

# MICROWAVE EXPERIMENTS



## What to do

1. Investigate reflection and interference of waves
2. Investigate polarisation
3. Investigate diffraction



**SAFETY:** Do not place eyes directly in the path of transmitted or reflected microwaves, particularly **DO NOT PLACE EYES VERY CLOSE TO THE TRANSMITTER**. This can damage tissue in the same manner that food is heated in a microwave oven. Otherwise, the output of the transmitter is a low enough power at 10mW to pose no risk. Microwave ovens are usually 1000W, 100 000 times the power supplied by this unit.

Microwaves are electromagnetic waves with wavelengths between 1mm and 1m. These waves have similar properties to light waves, but at a much larger scale, making them easier to experiment with. This particular microwave transmitter has a wavelength of 2.8cm. This corresponds to a frequency of 10.7 GHz. Microwave ovens typically have a wavelength of 12.2cm. Certain particles, such as water and fat, have naturally occurring dipoles. These dipoles move to align themselves with the electric field of the microwaves and this movement knocks neighbouring particles. This vibration of particles is the heating of food in the microwave.

## REFLECTION

Place the transmitter and receiver about 1m apart (using a modulated signal of 1kHz or 100Hz.) Investigate the effect of placing the hardboard plate and then the metal plate in front of the transmitter.



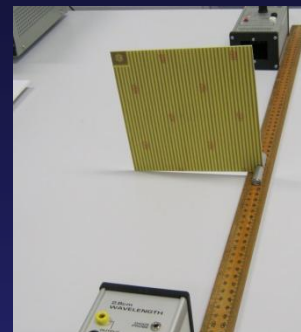
Now place the receiver and transmitter next to each other and place the metal plate about 0.5m away. Rotate the transmitter so that the microwave signal hits the metal plate at an angle and then rotate the receiver until it picks up the signal. You should find the angle of incidence equals the angle of reflection.



Next attach the diode probe and place a reflective metal plate about 1m away from the transmitter. Position the probe close to the metal plate and move it toward the transmitter. The interference of the transmitted wave with the reflected wave can be detected. The two waves form a standing wave with nodes (where the waves cancel each other) and anti-nodes (where the waves reinforce each other) occurring at quarter wavelengths.

## POLARISATION

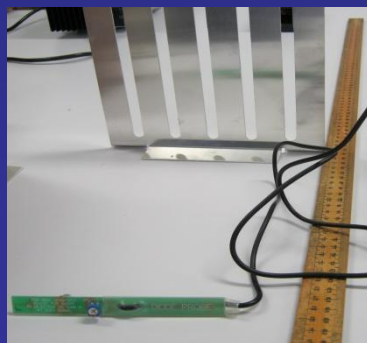
The polarisation of waves refers to the direction in which the electric field of the wave is travelling. If the travelling waves all have their electric field oscillating up and down they are said to be vertically polarised. The microwave transmitter and receiver transmit and detect vertically polarised microwaves.



Therefore, if the transmitter or receiver is translated about their horizontal axis by 90°, the signal will no longer be detected. Try this. A polarising grille has also been provided. Place this between the transmitter and receiver (in their usual orientations.) Now rotate the polarisation grille by 90°. Can you explain what is happening? The metal strips, which conduct charge, are oriented horizontally when the signal is transmitted and vertically when it is blocked. The re-radiation of the plate cancels the signal when the electrons can oscillate freely (when the strips are vertical), but has little effect otherwise.



## DIFFRACTION



Place the diffraction grating about 0.5m away from the transmitter and the diode probe (plugged into the receiver) about 0.3m away from the grating. Now, move the diode probe parallel to the grating. What do you hear?

The diffraction of the microwaves at the diffraction grating allows the slits to act as sources of radiation. At some distance away these sources interfere with each other and cause points of both constructive and destructive interference.