Wave phenomena exhibited by microwaves

Objective

To study different wave phenomena exhibited by microwaves.

Background information

1 All electromagnetic waves, including microwaves, exhibit reflection, refraction, diffraction and interference.

2 The 3-cm wave apparatus can be used to demonstrate that microwaves exhibit the wave phenomena. The transmitter connected to a power pack can emit microwaves of wavelength 3 cm. When the receiver or point-detector detects microwaves, the loudspeaker connected to it will sound.

<table>
<thead>
<tr>
<th>Apparatus</th>
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<tr>
<td>• 2 microwave transmitters/receivers</td>
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<td>• 1 power pack (0–12 V a.c./d.c.)</td>
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<td>• 1 loudspeaker</td>
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<td>• 3 metal plates (2 large, 1 small)</td>
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<td>• 1 convex paraffin len</td>
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<tr>
<td>• 1 point-detector</td>
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<td>• 1 screw jack</td>
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Procedure

A Reflection

1 Set up the apparatus as shown in Figure 6g-1.

2 Move the receiver to the position that the loudspeaker sounds.
### Refraction

3. Set up the apparatus as shown in Figure 6g-2. Adjust the screw jack such that the transmitter points at the middle of the convex paraffin lens. The tip of the point-detector should be at the same level as the middle of the lens.

4. Put the point-detector at a position close to the lens. Then move the detector away from the lens slowly along a straight line and note how the loudness of the sound produced by the loudspeaker changes.

#### Fig 6g-2

### Diffraction

5. Set up the apparatus as shown in Figure 6g-3. Point the transmitter at the slit formed by the metal plates. The slit should be about 3 cm wide.

6. Move the receiver to different positions and note how the loudness of the sound produced by the loudspeaker changes.

#### Fig 6g-3

It may not be necessary to demonstrate all 4 phenomena, since the key wave phenomena are diffraction and interference.
**D  Interference**

7  Set up the apparatus as shown in Figure 6g-4. Point the transmitter at the double-slit formed by the metal plates.

8  Move the receiver along the arrow and note how the loudness of the sound produced by the loudspeaker changes.

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### Results and analysis

**A  Reflection**

1  Does the receiver detect the microwaves emitted by the transmitter?

   Yes

**B  Refraction**

2  How does the loudness of the sound produced by the loudspeaker change when the point-detector moves away from the lens?

   The loudness increases to a maximum and then decreases.

**C  Diffraction**

3  Can the receiver detect any signal in the shadow region of the metal plates?

   Yes

**D  Interference**

4  How does the loudness of the sound produced by the loudspeaker change when the receiver moves along the arrow?

   The loudness switches between high and low levels alternately.
Discussion

About the procedure

1 Why is a metal plate put between the transmitter and receiver in part A?
   This prevents the microwaves emitted by the transmitter from reaching the receiver directly or by diffraction.

2 The slit in part C is about 3 cm wide. Explain why this is the case.
   The wavelength of the microwaves emitted is about 3 cm. Diffraction is most prominent when the width of the slit is about the same as the wavelength.

About the results

3 Do microwaves exhibit reflection, refraction, diffraction and interference?
   Yes

Further thinking

4 Do microwaves travel faster or slower in paraffin than in air?
   Slower

5 Suggest a method to verify that the wavelength of the microwaves emitted by the transmitter is 3 cm.
   Use the set-up in part D. Move the receiver along the arrow. Record the path differences $\Delta_1$ and $\Delta_2$ of two consecutive maxima. The difference between $\Delta_1$ and $\Delta_2$, equal to the wavelength of the microwave, should be about 3 cm.

Conclusion

Microwaves exhibit reflection, refraction, diffraction and interference.