Demonstrations: Notes for Teachers

1. **A b.** The AM radio is a practical device and no practical device is perfect. The noise is generated by electronic components inside the radio. The noise cannot be coming from outside the radio because the aluminium foil is acting as a shield to external signals.

A c. Ideally, if the radio is perfect, it would not produce such noise. In normal receiving service, the internally-generated noise is swamped by the incoming signal. The ideal signal-to-noise ratio would be "all incoming signal and no internally-generated noise".

B a. Aluminium foil is an electrical conductor. It will support surface currents induced in it by electromagnetic waves. Plastic, an insulator, is transparent to radio waves.

B b. Plastic is coloured by using inks. The ink in general use is non-conductive.

B c. Sound waves are longitudinal pressure changes in air. These pressure changes vibrate the wrapping and we hear them.

C b. Careful design of conductors for use as shields makes the separation of electrically-noisy equipment from sensitive receiving apparatus possible.

C c. To receive the maximum signal possible from the transmitted electromagnetic waves which carry the required programmes.

C d. A coaxial cable is a central conductor surrounded by a concentric metal "pipe". Insulation supports the central conductor in the pipe. The pipe acts to shield the external noise from the incoming signal.

The aerial is positioned in a clear position outside buildings to best collect the signals from the passing waves. The shielded down-lead, usually coaxial cable, carries the signal into and through the electrically-noisy areas where we live for processing by the receiver.

2. An electromagnetic wave is not visible. We need something to make us aware of its existence and for us to measure it and to determine its characteristics.

There is magic in the air! Energy to deflect the receiver meter starts at the battery, moves to the transmitter unit which passes it to an aerial where it is launched as an electromagnetic wave which travels on to the receiver.

But we don't need the air! This energy transfer will happen in a vacuum!

Prove it? Radio waves can be bounced off the moon or transmitted to and from distant space-craft.

3. This simple on/off signal can be used for communication, Morse code telegraphy signals are an example.

Other primitive applications include warning alarm devices such as door-bells or maximum-level indicators in a remote reservoir.

The meter-needle waggle will try to follow a new flash-rate.

1. No signal = *Transmitter OFF (or loss of signal)*
2. Steady signal = *Transmitter ON, Modulation OFF.*
3. Meter needle waggles = *Transmitter ON and Modulation ON.*

Signal identifying and selection methods are needed in practice to ensure that the receiver responds to the correct transmitter. The AM receiver (in Demonstration 1) exhibits this by its tuning control selecting the required radio station.

4. The vertical-dipole transmitting aerial should be omni-directional in its horizontal plane, transmitting energy equally in all directions.

Reflections from metal surfaces and objects within a building can distort the result. Try keeping the receiver aerial fixed in position and rotating the transmitter about the vertical axis through its dipole.

Aerials exhibit reciprocity - they work equally well for transmitting or for receiving.

5. The TV broadcasting industry uses vertical and horizontal aerial polarisation in its geographical-coverage planning to reject or to minimise the unwanted signal where two different programmes may share the same broadcast channel.

6. This demonstration builds on and confirms the concepts from Demonstration 1.

The colouring matter in the non-transparent plastic sheet (printer's ink?) should have no effect!

The plastic coating on our aerial elements should likewise have no effect.

7. Devices – reflectors of various types – can be fitted at both the transmitter and the receiver aerials to extend the signal communication distance without increasing the transmitter power output.

8. The analogy of the prisoner can be used: The prisoner (the vertically-polarised wave from the transmitter) wishes to get to the receiver. Can the prisoner get there by squeezing through vertical parallel bars? Or can the prisoner get there by climbing through a horizontal-wire fence? Which will it be? And if the prisoner can't get through, where does the prisoner go?

9. A grating is a useful polarising identifier.

Some UHF (ultra-high-frequency) TV aerials use a "square corner" reflector made up of several wires parallel to the receiving dipole. These simulate a metal sheet reflector but with a much reduced wind-loading.

10. The wave is concentrated in the "forward" direction by the addition of more "directors". The wave is reduced in the "reverse" direction by a single "reflector", so with a much-reduced wave in that direction, added reflectors have minimal effect.

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