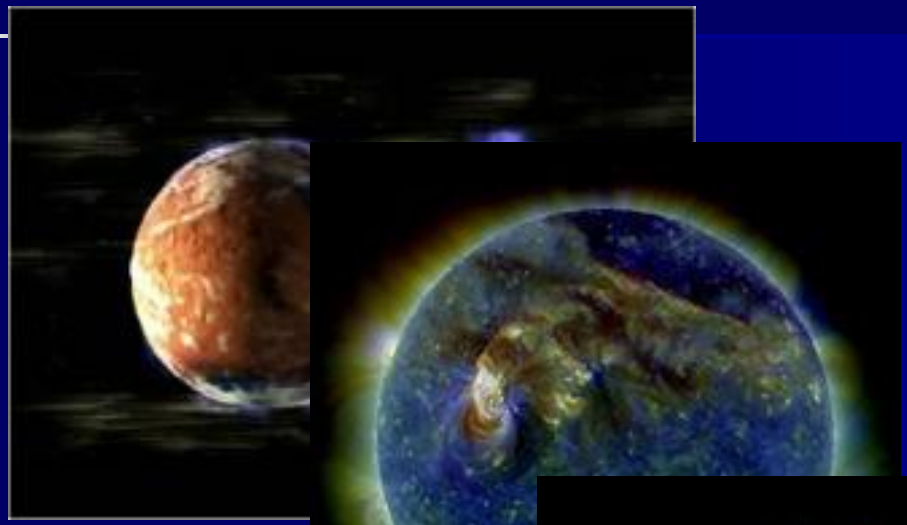
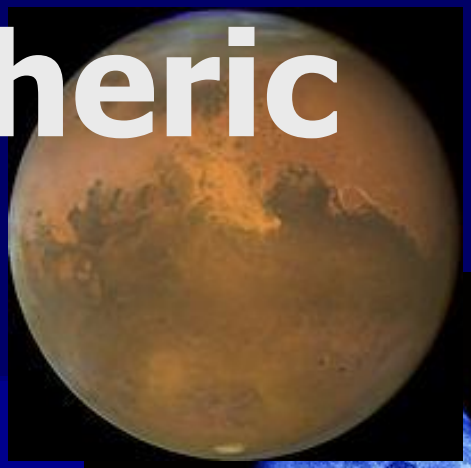
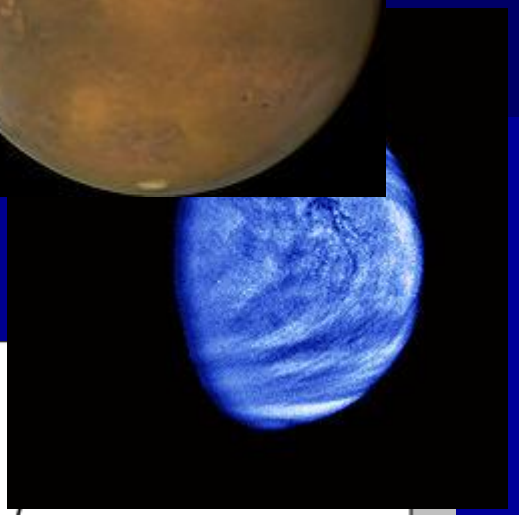
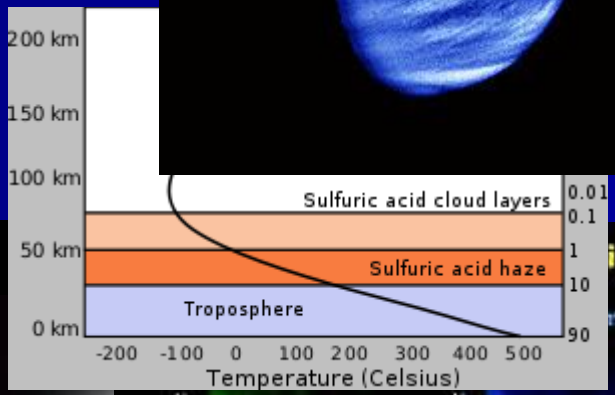
Space Physics

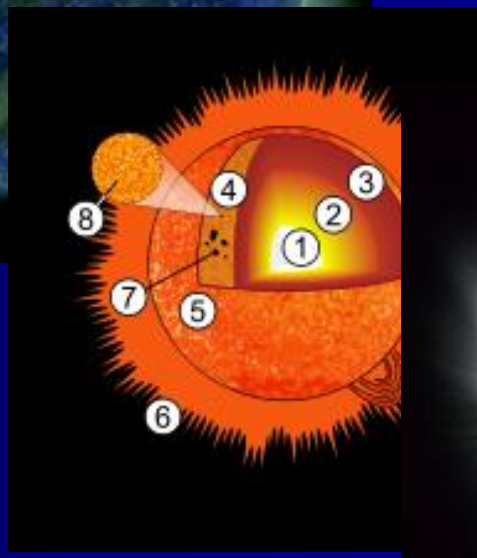
Space & Atmospheric Physics







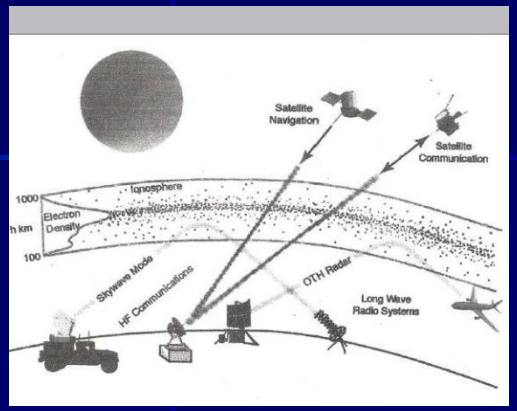




Lecture – 11 C

Radio Wave Communication

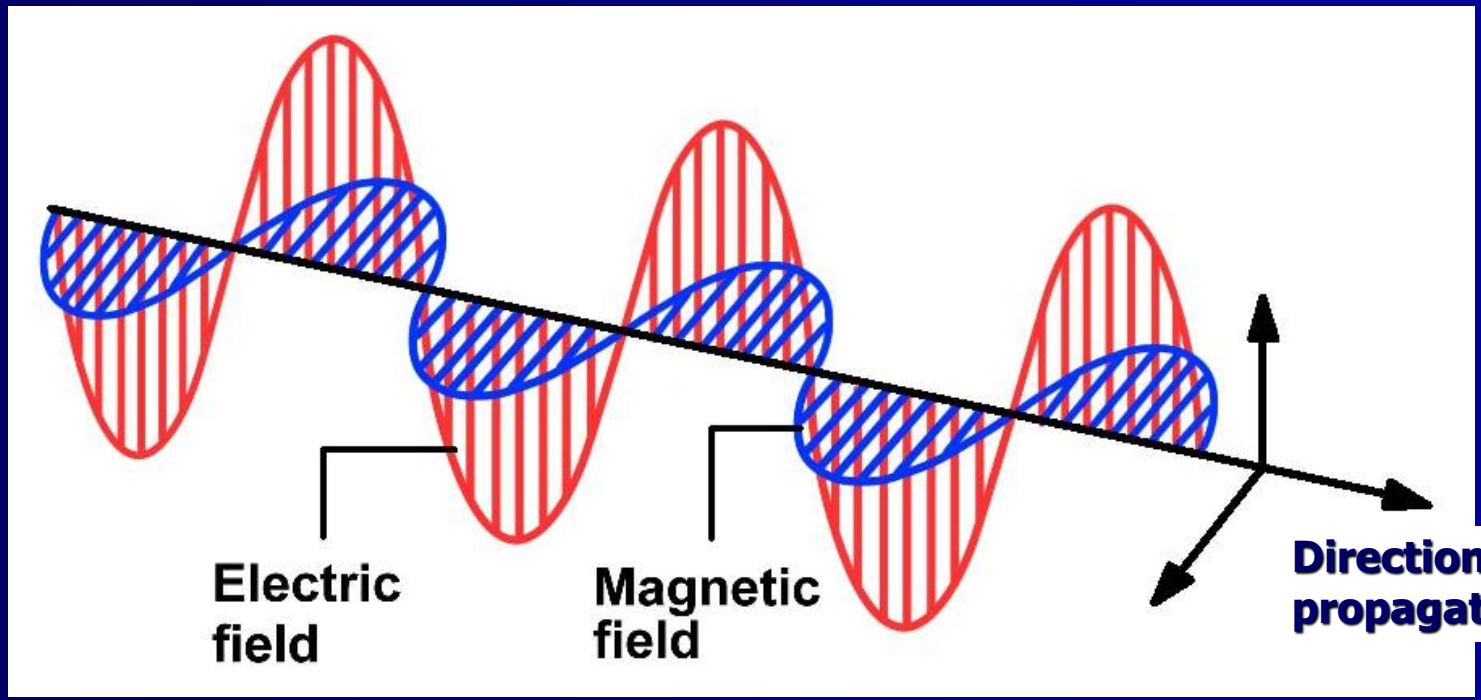
Radio Wave Communication



Radio waves
Radio Communication
Reflection of Radio Waves
Absorption of Radio Waves
Complex Refractive Index
Reflection Heights
Deviating Region Absorption, Non- Deviating Region Absorption
Ordinary/Extra Ordinary Waves
Ionosphere – Sounding Techniques
Pulse Reflection Methods

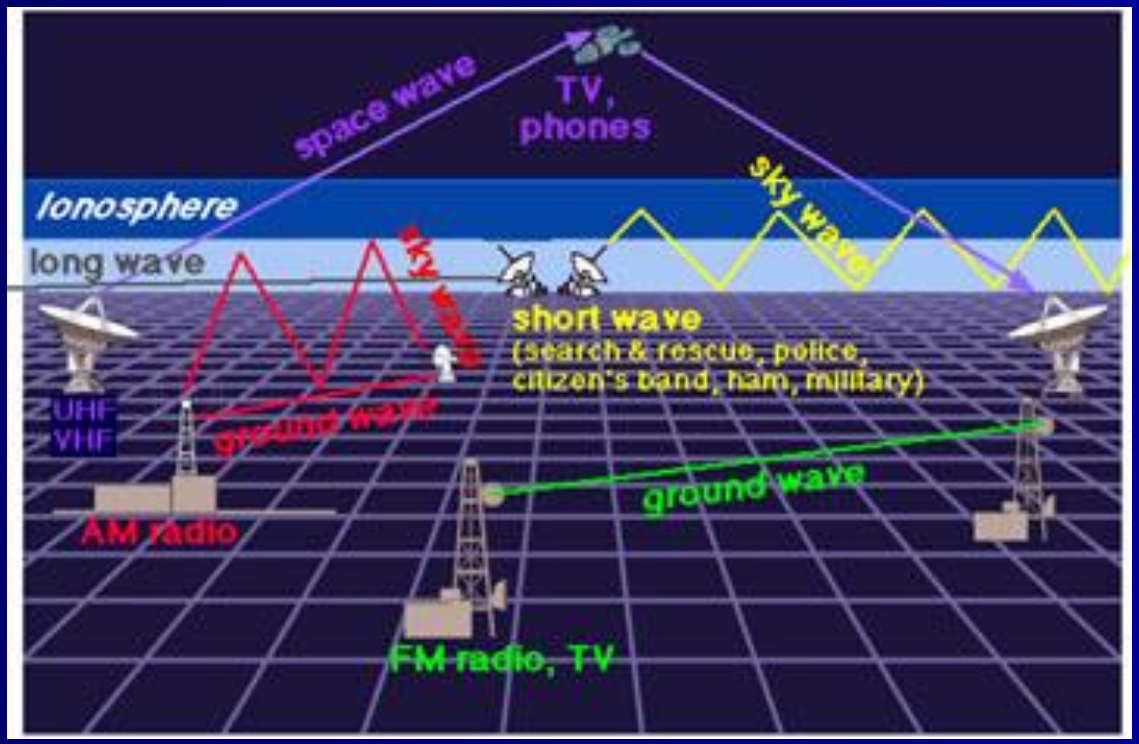
Radio waves

Radio waves are a type of **electromagnetic radiation** with wavelengths in the electromagnetic spectrum longer than infrared light. Like all other electromagnetic waves, they travel at the speed of light. Naturally-occurring radio waves are made by lightning, or by astronomical objects.



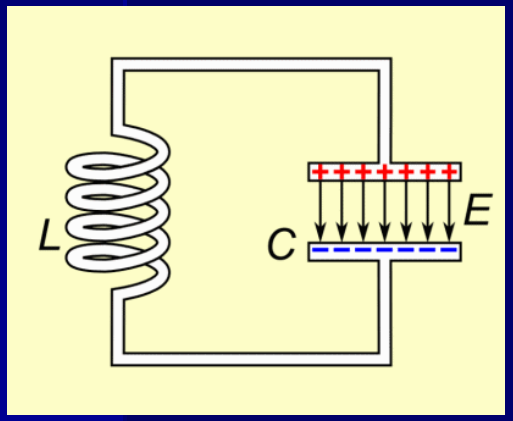
Propagation…

The study of electro magnetic phenomena such as reflection, refraction, polarization, diffraction and absorption is of critical importance in the study of how radio waves move in free space and over the surface of the Earth. Different frequencies experience different combination of these phenomena in the Earth's atmosphere, making certain radio bands more useful for specific purpose than others.



Radio Communication

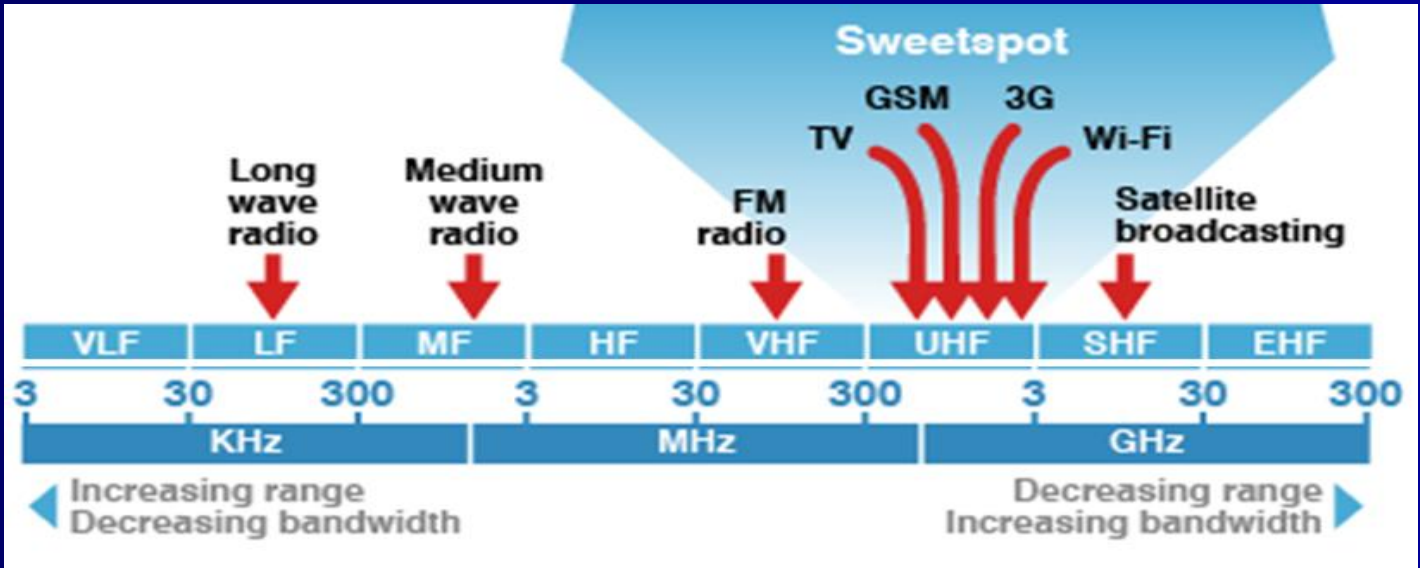
In order to receive radio signals, for instance from AM / FM radio stations, a radio antenna must be used. However, since the antenna will pickup thousands of radio signals at a time, a **radio tuner** is necessary to tune in to a particular frequency (or frequency range).

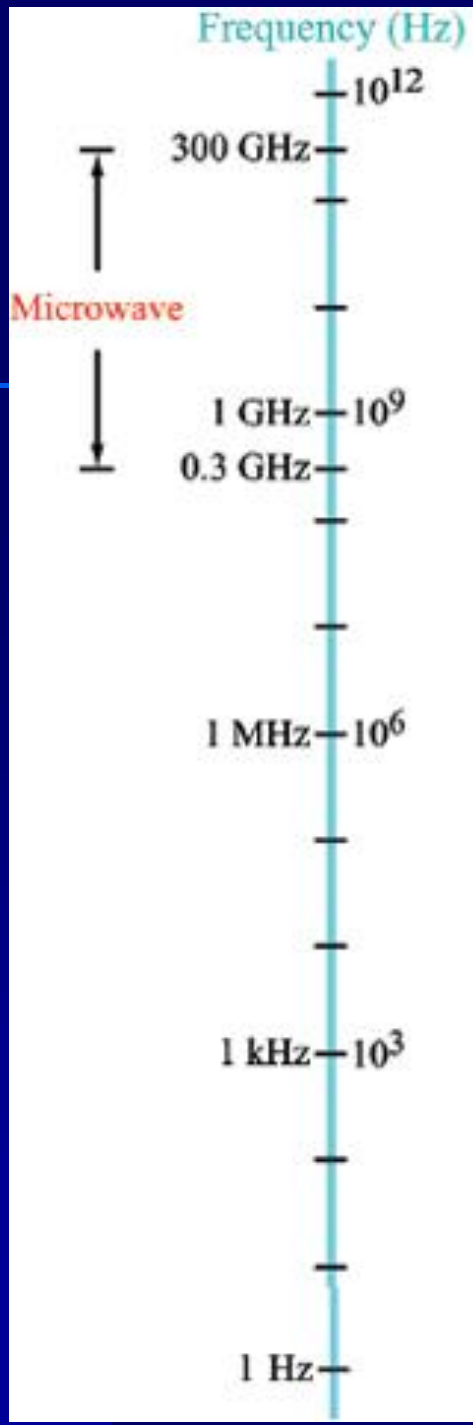


This is typically done via a **resonator** (in **the simplest form, a circuit with a capacitor and an inductor**). The resonator is configured to resonate at a particular frequency (or frequency band), thus amplifying since waves at that radio frequency, while ignoring other **sine waves**. Usually, either the inductor or the capacitor of the resonator is adjustable, allowing the user to change the frequency at which it resonates.

Radio Spectrum

Band	Frequency range	Wavelength range
Extremely low frequency (ELF)	< 3 kHz	>100 km
Very low frequency (VLF)	3 - 30 Hz	10 - 100 krn
Low frequency(LF)	30 - 300 kHz	1 - 10 km
Medium frequency (MF)	300 kHz - 3 MHz	100m - 1km
High frequency (HF)	3 - 30 MHz	10 - 100m
Very high frequency (VHF)	30 - 300 MHz	1 - 10m
Ultra high frequency (UHF)	300 MHz - 3 GHz	10cm - 1m
Super high frequency (SHF)	3 - 30 GHz	1 - 10cm
Extremely high frequency (EHF)	30 - 300 GHz	1mm - 1cm





Band	Applications
Extremely High Frequency (30–300 GHz)	Radar, advanced communication systems, remote sensing, radio astronomy
Super High Frequency (3–30 GHz)	Radar, satellite communication systems, aircraft navigation, radio astronomy, remote sensing
Ultra High Frequency (300 MHz – 3 GHz)	TV broadcasting, radar, radio astronomy, microwave ovens, cellular telephone
Very High Frequency (30–300 MHz)	TV and FM broadcasting, mobile radio communication, air traffic control
High Frequency (3–30 MHz)	Shortwave broadcasting
Medium Frequency (300 kHz – 3 MHz)	AM broadcasting
Low Frequency (30–300 kHz)	Radio beacons, weather broadcast stations for air navigation
Very Low Frequency (3–30 kHz)	Navigation and position location
Ultra Low Frequency (300 Hz – 3 kHz)	Audio signals on telephone
Super Low Frequency (30–300 Hz)	Ionospheric sensing, electric power distribution, submarine communication
Extremely Low Frequency (3–30 Hz)	Detection of buried metal objects
	Magnetotelluric sensing of the Earth's structure

How Radio Communication Works ?

Sound and **Radio Waves** are different phenomena.

Sound consists of pressure variations in matter, such as air or water. Sound will not through a vacuum.

Radio Waves, like infrared, ultra-violet, visible light, X-rays and Gamma rays are **electro-magnetic waves** that do travel through a vacuum. When you turn-on a radio you have sounds because the transmitter at the radio station has converted the sound waves in to electro-magnetic waves, which are then encoded into an electro-magnetic wave in the radio frequency range
(generally in the range of

500 kHz - 1600 kHz for AM stations

or

86 MHz - 108 MHz for FM stations

).

How Radio Communication Works ?

Radio **FM waves** are used because they can travel **very large distance** through the atmosphere **without** greatly **attenuated** due to scattering or **absorption**.

Your Radio Receives the radio waves decodes this information , and uses a speaker to change it back into a sound wave. An picture illustration of this process is given below.

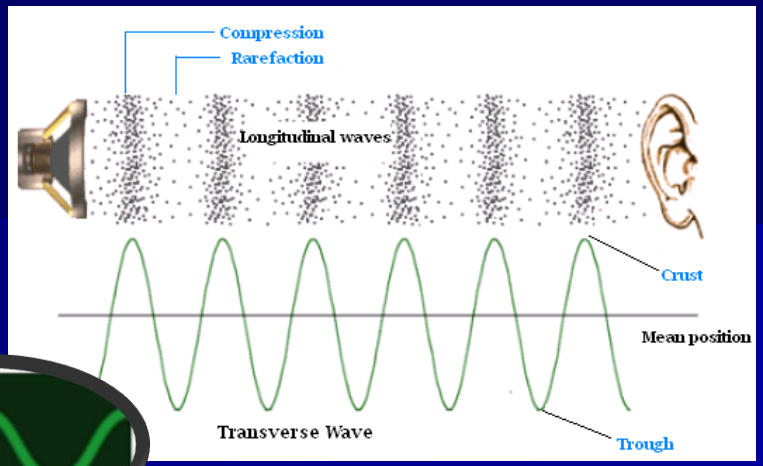
Step – 01

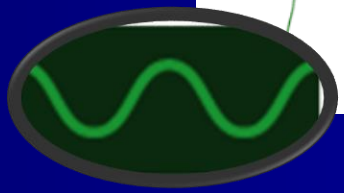
A sound wave produced with a frequency of 5 Hz – ~20 kHz

How Radio Communication Works ?

Step – 02

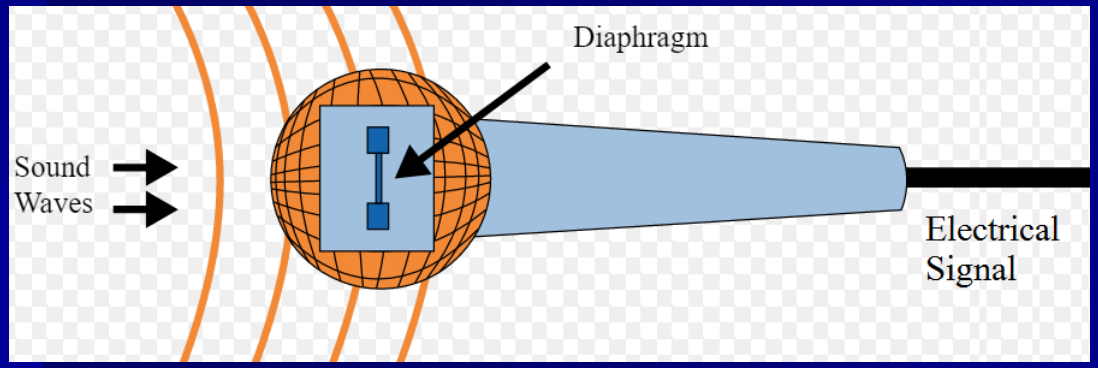
The sound wave is equivalent to pressure wave travelling through the air.

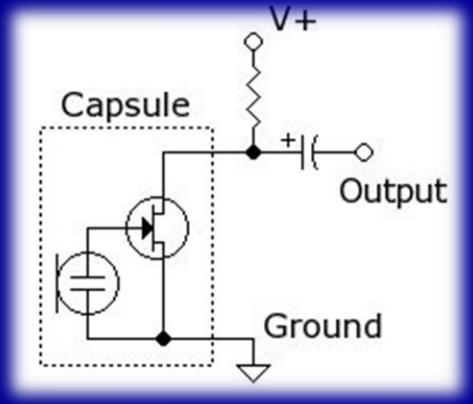




Step – 03

A microphone converts the sound wave into an electrical signal

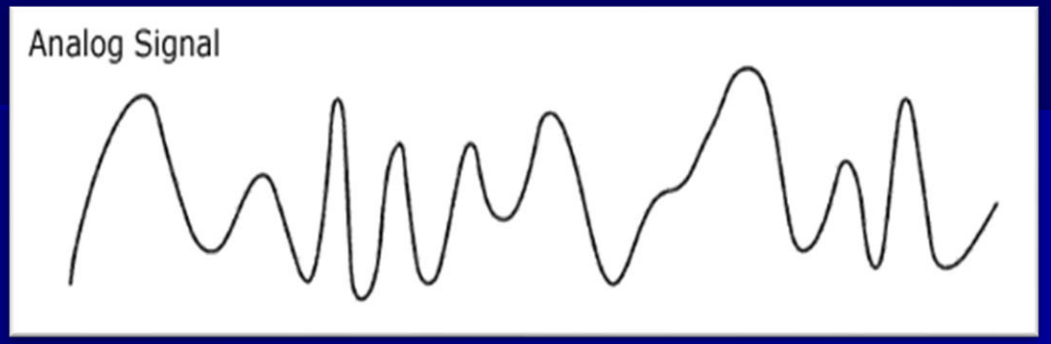




How Radio Communication Works ?

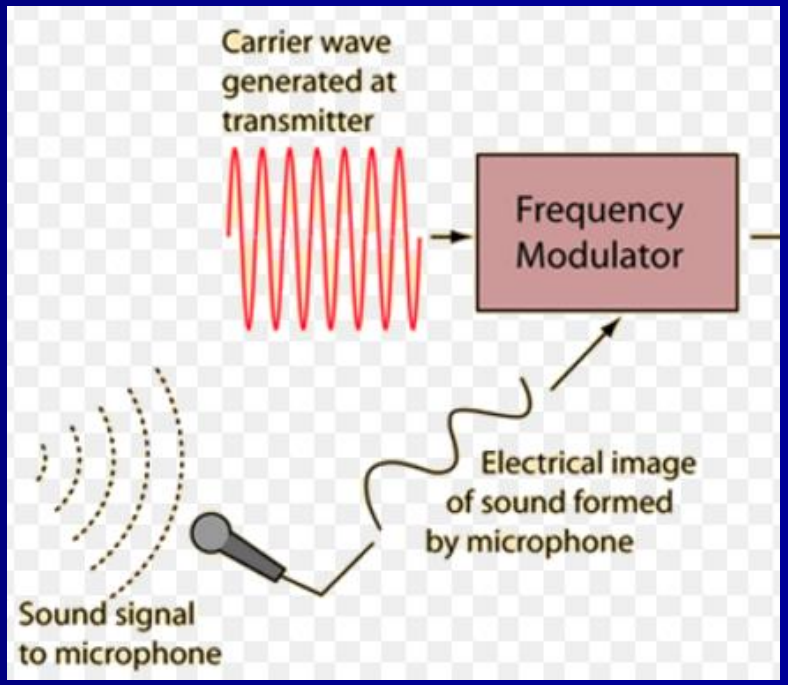
Step – 04

The electrical wave travelling through the microphone wire is analogous to the original sound wave.



Step – 05

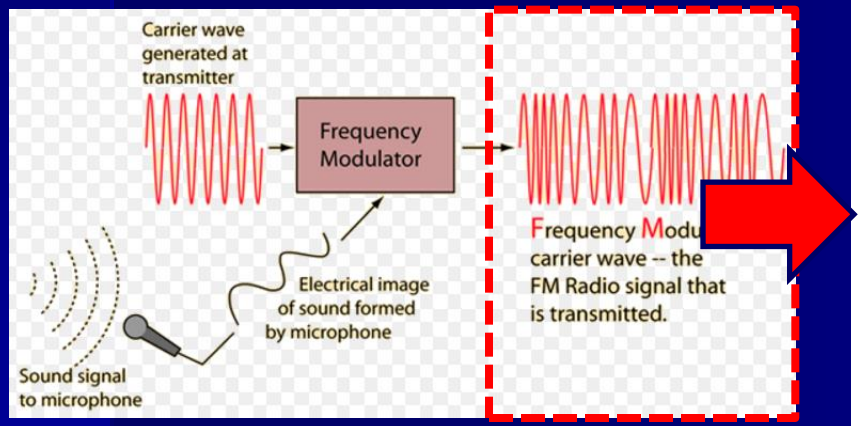
The electrical wave is used to encode or modulate a high-frequency "carrier" radio wave. The carrier wave itself does not include any of the sound information until it has been modulated.

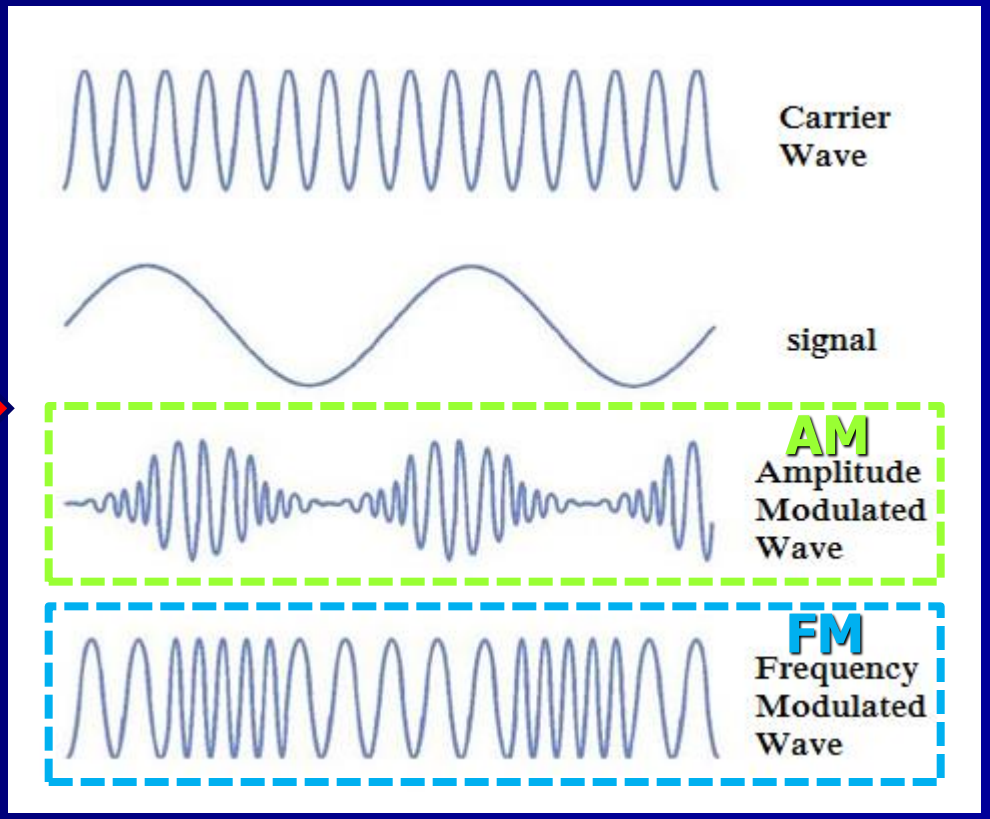


How Radio Communication Works ?

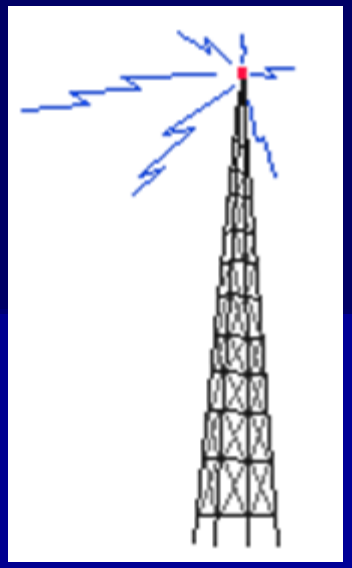
Step – 06

The carrier wave can either be amplitude modulated (AM, top) by the electrical signal, or frequency modulated (FM, bottom).





How Radio Communication Works ?



Step – 07

The signal is transmitted by a radio broadcast tower.

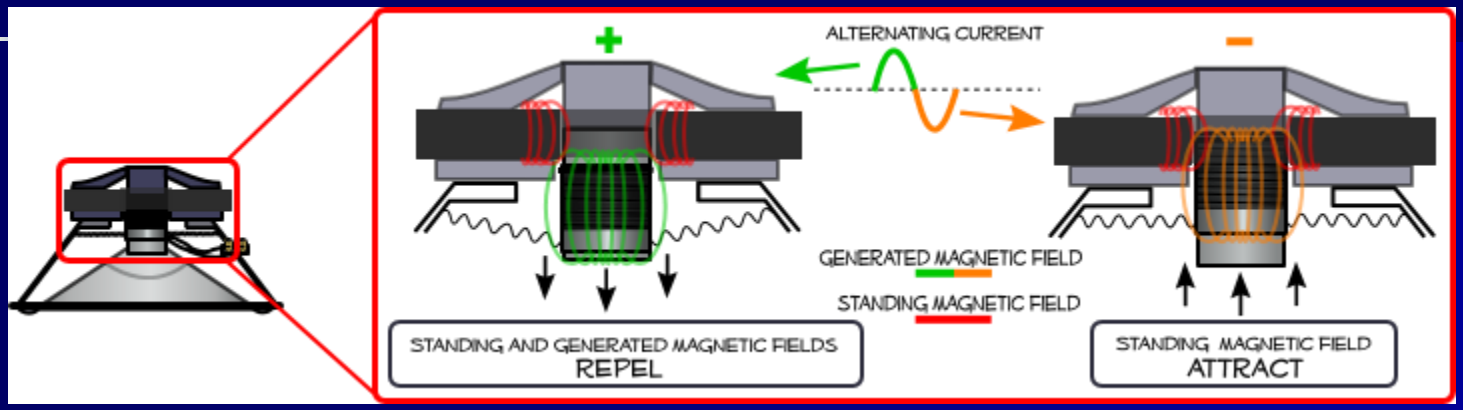
Step – 08

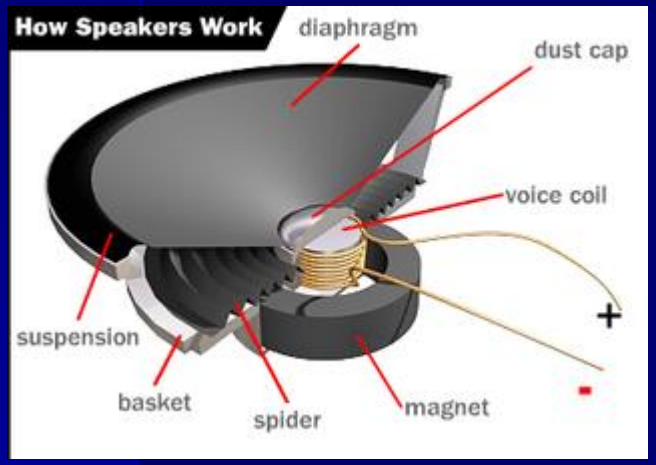
Your radio contains an antenna to detect the transmitted signal,
a tuner to pick out the desired frequency,
a demodulator to extract the original sound wave from the transmitted signal, and
an amplifier which sends the signal to the speakers.

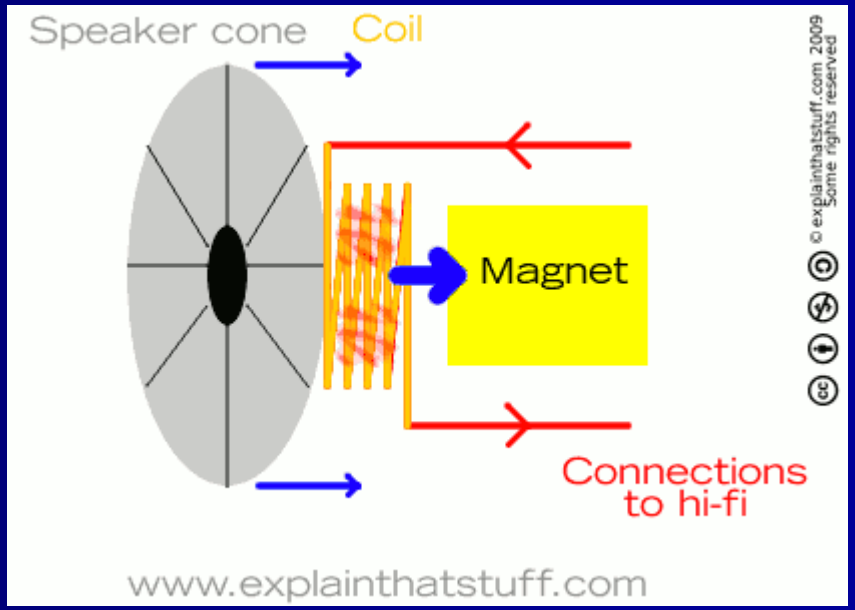
The speakers convert the electrical signal into physical vibrations (sound).

How Radio Communication Works ?

Step – 08 : How to a speaker works ?







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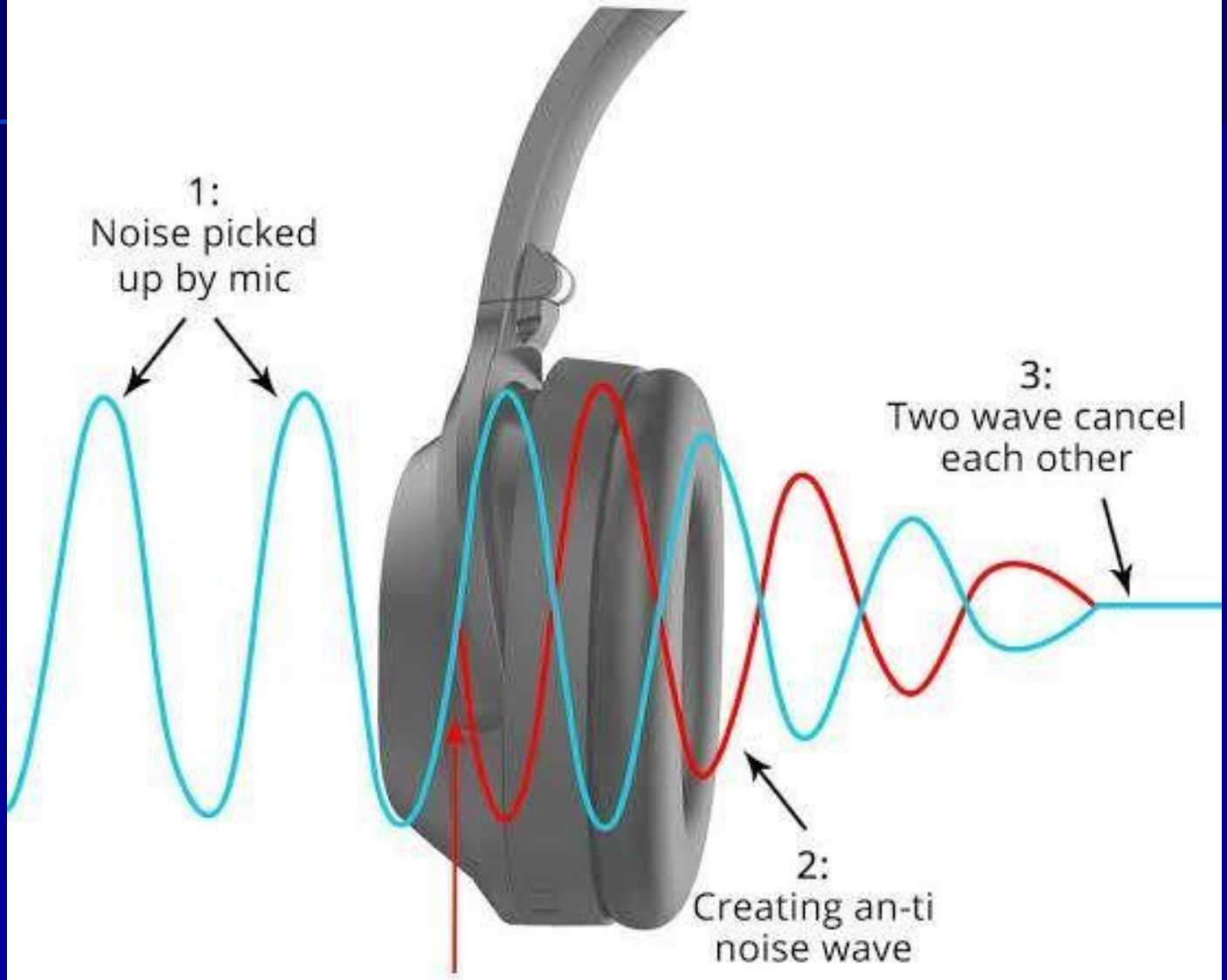
Noise Cancelling Earphones / Headphones

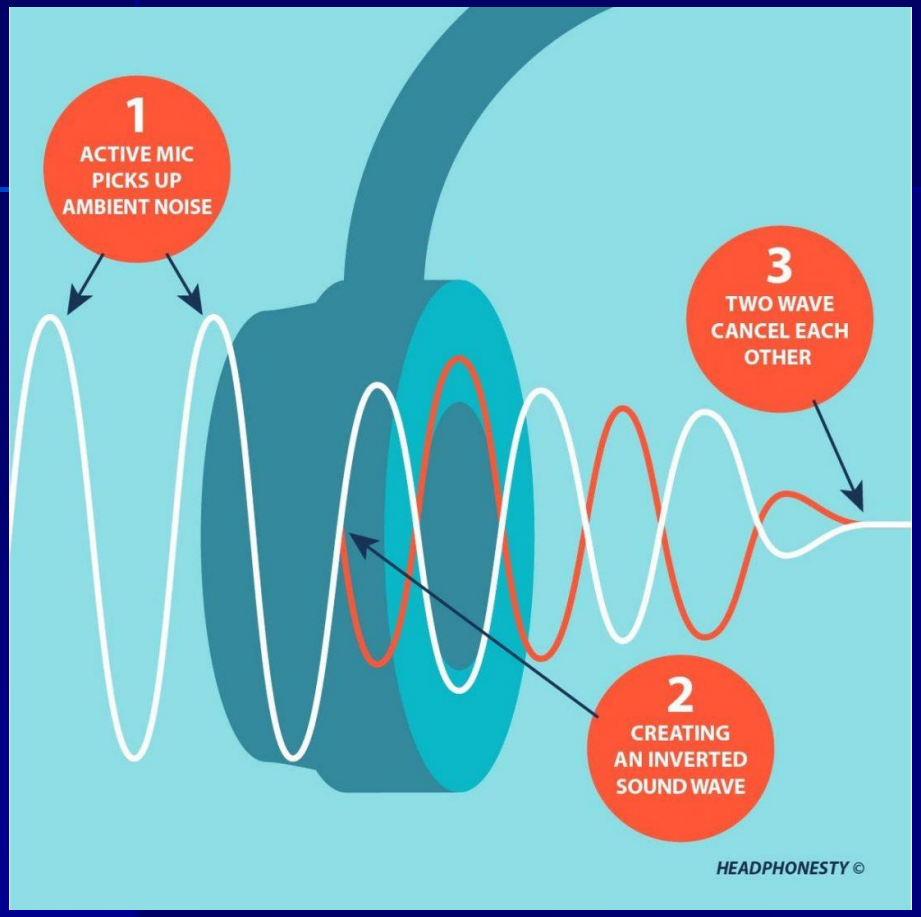
What does noise cancelling do?

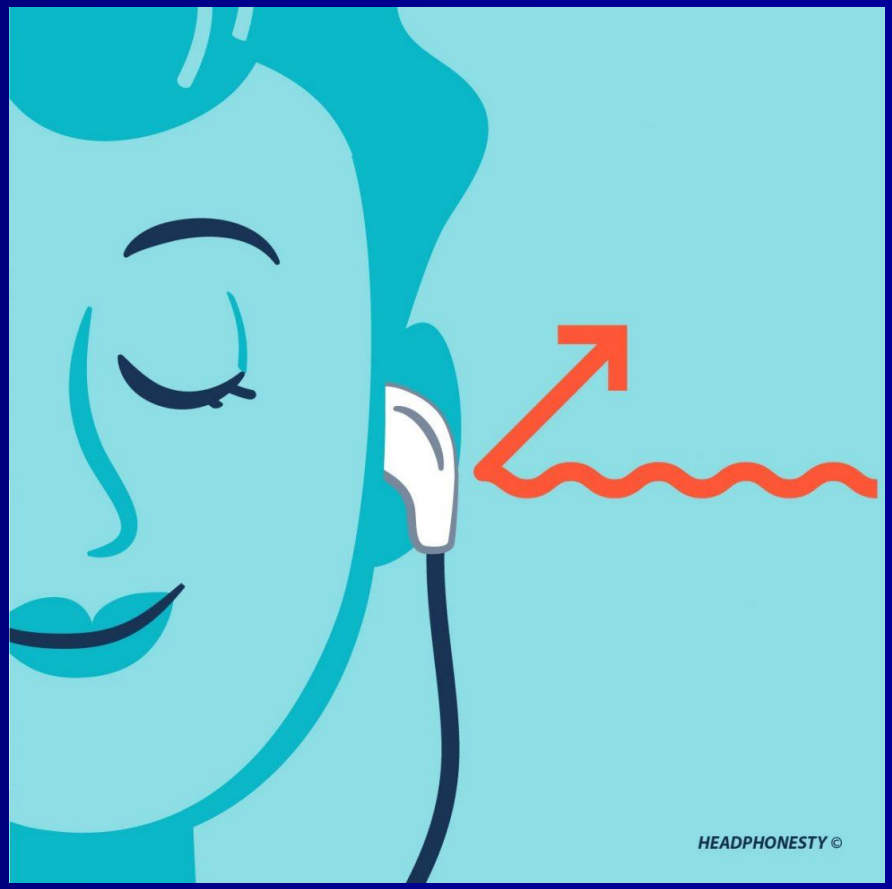
Noise-cancelling audio devices use a built-in microphone to analyse the ambient sound waves around you and generate the opposite sound waves to reduce surrounding sound. Noise-cancelling devices have a built-in microphone which produces the opposite reversed sound waves to neutralise surrounding noise

ACTIVE NOISE CANCELLATION



Noise Cancelling vs. Noise Isolating





Noise Cancelling vs. Noise Isolating

What Is Noise Isolation?

Noise isolation, “Passive Noise Cancellation”, is the act of blocking noise through the use of physical barriers. Just as you hear less noise when you cover your ears with your palms, noise isolation in headphones achieves the same result by forming a secure seal using the foam pads in the ear cups.

Noise Cancelling vs. Noise Isolating

What Is Noise Cancellation?

Also known as "Active Noise Cancellation" (ANC), it's a process for blocking off ambient sound through a system of components placed within the ear cups of the headphones.

Noise Cancelling vs. Noise Isolating

What Is Noise Isolation?

Noise isolation, “Passive Noise Cancellation”, is the act of blocking noise through the use of physical barriers. Just as you hear less noise when you cover your ears with your palms, noise isolation in headphones achieves the same result by forming a secure seal using the foam pads in the ear cups.

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