COMPACT RIPPLE TANK

inspire

CE & CSA Certification to BSEN61010-2010 (EN 61010-1:2010 3rd Edition)

Introduction

The Compact Ripple Tank comprehensively demonstrates wave phenomena and is available in two versions, Simple and Advanced.

Features of both versions:

- self-contained for ease of use and storage
- membrane keypad for all controls
- independent control of wave generation and strobe frequency
- frequency range: Simple 50 to 175 Hz, Advanced 1 to 250 Hz
- digital displays of wave and strobe frequencies
- wave and strobe frequencies can be synchronised
- dippers simply plug into a 4 mm socket
- clear wave display on the built-in screen
- viewing screen can be removed for upward projection
- shallow water tank locates into slots, reducing risk of spills
- storage compartment holds all the accessories
- low voltage plugtop power supply

Accessories include: single, double and plane dippers, barriers, reflectors, refractors, Young's slits and a pipette dropper.

Additional features of the Advanced Ripple Tank:

- wave amplitude control
- strobe intensity control
- camera projection mode, via PC

Advanced Ripple Tank

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Guide to the Ripple Tank

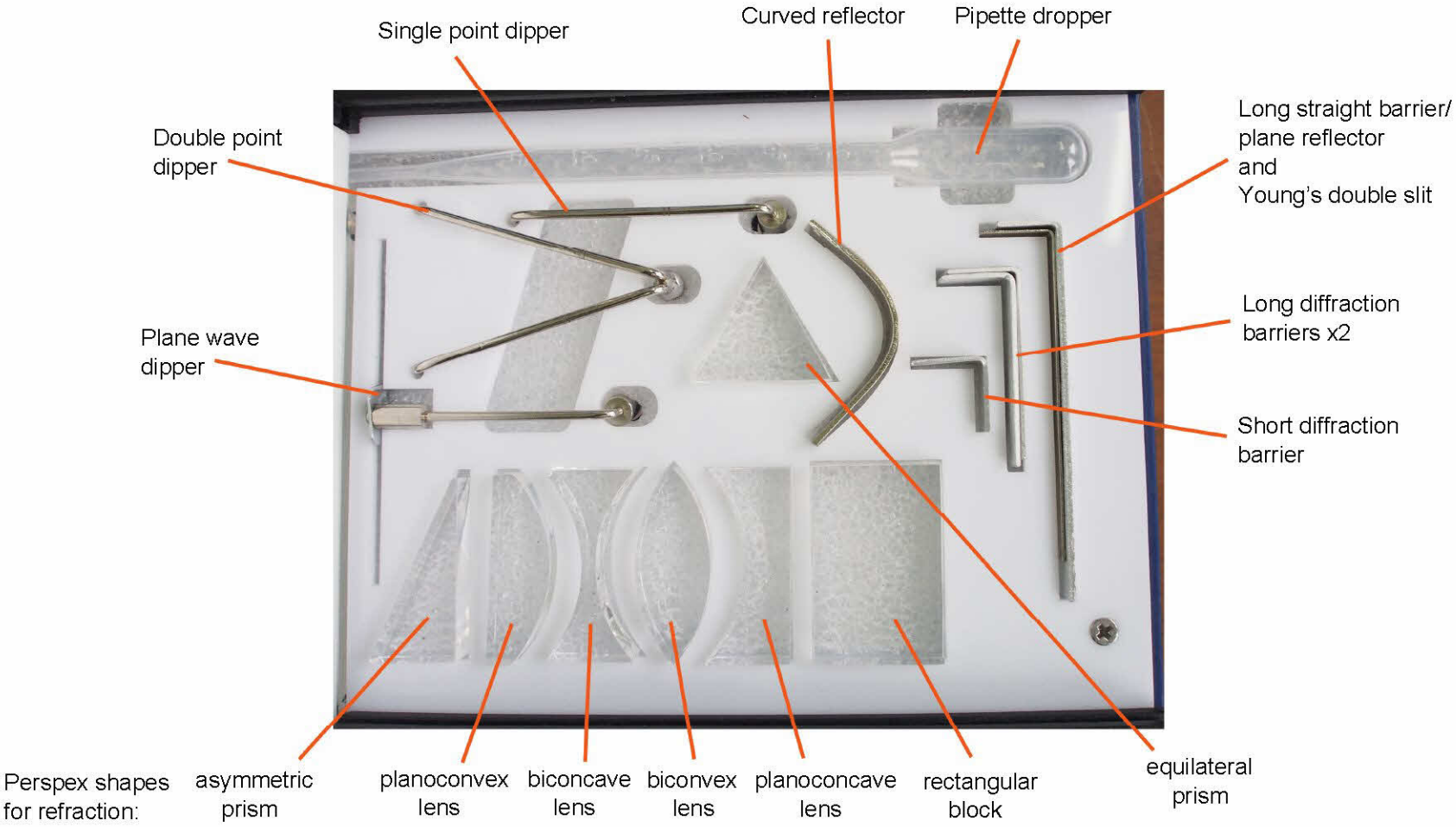
The control panel and accessories are described in detail on the next page

Power input : 12 V dc from plugtop power supply
Dimensions : 250 x 265 x 135 mm
Weight : 4.2 kg

Operating temperature range: 5 to 40°C
Operating humidity range: up to 80% RH
For indoor use only

Accessories

A 12 V plugtop power adaptor is also included.



Control panel functions

The Simple and Advanced versions have many features in common:

Two LED displays show the frequencies of vibration and strobe in Hz.

Vibration ON/OFF
Vibration frequency up/down

Strobe ON/OFF
Strobe frequency up/down

Mode key selects Synchronised or Independent mode.

By default, the vibration frequency and strobe frequency are set to 60Hz in Synchronised mode. In this mode, the waves appear to be stationary.

Adjusting either the strobe or vibration frequency in Synchronised mode, will change both frequencies.

In Independent mode, the two frequencies can be varied independently. If the frequencies are close together, the waves appear to travel across the viewing screen in slow motion.

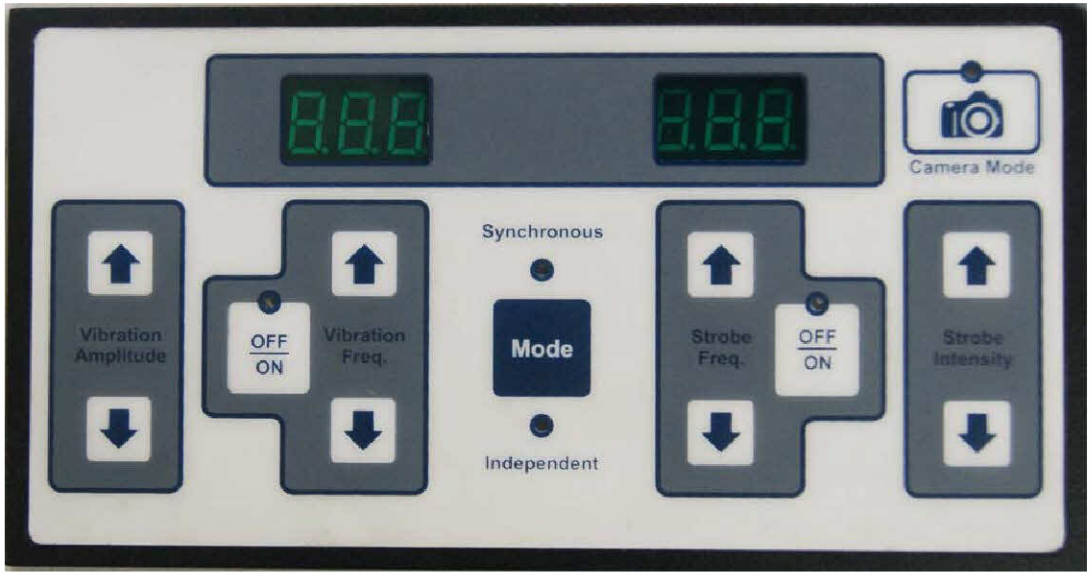
Advanced functions

Vibration amplitude up/down varies the amplitude/height of waves in the tank, and has four levels.

Strobe intensity up/down varies the strobe LED intensity, and has four levels.

Camera mode sets the Ripple Tank to allow display and recording of the wave patterns using a USB camera and computer.

Further details of this facility are given after the suggested experiments.



Setting up the Ripple Tank

Place the unit on a level surface and connect the power adaptor to the rear socket.
Plug the power adaptor into a mains supply. Switch on the Ripple Tank at the rear.

Now slide the viewing screen out to reveal the water tank.

Open the accessory compartment by sliding its cover sideways.
Choose one of the dippers (single, double or plane dipper).
Insert the 4 mm plug of the dipper vertically into the vibration stem.
Avoid applying any sideways force.

Add clean water to the tank until the dipper just touches the surface - approximately 110 to 120 ml of water.
In the course of doing the experiments, you may need to increase and decrease the water level to achieve the best wave patterns. The pipette dropper enables you to adjust the water level by small amounts.

Slide the viewing screen into its normal position.

Switch Vibration and Strobe ON by pressing the ON/OFF keys.
By default the frequencies are synchronised at 60 Hz. The waves are stationary.
Adjust the frequencies using either of the frequency up/down keys.

Press the Mode button to select Independent mode. You can now vary the frequencies independently.
A small difference between the frequencies allows you to see the waves travelling slowly across the screen.

Using the Advanced Ripple Tank

Vibration amplitude up/down gives control of the wave height within the tank.
Adjustment of the amplitude can make wave patterns clearer in some experiments.

Strobe intensity up/down gives control of the brightness of the strobe LED.
This can make wave patterns clearer in some experiments.

Adjust Vibration amplitude, Strobe intensity and the frequencies to become familiar with their effects.

Camera mode is described after the Suggested experiments.

Precautions

Always place the unit on a stable and level surface.
Avoid spillage of water on the Ripple Tank base unit.
Avoid excess force on vibration stem.
Avoid looking directly at the strobe LED.
For best results, perform experiments in shallow water.

Maintenance

Unplug the power adaptor after use and check that all the accessories are dry and put away in the storage compartment.
Carefully remove and empty the water tank, then dry it using a soft cloth, not a paper towel.
Keep the tank and viewing screen clean.
Avoid scratching the tank and screen as any scratches might impair the clarity of the wave display.

Exploring wave phenomena

Reflection

Start with about 115 ml of clean, fresh water in the water tank.
Insert the plane wave dipper into the vibration stem.

Place the straight barrier in the tank at 45° in front of the dipper.
In Synchronised mode, set the frequency to 90 Hz.

Observe the incident and reflected wave fronts.

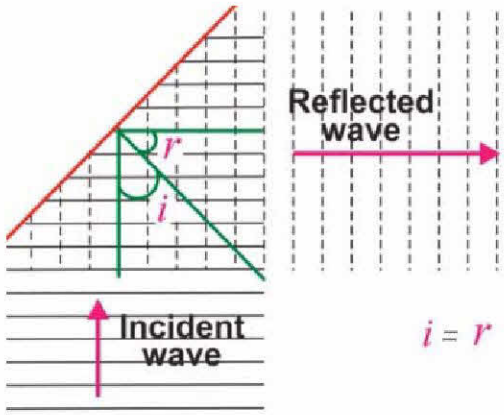
Change to Independent mode and adjust the Strobe frequency, so that the incident waves are moving towards the angled barrier.

Using a ruler and a protractor on the viewing screen, it should be possible to measure the angles of incidence and reflection.

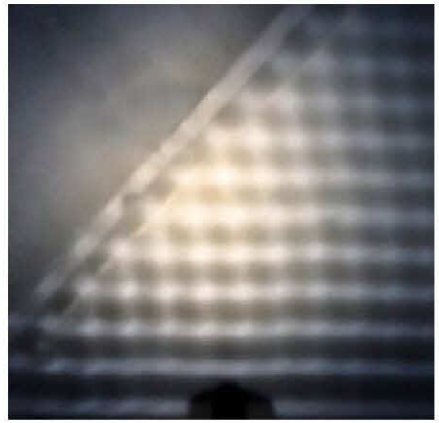
A curved barrier is supplied, with which to model the behaiour of convex and concave mirrors.

Using the Advanced Ripple Tank

Adjusting the Vibration amplitude and Strobe intensity may give clearer wave patterns.



Idealised pattern showing plane waves being reflected and the angles involved



Refraction

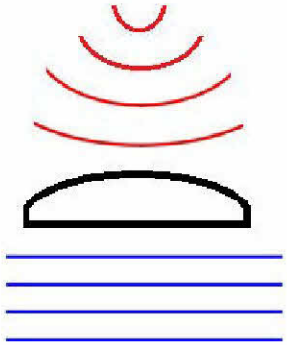
Use water with a very small amount of liquid detergent added (2 drops per 100 ml of water). Stir but avoid making bubbles. Start with about 120 ml of water in the tank. Insert the plane wave dipper into the vibration stem.

Place the planoconvex lens in the water tank in front of the dipper as shown.
Add or remove water so that the refractor is covered by a thin layer.
A thin layer of water serves as the refracting medium.

In Synchronised mode, set the frequency to 70 Hz.
Observe the incident and refracted wave fronts.

Adjust the water level with the pipette dropper, and adjust the frequency until the wave pattern is similar to the example. Patient adjustment is necessary.

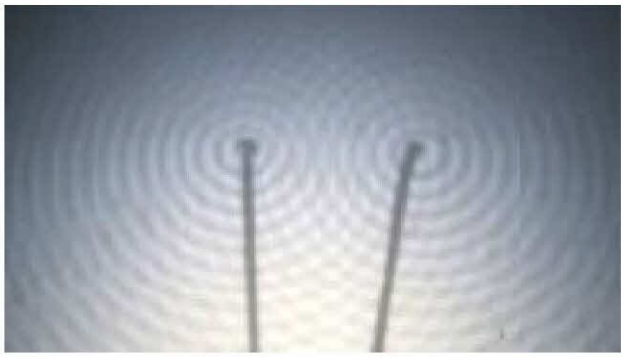
The other shapes for refraction can model the behaviour of light incident upon a rectangular glass block, an equilateral prism, or a concave lens.



Idealised pattern showing the focusing effect of a planoconvex lens

Waves passing over a refractor shape are slowed relative to waves bypassing the shape. Waves at the centre are slowed more, producing the curved waves beyond the shape.

Interference



Start with about 115 ml of clean, fresh water in the tank.
Insert the double point dipper in the vibration stem.

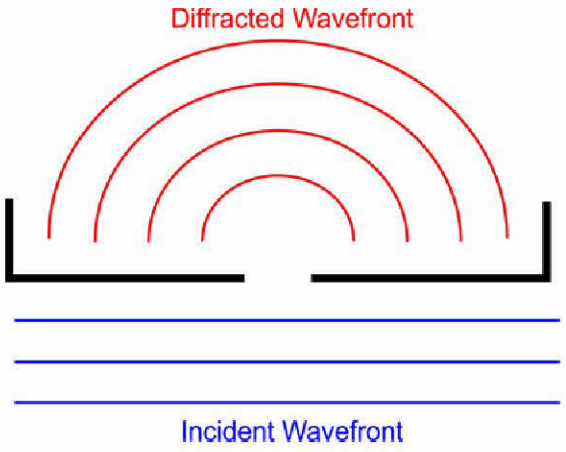
In Synchronised mode, use the frequency range 90 to 150 Hz

Observe the interference pattern.
This the result of two identical sets of circular waves meeting and interfering.

At some points within the tank, a wave crest meets a wave crest and a "super-wave" is produced.
At other points, a wave trough meets a wave trough and "super-trough" is produced.
At some other points, a wave crest meets a wave trough and they cancel out, leaving calm water.
Because the waves are regular, the pattern of super-waves/troughs, and calm water is regular.

Using the Advanced Ripple Tank
Adjusting the Vibration amplitude and Strobe intensity may give clearer wave patterns.

Diffraction



Start with about 115 ml of clean, fresh water in the tank.
Insert the plane wave bar dipper into the vibration stem.

Place the two L-shaped diffraction barriers in front of the plane wave dipper with a narrow gap (3 mm) between them.

In Synchronised mode, set the frequency to 90 Hz.

As the plane waves arrive at the gap, the water in the gap moves up and down at the same frequency. Because the gap is narrow, it acts as a point source of waves, which are therefore circular.
This is an example of diffraction, a feature of all types of wave.

Adjust the width of the gap. You should find the clearest diffraction when the gap is equal to the wavelength of the incident waves.

Using the Advanced Ripple Tank
Adjusting the Vibration amplitude and Strobe intensity may give clearer wave patterns.

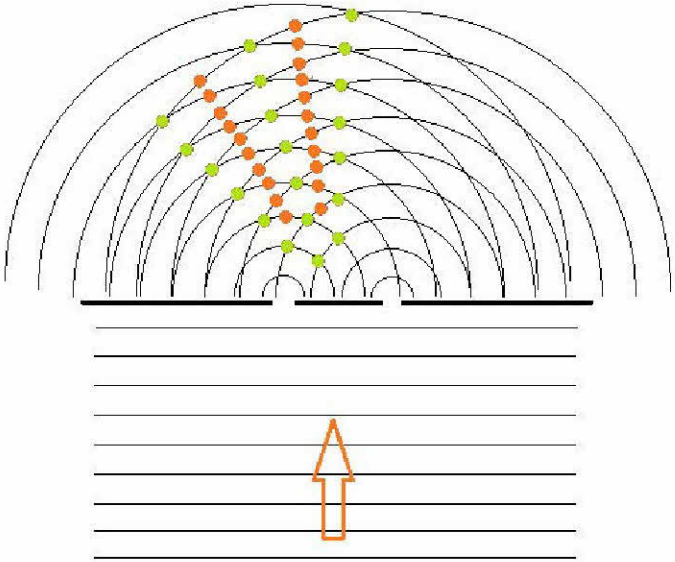
Diffraction is the property that explains the behaviour of Young's double slit.

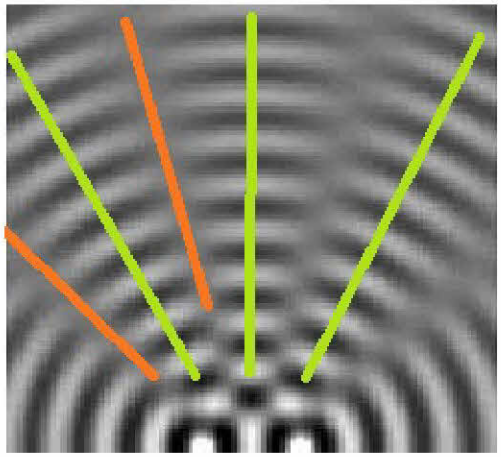
Young's double slit
Start with about 115 ml of clean, fresh water in the tank.
Insert the plane wave bar dipper into the vibration stem.

Place the Young's double slit barrier in front of and parallel to the plane wave dipper.
In Synchronised mode, set the frequncy to 90 Hz at first.

As the plane waves arrive at the barrier, diffraction occurs at both slits. Two sets of identical circular waves are created.
As these circular waves travel they meet, overlap and interfere.

Adjust the frequency, so that the wavelength of the waves is similar to the width of the gap. You should find the clearest wave pattern when the wavelength of the incident waves is equal to the width of the gap.





Look for the places where constructive interference produces "super-waves" these radiate outwards in lines from a point between the two slits (green dots).
Likewise, look for the places where a wave and a trough interfere destructively to produce calm water. These also radiate outwards in lines (orange dots).

The lines of green dots correspond to the formation of first, second and third order images, when laser light is incident on a double slit.
These observations are at the heart of the wave-particle duality of light and other electromagnetic radiation.

Using the Advanced Ripple Tank
Adjusting the Vibration amplitude and Strobe intensity may give clearer wave patterns.

Curriculum references

Experiments and demonstrations using the Ripple Tank, provide support and tangible explanation for many wave phenomena:
- reflection and refraction of light
- interference of sound waves from two identical sources
- interference and diffraction of laser light

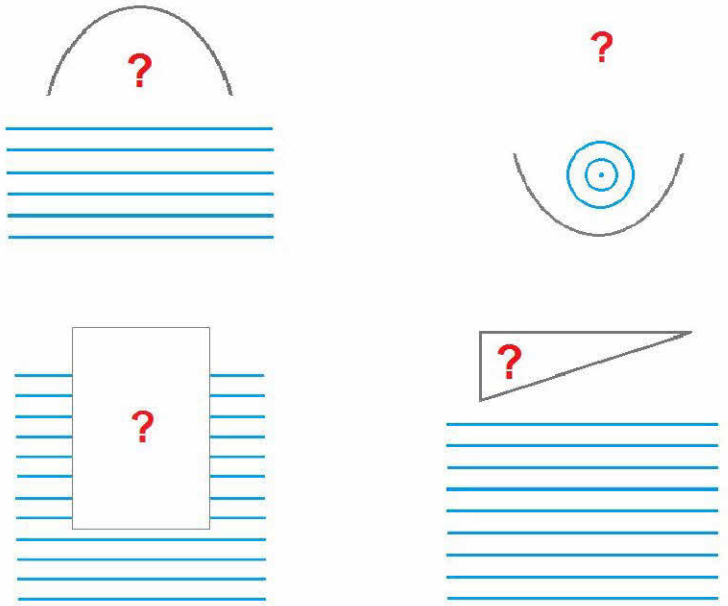
AQA Required practical 2: Investigation of the interference effects by Young's slit and diffraction by a diffraction grating
EDEXCEL Core practical 8: Determine the wavelength of light from a laser or other light source using a diffraction grating
OCR Practical activity 5: Investigating waves - determination of the wavelength of light and sound by two source superposition with a double-slit and diffraction grating

Suggested experiments

Reflection

Use the plane wave dipper to send plane waves toward the curved barrier.
Look at the waves after they have been reflected.
Do they seem to converge to a focus?

Switch off the vibration. Reverse the curved reflector.
Use the single point dipper to make circular waves near the centre of the reflector. Adjust the position of the reflector.
Can you make plane waves appear in front of the reflector?



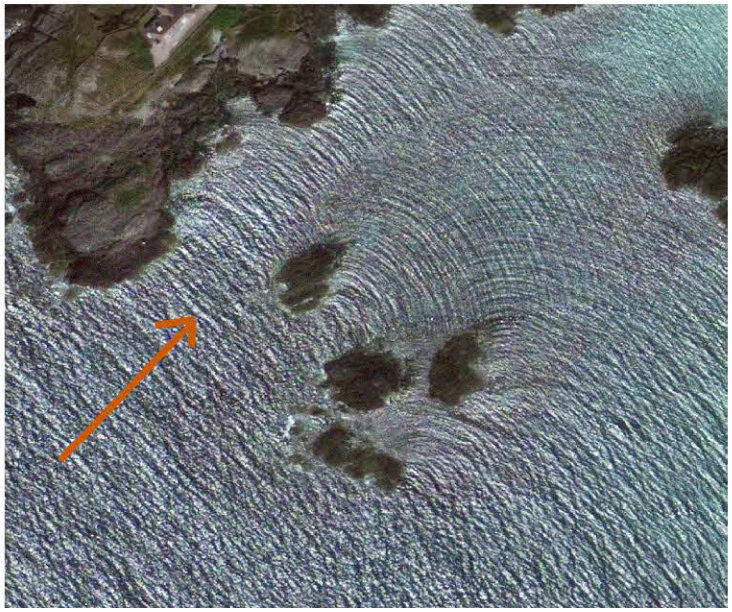
Refraction

Use water with a little liquid detergent added (2 drops per 100 ml).
Use the plane wave dipper to send waves toward the rectangular block, at 90 Hz.
Make sure there is a thin layer of water covering the block.
What happens to the waves as they pass over the block?
Do they travel at the same speed as waves that do not pass over the block?

Repeat the experiment, using the asymmetric prism.
Again, be sure the prism is covered by a thin layer of water. Frequency 60 Hz.
If the waves change speed as they pass over the prism, what will happen to their direction in the space beyond the prism?

Real world diffraction and interference

Study the photograph of waves travelling into a bay.
Approximately plane waves arrive, travelling towards two gaps between the rocks.



The circular shape of the waves beyond the gaps, show that diffraction has occurred.

Further to the right, two sets of circular waves have met and overlapped, giving a typical interference pattern.

Diffraction and interference are features of all types of wave: water, sound, radio and light. Laser light passing through a diffraction grating gives a clear example.

How to use Camera Mode

The Advanced Ripple Tank control panel includes the Camera mode key.
This provides the ability to capture and display wave patterns on a computer screen or whiteboard.

To use the Camera mode, you may use any suitable camera, with the following or similar specifications:

Optical Resolution	640x480 or better
Focal Length	2.3 mm
Image Capture (4:3 SD)	640x480, 1.3MP, 3MP, 5MP
Image Capture (16:9 W)	320x180, 360P
Video Capture (4:3 SD)	320x240, 640x480, 1024x768
Video Capture (16:9 W)	320x180, 360P
Frame Rate (max)	640x480@30

Setting up the camera

Connect the camera to the computer via USB Cable.
Open the recommended software for camera.

Press the Camera mode key.

Set the Strobe frequency to an integral multiple of the camera's frame rate,
e.g. if the frame rate is 30 Hz then set the frequency to 30, 60 or 90 Hz.

Select Independent mode, so that the Vibration frequency may be different by
a few Hz to show moving waves.

Position the camera directly above the viewing screen to get a clear rectangular image of the viewing screen.

Please note:

While using camera mode, the wave pattern is not visible in the viewing screen.
Wave patterns are only visible on the computer screen when Camera mode is on.

The Ripple Tank strobe frequency has been synchronised with the camera's frame rate.
For our experiments we used a Logitech Camera (Model C170).