Summerland Amateur Radio Club

Foundation Module 1

for the AMC Foundation & Practical Syllabus V10

Technical Basics

Syllabus Assessment Objectives

3.1	Recall using supplied reference material, the relationship between Voltage, Current, Resistance and Power. Calculate an unknown value given the value of the remaining components
3.2	Recall what is meant by the abbreviations DC and AC.
3.3	Recall using supplied reference material, the range of frequencies described as Audio Frequency (AF) and Radio Frequency (RF).
3.4	Recall what is meant by the abbreviations AM and FM. Describe how the radio frequency carrier is modified for AM and FM.
3.5	Recall the meaning of Voltage, Current, Resistance and Power.
3.6	Recall using supplied reference material, the relationship between Voltage, Current, Resistance and Power. Calculate an unknown value given the value of the remaining components.
3.7	Recall that electronic circuits can be damaged by applying an excessive voltage or voltage of wrong polarity.
3.8	Recall the unit of frequency.
3.9	Recall the graphic representation of a sine wave and that sine waves are produced by oscillators.
3.10	Recall the voltage and frequency of the mains electricity supply used in Australia.
3.11	Identify from supplied reference material the range of frequencies for normal human hearing.
3.12	Identify from supplied reference material the range of audio frequencies commonly used in radiotelephony.
3.13	Identify from supplied reference material the frequency bands for HF, VHF and UHF.
3.14	Recall the relationship between frequency and wavelength. Convert from one to the other using supplied reference material.

Resources

CARS F slide 3 Technical Basics – download at
http://www.g0mwt.org.uk/training/courses/foundation.htm

WIA Foundation Manual Chapter 1

SARC Education Module Content

Electricity

Atoms have a positively charged nucleus surrounded by negatively charged electrons. The overall charge of an atom is normally balanced or neutral, such that there are equal numbers of protons and electrons.

Material with a shortage of electrons is said to have a **positive** charge.
Material with a surplus of electrons is said to have a **negative** charge.

The relative difference in charge is called the **potential difference or PD**.
A potential difference that is constantly being recharged from another energy source such as a generator (mechanical), battery (chemical) or solar cell (photovoltaic) is called an. **Electromotive force or EMF**.

Electrons will flow from negatively charged points to positively charged points when possible. The flow of electrons is called an **electric current**.

A long time ago before the nature of electrons was discovered people realised that the stuff called electricity actually flowed. They took a guess on the direction and got it wrong! Texts that refer to electricity flowing from positive to negative are said to use conventional flow theory. Text that refer to electricity flowing from negative to positive are said to use electron flow theory. Conventional flow is still used but increases the difficulty of understanding semiconductor theory. **SARC Education prefers to use electron flow.**

Conductors allow electrons to move freely – like copper or aluminium.
Insulators do not allow electrons to move freely – like glass or porcelain.
Conductors (and insulators) are never perfect. Their opposition (or resistance) to the flow of an electric current is called **resistance**.

Current moving through a conductor in one direction only, such as from a battery, is called **Direct Current or DC**.

Many components in a DC circuit expect current to flow in one direction, from **- to +**
They must be connected with the positive end towards the **+** side of the circuit and the negative end towards the **–** side of the circuit. This is their **polarity**. They are usually found in DC circuits. Current flowing in the wrong direction may damage these components.

Current moving through a conductor in one direction and then in the opposite direction such as from an alternator is called **Alternating Current or AC.**
In Australia, the mains power supply is AC, at a (deadly) voltage of 230 V.
Too much current through any circuit may damage components and cause a fire (ie let the smoke out).

Basic electrical units

Value	Unit	Symbol	Definition
Potential Difference PD	Volt	**V**	The relative difference in the amount of electric charge between two points.
Electromotive Force EMF	Volt	**V**	The difference in the amount of electric charge available at the two points where another form of energy is converted into electrical energy.
Current	Ampere (Amp)	**I**	An orderly movement (flow) of electrons from a negative point to a positive point.
Resistance	Ohm	**R and Ω**	The opposition to the flow of electric current.
Power	Watt	**P**	The rate at which electrical energy is transformed into or from another source of energy.

Ohm's Law and Power

Ohm's Law defines the relationship between current, voltage and resistance.
The current flowing through a resistor is equal to the voltage across the resistor divided by the value of the resistance.
The basic formula is **E = I x R .** E is the voltage in Volts, I is the current in Ampere (amps), R is the resistance in Ohms.

The Power consumed in a resistor is defined as the voltage across the resistor multiplied by the current.
The basic formula is **P = E x I**
P is power in Watts E is voltage in Volts I is current in Ampere (amps)

Formulae will be supplied with an exam question involving Ohm's law or power calculations. Find the formula that fits the question, insert the numbers and do the calculation.

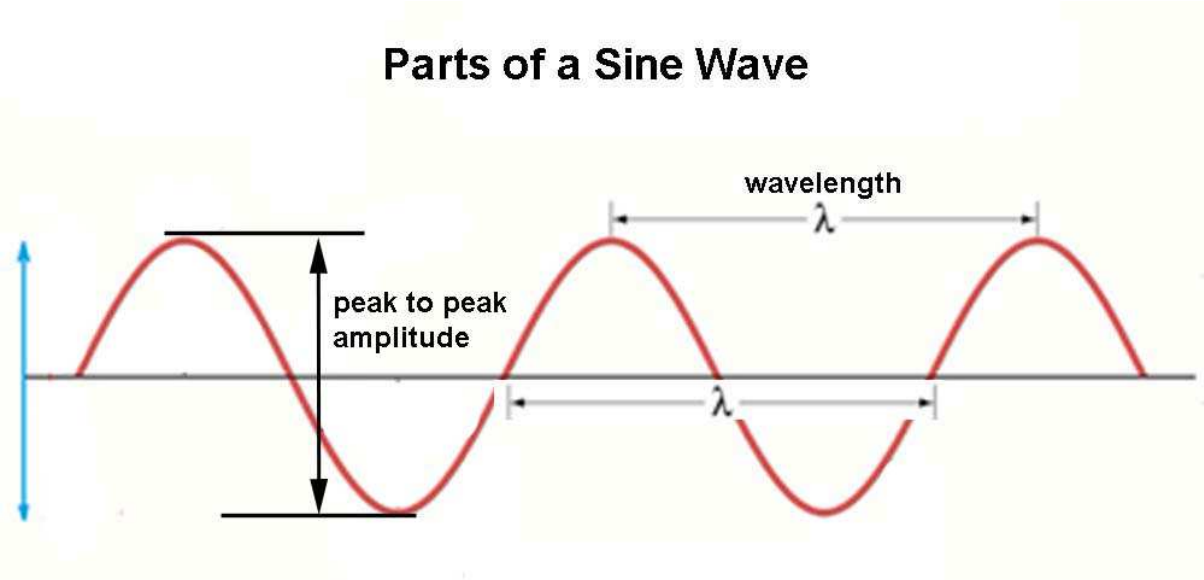
Prefixes, multipliers and engineering notation

You will need to be able to convert values from one factor and another.

Prefix	Name	Factor	Engineering Notation
M	Mega	X 1,000,000	10^6
k	kilo	X 1,000	10^3
	Unit	1	1
m	milli	÷ 1,000	10^{-3}

Radio Waves

Radio waves are 'electromagnetic' waves, which travel via 'oscillations' of magnetic and electric fields. The basic type of radio wave is the **Sine Wave,** as shown in this diagram -



In a simple radio wave, the intensity of the electric and magnetic fields oscillate (they change direction smoothly) at a particular frequency.

The unit of frequency is the **Hertz**. Its symbol is **Hz**.

1 Hz is defined as the number of complete oscillations in one second. Or, in everyday speak – the number of waves to pass a point in one second.

Wavelength is measured in metres and is represented by the Greek letter *lambda* **λ**

Frequency and wavelength are related to each other through the following formula;

$$V = f\lambda \quad \textbf{or}$$

$$f = \frac{V}{\lambda} \quad \textbf{or} \quad \lambda = \frac{V}{f}$$

V is the velocity of the wave (in metres per second). For radio waves travelling in free space, this is the speed of light = 300,000,000 metres per second.

f is the frequency of the wave (In Hertz) and

λ is the wavelength of the wave (in metres).

Here is an example -

A radio wave has a wavelength of 20m. What is the frequency?The velocity (V) is 300,000,000 metres per second, the wavelength (λ) is 20 m,

Therefore - $f = \frac{V}{\lambda} = \frac{300000000}{20} = 15000000$ hertz

This translates into a frequency of 15 MHz.

To make these calculations simpler, the formula is usually expressed as follows -

$$f = \frac{300}{\lambda} \textbf{ or } \lambda = \frac{300}{f}$$

To use these simpler formulae, f must be in MHz and λ must be in metres.

Another example –

The frequency is 150 MHz, what is the wavelength?

λ = 300/ f = 300/150 = 2 metres

Sound (air compression) waves heard by the average human ear range from about 20Hz through to around 15kHz. A narrower band of these frequencies (300Hz to 3kHz) provide the range that conveys enough quality for voice communications in radio. These are called 'Audio' frequencies.

Radio waves can range in frequency from approximately 20kHz up to 100GHz. This range is often broken down further into sections or 'bands' which include HF, VHF and UHF.

BAND	Frequency Range
HF (high frequency)	3 MHz through 30 MHz
VHF (very High frequency	30 MHz through 300 MHz
UHF (Ultra high frequency)	300 Mhz through 3 GHz

We can't hear radio waves as they are not compressional waves. We have no organs that can sense them.

If a wave's velocity is fixed then only 3 properties can be varied. These are *frequency*, *amplitude* and *polarisation*. We will deal with polarisation later.

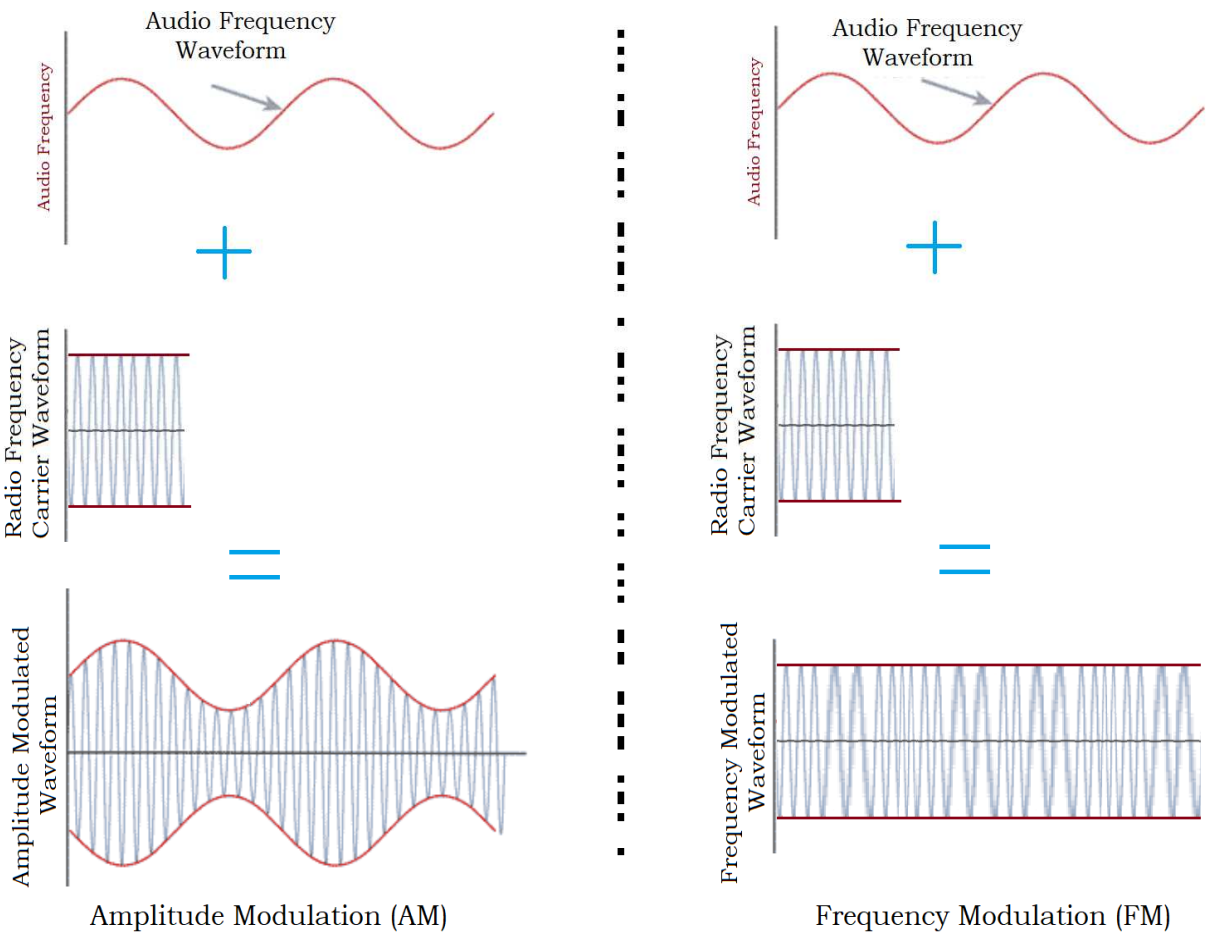
A radio wave can be varied in frequency or amplitude, in order to carry audio or digital information. This is called ***modulation***.

The diagram below shows how a radio wave can be modulated with an audio wave of a much lower frequency.

If the frequency is changed then it is Frequency Modulated **(FM)**.

if the amplitude is changed then it is Amplitude Modulated **(AM).**

(Note: modulation is also covered in Module 2 – Transmitters and Receivers)



Question 1:

If 7,100,000 waves leave your antenna every second, what is the frequency?

A) 1 MHz B) 7.1 m C) 40 m D) 7.1 MHz

Question 2:
Which of the following is the correct wavelength for a radio wave with a frequency of 3.604 MHz?

A) 8.3 m **B)** 3.6 m **C)** 83.2 m **D)** 8.3 Hz

Question 3:
A radio wave with a frequency of 146.8 MHz falls into which general band?

A) MHz **B)** HF **C)** UHF **D)** VHF

Question 4:
The range of frequencies normally used for audio in amateur radio are;
A) 20 Hz to 15 kHz **B)** 300 Hz to 3 kHz

C) 20 kHz to 100 GHz **D)** 20 Hz to 100 GHz

Question 5:
1000 volts can also be represented as:

A) 1 kV B) 1 nV C) 1 MV D) 1 mV

Question 6:
If 0.5 A flows through a 20 Ohm resistance, the applied voltage is:

A) 0.025 Volts **B)** 40 Volts **C)** 10Volts **D)** 20.5 Volts

Question 7:
Power is measured in:

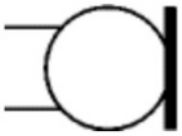
A) Amps **B)** Volts **C)** Ohms **D)** Watts

Question 8:
Good insulators are:

A) glass, wood, plastic, porcelain **B)** glass, wood, copper, porcelain

C) paper, glass, air, aluminium **D)** plastic, rubber, wood, lead

Question 9:
The symbol represents:



A) a fuse **B)** an earth connection

C) a microphone **D)** a lamp

Question 10:
A voltage of 20 volts is applied to a 10 ohm resistor. The current will be:

A) 500 milliamps **B) 2 amps**

C) 30 amps **D) 200 milliamps**