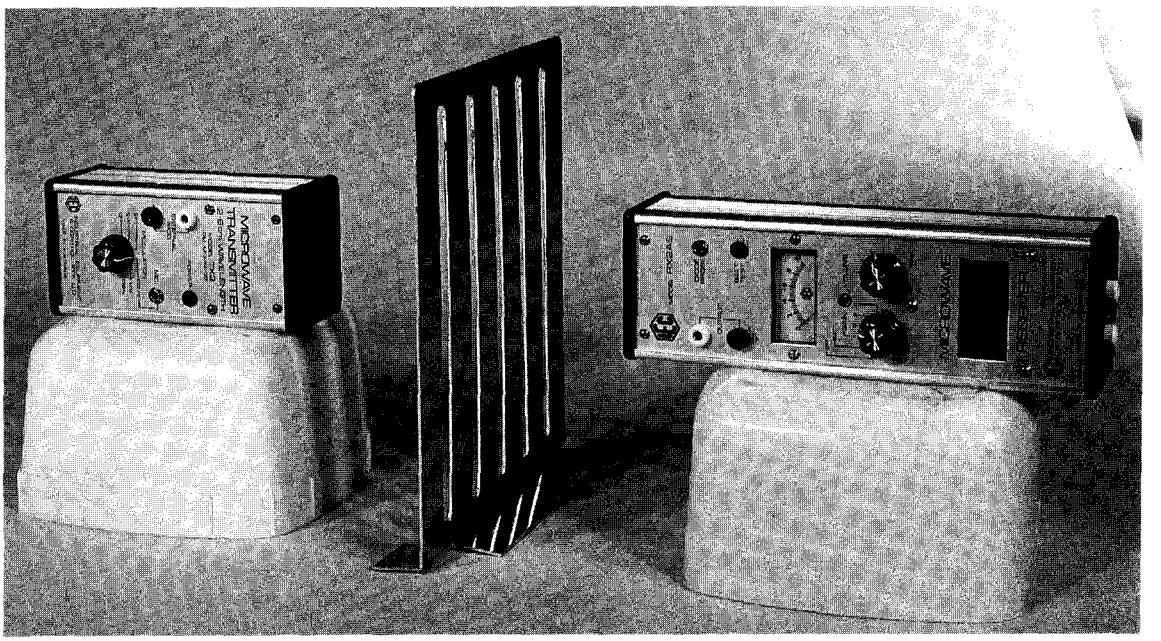
MICROWAVE KIT



The microwave kit is an excellent tool to demonstrate the similarities in the properties of microwaves and lightrays. This canbeextrapolated to suggest the similarities the properties of all electromagnetic radiation.

A major advantage in working with microwaves is that the long wavelength allows experimental measurements to be taken with protractors and metre rules.

The beam of microwaves is also perfectly polarised and monochromatic which allows it to be used as a 'long wavelength laser' to demonstrate properties of electromagnetic waves such as reflection, refraction, absorption, diffraction, interference, polarisation, the inverse square law, doppler effect and radio transmission.

The microwave kit consists of a microwave transmitter, a receiver and a number of accessories including a diode probe unit, hollow shapes, wax lenses, metal screens and grids.

The transmitter produces microwaves of approximately 3cm wavelength and 9000 MHz frequency at a power output of 10 mW. The microwaves are produced inside a rectangular waveguide fitted with a horn from which they emerge, plane polarised vertically (electric component) and completely coherent. The microwaves are modulated by an audio oscillator to enable the user to hear where the intensity of radiation is a maximum or minimum.

The receiver consists of a dipole in a tuned waveguide section fitted with a horn. This enables it to discriminate the direction of polarisation of the electric field. A second receiver, called a diode probe unit, is not as sensitive as the horn receiver, but detects microwaves through a 360° arc.

SAFETY PRECAUTIONS

The microwave equipment is safe to use because the poweroutput is so low. *- 10^{-5} times thepoweroutput of an average microwave oven.* However, since excessive microwave energy can destroy tissue, a few recommended safety measures have been set out as follows:

- Don't look directly into the beam at close range (1 m).
- Take particular care when using the wax "lenses", as they focus the intensity of the beam to a point.
- Avoid reflective surfaces, such as metal taps, which might reflect the beam in many different directions.
- *Do NOT connect the older style receivers to a power supply, as this will destroy it.* (A power supply is only required to run the audio amplifier.)

SETTING UP AND USING THE MICROWAVE KIT

It is worth checking the following before setting up the equipment.

There are many different models of this equipment, varying mostly in the design of the receiver. In some models a milliammeter and audio amplifier are included internally while in others, just the milliammeter. It is important to follow the instructions appropriate for your model.

Check the fuse in the transmitter - in the newer models, it is located internally.

Extra equipment for the suggested learning experiences includes:

- a meter rule
- 2 power packs
- a demonstration microammeter *(if not included in the receiver)*
- an audio amplifier *(if not included in the receiver)*
- *8* leads with banana plugs
- a protractor
- large sheets of paper
- paraffin oil

Setting up the Microwave Equipment

- Connect the microwave transmitter to the AC terminals of a power pack or klystron power supply, if applicable. Switch the power supply to 12 V AC ('G' setting).
- Connect the audio amplifier, *if not included in the receiver*, to the AC terminals of the other power pack. Switch the power supply to 12 V AC ('G' setting).
- Connect the milliammeter, *if not included in the receiver*, to the microwave receiver and to the input terminals of the audio amplifier. *See figure 1.*
- Position the transmitter and receiver facing each other and approximately 1 metre apart.
- Elevate both the transmitter and receiver above the desktop to avoid unwanted reflections from the wood. (Especially the smaller, newer models.)
- Switch on the transmitter and set it to 1000 Hz. Where possible, 'tune' the transmitter to produce a maximum reading on the milliammeter.
- Switch on the receiver and, where appropriate, choose a *'gain'* setting and volume setting which gives close to a full scale deflection on the internal meter.
- Turn the transmitter off and record the background reading on the milliammeter. Use this as

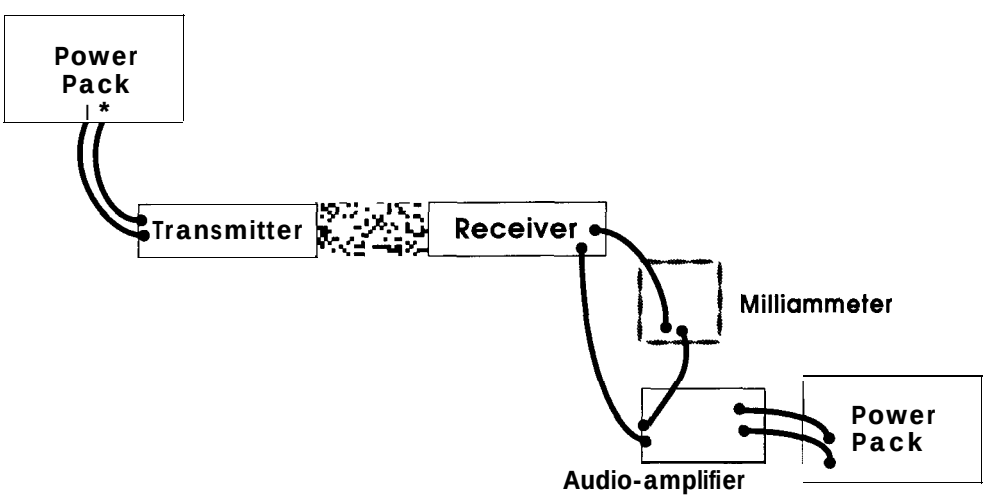


figure 1

your 'zero' reading for all future calculations. If you change the gain setting on the receiver of the newer models you will have to note the new "zero' reading for each setting used.

- When using the diode probe unit, connect it to the receiver and check that there are no reflective surfaces nearby to affect the results.
- To avoid spurious results, use reflective screens between the transmitter and detector when they are side by side.

HANDY HINTS

- Use a metre rule to align the transmitter and receiver with each other.
- When using the newer IEC model, *do notforget to switch off the receiver after use* as it contains an internal battery which, if left on, will quickly become flat.
- You will need a large working space to set up most of the following learning experiences -one large bench or perhaps spread over two benches.

SUGGESTED LEARNING EXPERIENCES

TOPIC -Electromagnetic Radiation

The microwave equipment is a versatile tool for demonstrating many important principles. The manual which accompanies the kit contains detailed instructions for the procedure of each of the following demonstrations:

1. **The similarities in the behaviour of microwaves and light rays** can be shown by performing similar experiments with a ray box as with the microwave kit.
2. **The law of reflection,** using the metal screen and other curved surfaces.
3. **Absorption and partial transmission,** using a sheet of perspex or masonite.
4. **Polarisation of microwaves** using the metal polariser provided.
5. **The law of refraction** through the wax objects and the hollow prism filled with liquids such as water and cooking oil. NOTE: water absorbs the microwaves, showing the principle of microwave cooking.
6. **The refractive index of wax** can be calculated, using wax prism.
7. **The phenomenon of total internal reflection** using wax prism.
8. **The phenomenon of standing waves** using two reflecting surfaces.
9. **The diffraction of waves** around the straight and curved edges of objects.
10. **Diffraction through a single slit** using the metal sheets.
11. **Interference through a double slit** using metal sheets of different sizes.
12. Diffraction through a diffraction grating, using the metal grate provided.
13. Thin film interference using sheets of perspex and metal.
14. The inverse square law for electromagnetic radiation.
15. The doppler effect using a moving source.
16. Demonstrate the concept of radio transmission using a microphone to modulate the wave.