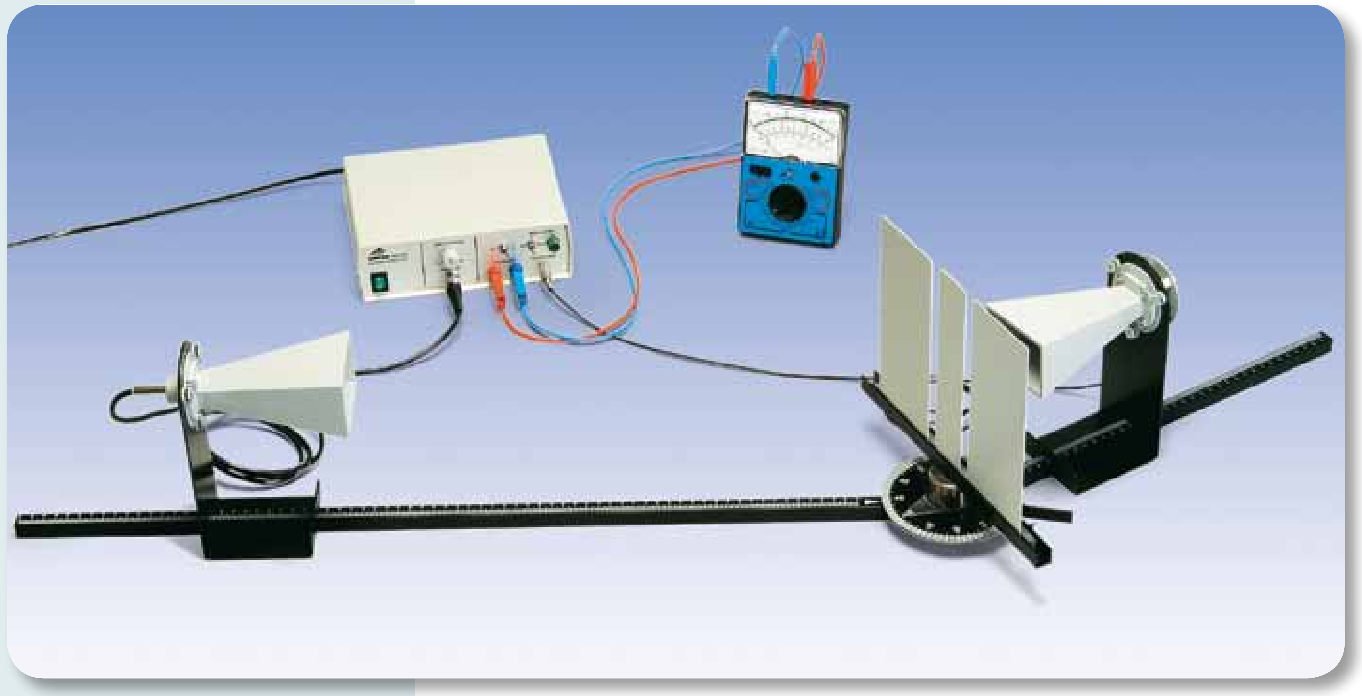

EXPERIMENT PROCEDURE

- **Take point-by-point measurements of the intensity when microwaves are diffracted at a pair of slits.**
- **Determine the positions of the maxima for different diffraction orders.**
- **Determine the wavelength when the distance between the slits is known.**
- **Investigate the polarisation of the emitted microwaves and modify it.**

OBJECTIVE

Demonstrate and investigate the phenomena of interference, diffraction and polarisation using microwaves.

SUMMARY

Using microwaves, many experiments can be conducted on interference, diffraction and polarisation, as an aid to understanding these phenomena for visible light. Diffracting objects and polarisation gratings can be used which possess a structure that can be seen with the unaided eye and easily understood. In the case of diffraction by a pair of slits, maximum intensity can be detected at a position where radiation travelling in a straight line from the transmitter could not possibly reach.

REQUIRED APPARATUS

Quantity	Description	Number
1	Microwave Set 9.4 GHz (230 V, 50/60 Hz)	**1009951** or
	Microwave Set 10.5 GHz (115 V, 50/60 Hz)	**1009950**
1	Analogue Multimeter AM50	**1003073**
1	Pair of Safety Experimental Leads, 75cm, red/blue	**1017718**

BASIC PRINCIPLES

In wave optics light is regarded as consisting of transverse electromagnetic waves. This explains the phenomena of interference, diffraction and polarisation. Microwaves too are electromagnetic waves and they exhibit the same phenomena, but the wavelengths are much greater than those of visible light. Consequently, wave optics experiments can also be carried out using microwaves with diffraction objects and polarisation grids, the internal structure of which is obvious to the unaided eye.

This experiment investigates the diffraction of microwaves of wavelength at a pair of slits separated by a distance *d* of several centimetres. Measure the characteristic intensity distribution for diffraction by a pair of slits (see Fig. 1), with maxima at the angles $_m$ satisfying the condition:

(1) $$\sin\alpha_m = m \cdot \frac{\lambda}{d}, \quad m = 0, \pm 1, \pm 2, \ldots$$

Evidently the maximum intensity is observed when the detector is positioned exactly behind the central strip between the slits (= 0, *m* = 0), where it could not have detected radiation travelling along a straight-line path from the transmitter. This phenomenon can be explained as the result of interference between the partial wave beams from the two slits and is clear evidence for the wave nature of the microwaves.

By rotating the detector about the direction of the source, clear evidence for the linear polarisation of the emitted microwaves can be obtained. When the planes of the transmitter and the detector are crossed at 90° the observed intensity falls to zero. If one of the polarising grids is then placed in the beam at an orientation of 45° to the other, the detector again detects radiation, although with a smaller amplitude than before. The grid transmits that component of the electric field vector of the incoming microwaves that vibrates parallel to the direction of the polarising grid. In this way the component vibrating in the direction parallel to the plane of the detector can be measured.

NOTE:

Experiments on the absorption, reflection, refraction and polarisation of microwaves can be performed using the same equipment.

EVALUATION

Measure the diffraction angles α_m for the different intensity maxima and plots a graph of $\sin \alpha_m$ against the diffraction order *m*. The experimental measurements lie on a straight line through the origin, the gradient of which corresponds to the ratio λ/d.

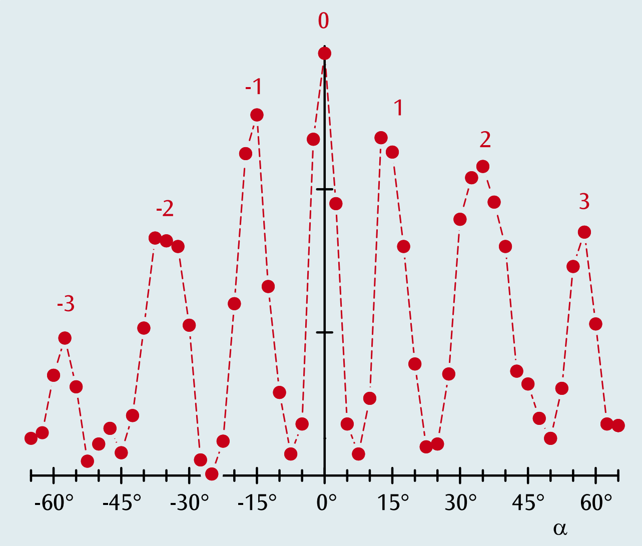

Fig. 1: Intensity distribution resulting from the diffraction of microwaves at a pair of slits.

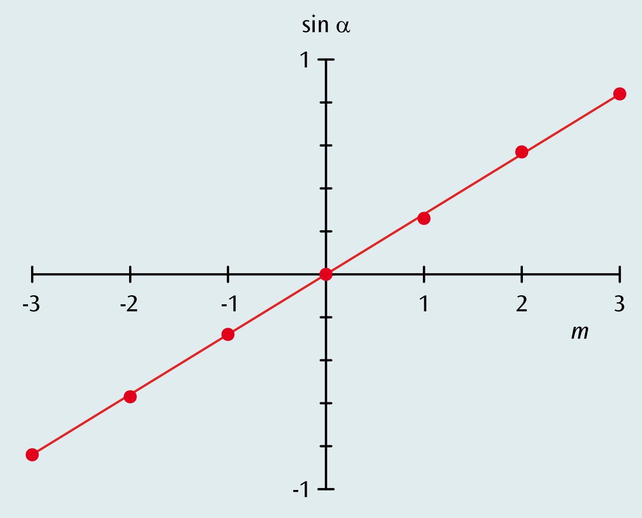

Fig. 2: Positions of the intensity maxima as a function of the diffraction order *m*.