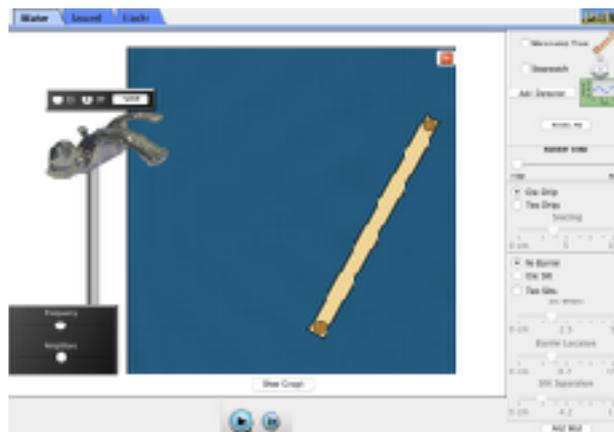
- Run the animation so no waves are present
- Click on the “**Add Detector**” button and place the crosshairs in the centre of the screen as shown in the image below. Click the tap ON and watch the amplitude of the waves. Take a screenshot before the waves hit the barrier but have passed the crosshairs of the detector and after they have hit the barrier and PASTE them in the spaces provided on the next page.



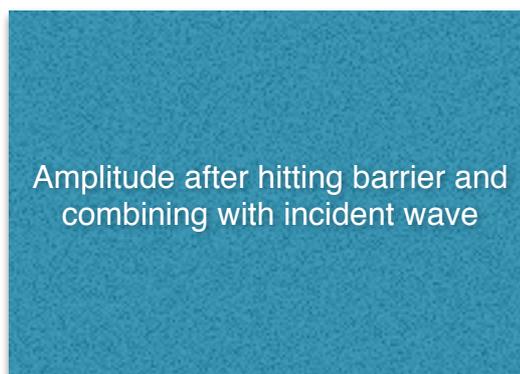


- Compare and contrast the two images and give a reason for any differences

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- Now grab one end of the barrier and place at an angle as shown in the diagram.

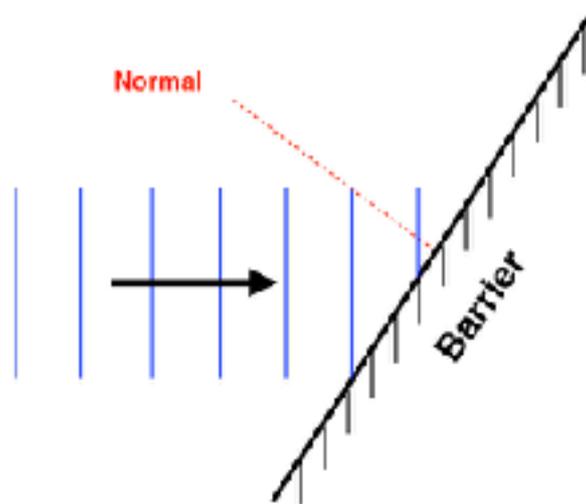


- Run the animation on 50% frequency and take a screenshot of the pattern produced.
- Using the measuring tape run the program and pause after a few seconds. Take a screenshot of the picture and paste it below in the space provided.



- Measure the wavelengths and the amplitudes as stated before.
- **What do you notice about the wavelengths and the amplitudes and compare with those formed when hitting a vertical barrier.**

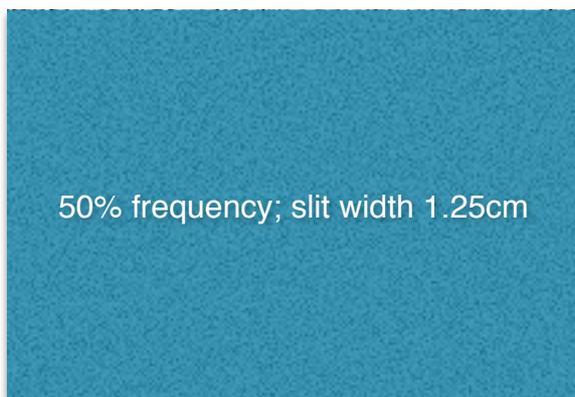
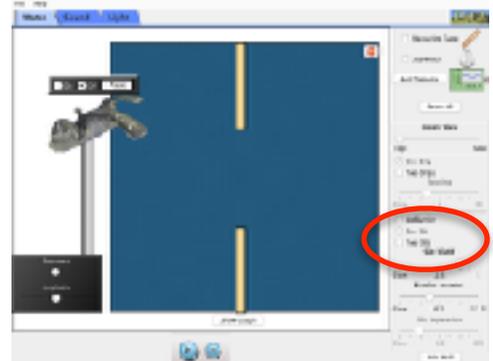
- **Look at the diagram below and complete the diffraction pattern showing the reflected waves using the information you have gathered.**



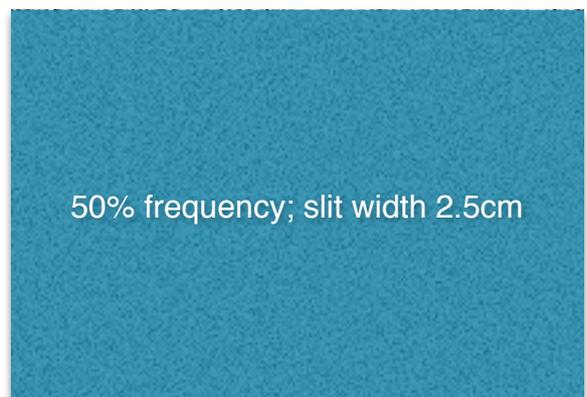
- **TO summarise what relationship is there between the angle of incidence of the wavefront and the angle of reflection?**

Activity B: How do waves react passing through small to large barriers and at high and low frequency.

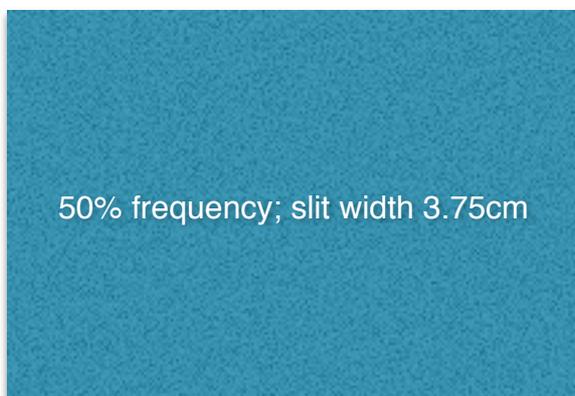
- Set up the scenario as show in the image opposite. Click on the single slit which is found in the red circle area on the image.
- Make sure the barrier is approximately halfway across the screen.
- Place the frequency on 50% and the slit width at 1.25cm. Run the animation. Allow the animation to run so you get a clear picture the PAUSE and take a screenshot of the pattern.
- Set the amplitude to 100% for the best resolution.
- Increase the slit width to 2.5cm; 3.75 and 5cm and take a screenshot of each. PASTE these below.



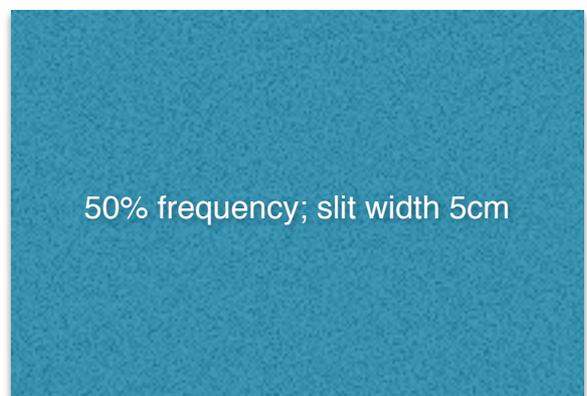
50% frequency; slit width 1.25cm



50% frequency; slit width 2.5cm



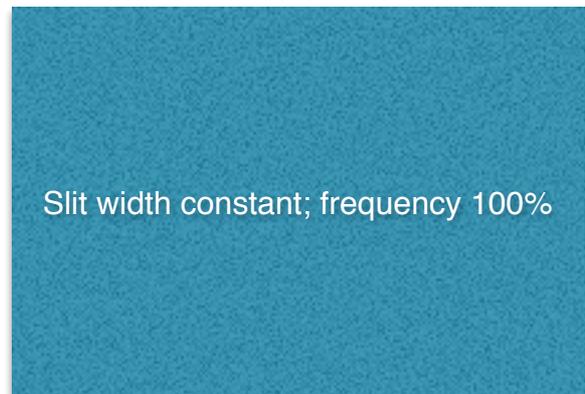
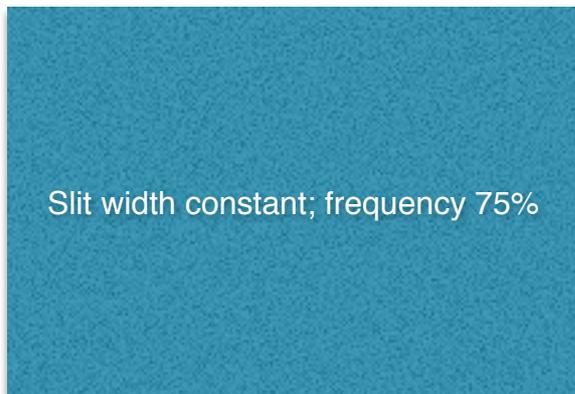
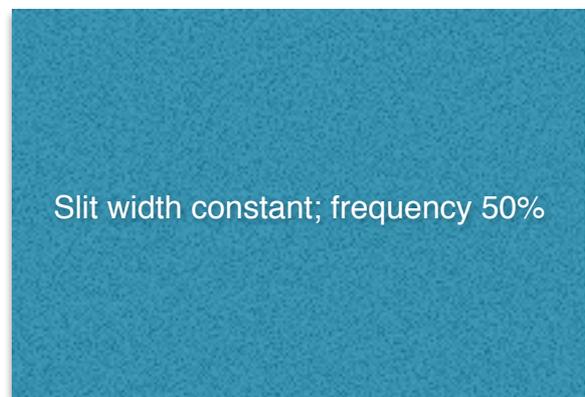
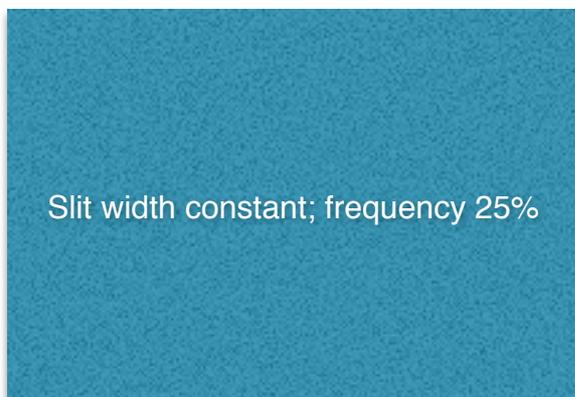
50% frequency; slit width 3.75cm



50% frequency; slit width 5cm

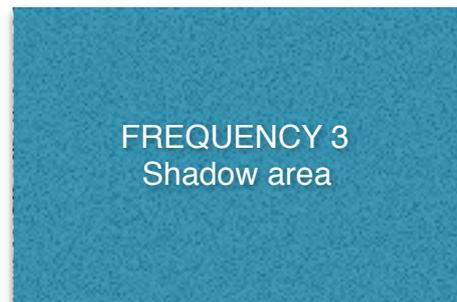
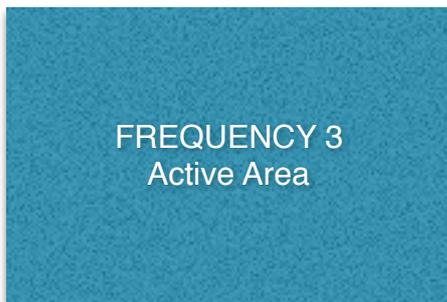
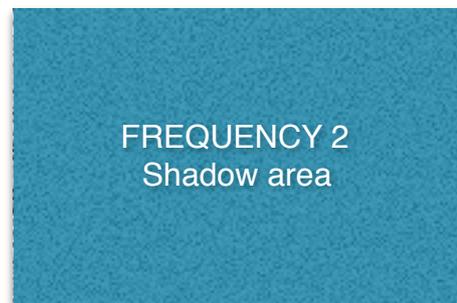
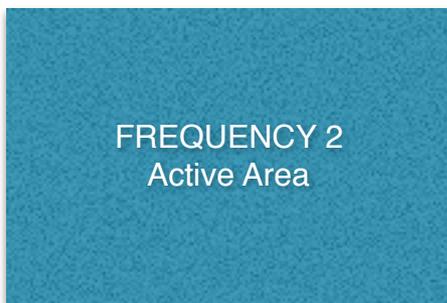
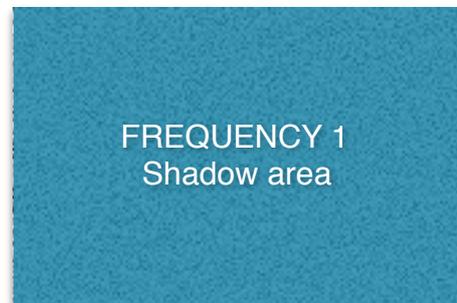
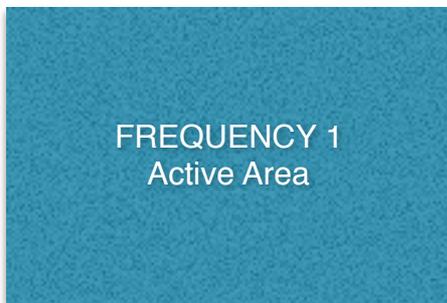
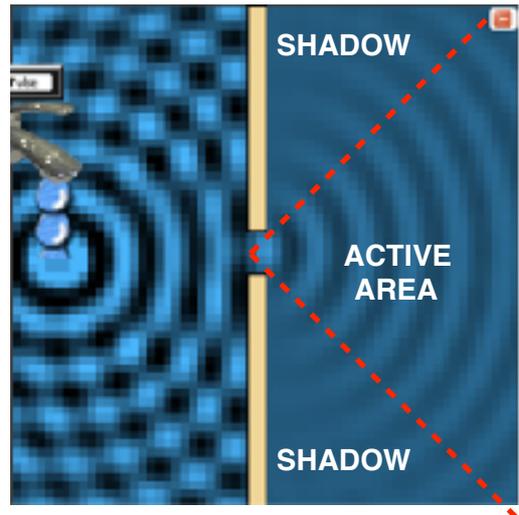
- Compare the 4 patterns and state what happens as slit width increases

- Now choose a single slit width and alter the frequency from 25%; 50%; 75% and 100%. Set the amplitude to 100% for the best resolution.



- Compare the 4 patterns and state what happens to the pattern as frequency increases.

- Add the detector and analyse the amplitude of the waves passing through the slit (active area) and then into the shadow area. As shown in the image opposite.
- Do this at different frequencies and take three screenshots to show the amplitude in each area at each frequency and PASTE them below.
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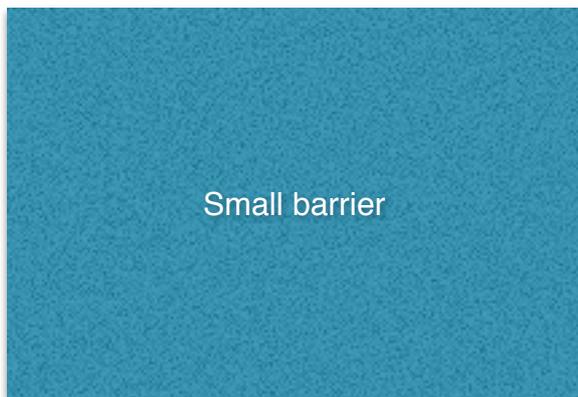
- Compare the amplitudes between changing the frequency in the active and shadow areas.

Activity C: How waves react when passing around barriers that are wide and narrow at high and low frequency.

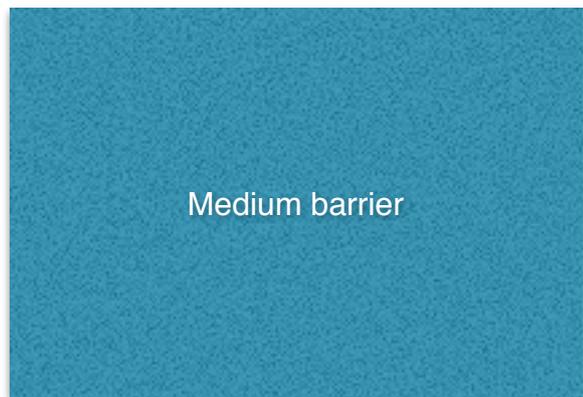
- Set up the scenario as shown in the image opposite. Use the “**Add Wall**” button to add a barrier and then minimise.
- Set the barrier to a small size; frequency to 50% and amplitude to 100%. Then run the animation. Increase the barrier to a medium and then large size giving enough room for the water to move around it



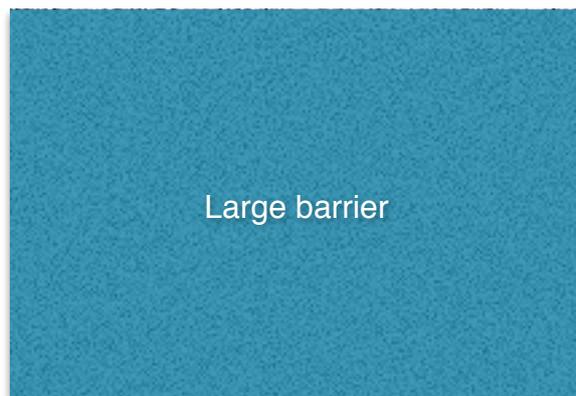
- Take screen shot of of each of the barriers and their diffraction pattern.



Small barrier



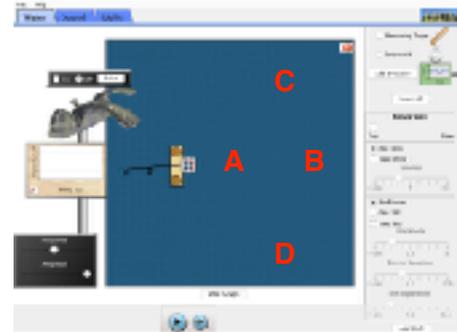
Medium barrier



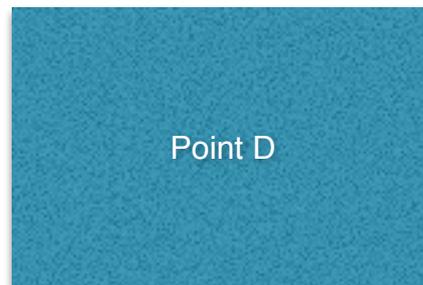
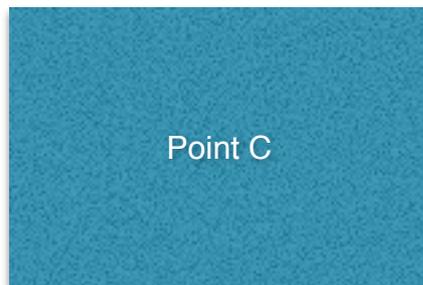
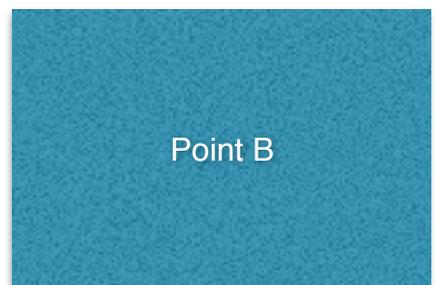
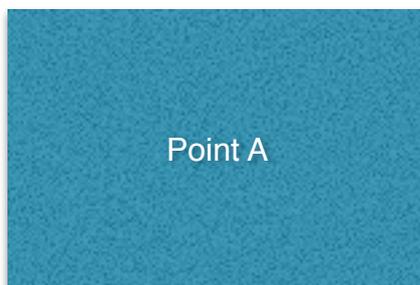
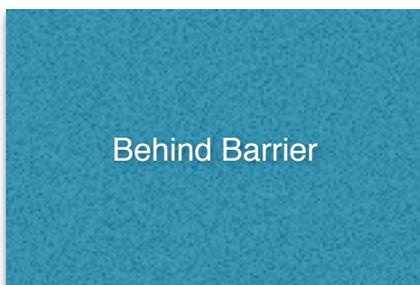
Large barrier

- **What are the differences and explain how the patterns change.**

- Measure a small barrier and click on the “**Add Detector**” button and place crosshairs in the position shown in the image opposite. Start the animation and take a screenshot of the amplitude.



- Move the crosshairs to points A; B; C and D and do the same.
- PASTE the screenshots in the area provided below.



- Compare your five screenshots and explain what you see in terms of wave amplitude.

Waves & Kayaking

- Look at this image. You will notice that there is a kayaker who is acting as spotter for the raft. This is a safety requirement if anyone falls out of the raft.



- **What can you say about the position the kayaker has taken with respect to wave diffraction that allows them to be suitably positioned but won't cause him to drift downstream. Use a diagram to help explain this.**

Place your diagram here

- This is an image of one of the gates at the Rio Olympics kayaking slalom course.
- **Identify on the image where you would place safety spotter to monitor this gate and explain why**



SUMMARY:

- When a wave hits a barrier what can you say about....

1. the angle of reflection of the wavefront

2. the wavelength of the reflected wave

- As the slit between a barrier increases in size how is the diffraction pattern affected?
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- If you increase the frequency of the wave passing through a slit what happens to the pattern.
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- What happens to the amplitude of the waves as they pass through a slit, explain the two areas.
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- What happens to waves as they move around a barrier?
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- If you increase the frequency of a wave what will happen to the pattern as it moves around a barrier?
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