South Bristol Amateur Radio Club
Lesson 2 – Technical Basics 01
Syllabus Sections 3b.4 – 3b.7, 3c.1 – 3c.3

Technical Basics #1

(Syllabus section 3b.4 to 3c.3)

Electricity and Frequency

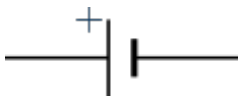
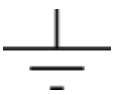
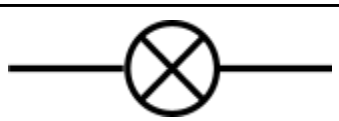
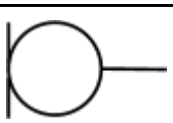
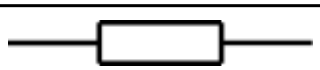
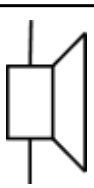
A battery provides **voltage** at its terminals; this is often referred to as a **potential difference**. In order for electrical current to flow there must be a continuous circuit from one battery terminal to the other.

In simple circuits, such as a filament lamp, battery and switch, it does not matter which way round the battery is connected. But in a more complex piece of equipment, such as a radio, television, calculator etc., the positive and negative terminals of the battery must be connected to the correct polarity (positive battery terminal to positive side of the circuit and vice-versa) otherwise serious damage can be caused to the equipment.

The current from a battery flows out of the positive terminal around the circuit and back into the negative terminal. We call this **direct current (D.C.)**. **Alternating current (A.C.)** is different; it keeps changing directions (polarity) first one way then the other. A.C. is much easier to generate and to change from one voltage to the other. The mains electricity supply in the UK is 230 volts A.C.

When an electrical circuit is illustrated a number of symbols are used to show the various components in the circuit. The following symbols may be used in the exam.

Circuit Symbols

Description	Symbol	Description	Symbol
Cell		Switch (s.p.s.t)	
Battery		Antenna	
Fuse		Earth	
Lamp		Microphone	
Resistor (General)		Loudspeaker	

Frequencies used in power, audio and radio systems

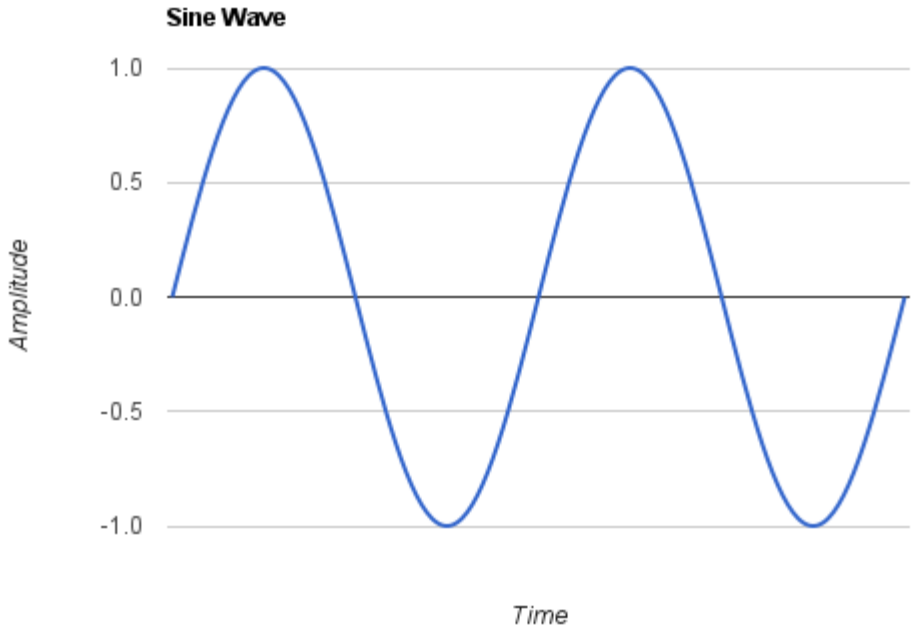
Some facts you need to know:

- Frequency is measured in Hertz (Hz).
- 1 Hz is one cycle per second.
- 1 kilohertz (kHz) is one thousand cycles per second.
- 1 Megahertz (MHz) is one million cycles per second.
- The UK mains supply operates at 50Hz
- The normal hearing range - audible frequencies (A.F.) are 100Hz to 15 kHz.
- The range of frequencies for audible communications is 300 Hz to 3 kHz.

Radio frequencies (R.F.) are much higher than A.F. and are divided into various bands. For this course you need to know that:

- High Frequency (H.F.) covers: 3 MHz to 30 MHz
- Very High Frequency (V.H.F.) covers: 30 MHz to 300 MHz
- Ultra High Frequency (U.H.F.) covers: 300 MHz to 3000 MHz

The frequency is generated by an oscillator and when graphically represented looks like a sine wave.



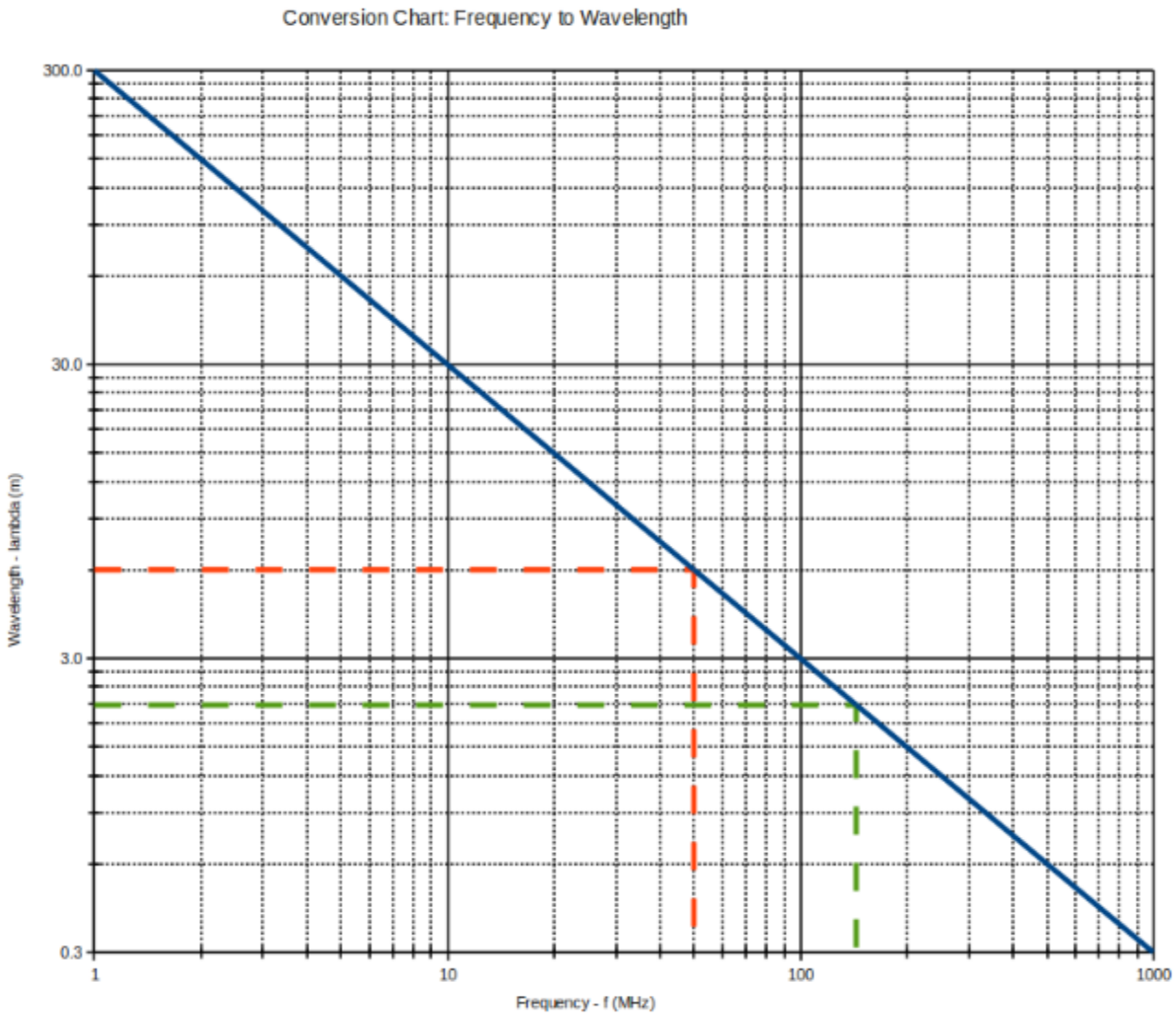
Different services such as broadcasting, emergency services, maritime, mobile telephones etc. are allocated different parts of the radio frequency bands. This ensures that all services can operate without interfering with each other.

Typical Radio Frequency Allocation

Frequency	Use
87.5 - 108.0 MHz	Broadcasting
108.0 - 117.975 MHz	Aeronautical Radionavigation
117.975 - 137.0 MHz	Aeronautical Mobile
137.0 - 138.0 MHz	Space Operations and Space Research
138.0 - 144.0 MHz	Land Mobile
144.0 - 146.0 MHz	Amateur and Amateur Satellite
146.0 - 149.9 MHz	Mobile (except aeronautical mobile)
149.9 - 150.05 MHz	Radionavigation - Satellite
150.05 - 152.0 MHz	Radio Astronomy
152.0 - 156.0 MHz	Land Mobile
156.0 - 158.525 MHz	Maritime Mobile
158.525 - 160.6 MHz	Land Mobile
160.6 - 160.975 MHz	Maritime Mobile

A copy of this table will be provided in the exam, however you must understand the information contained within it to be able to use it answer questions.

Also you should be aware that as the frequency increases then the wavelength decreases and vice-versa, i.e. they are inversely proportional. The chart below shows the relationship between wavelength and frequency and provides a simple way of converting between the two.



Note that both the horizontal-axis (frequency) and the vertical-axis (wavelength) are displayed on a logarithmic scale.

This means that on the horizontal axis (frequency), in the first frequency box (1MHz – 10MHz) each division is 1MHz, whilst in the second box (10MHz – 100MHz) each division is 10MHz, and in the final box (100MHz – 1000MHz) each division is 100MHz.

Similarly on the vertical axis (wavelength) each division in the first box (0.3m – 3.0m) is 0.3m, whilst in the second box (3.0m – 30.0m) each division is 3m, and in the final box (30.0m – 300.0m) each division is 30m.

As a couple of examples, consider the wavelength of 6m. To determine the frequency of a radio wave with a wavelength of 6m:

- First locate 6m on the vertical axis (wavelength). Referring to the notes above about logarithmic axes then you will see that this is the first division mark above 3.0m, where the orange dashed line starts.
- Project this line horizontally, until it reaches the blue conversion or pivot line.
- Once it reaches the conversion or pivot line project it vertically until it reaches the horizontal-axis (frequency).

- Read off the point on the horizontal axis (frequency) where the line meets the horizontal-axis (frequency), in this case 50MHz. Note that the frequency is in MegaHertz (MHz)

Now consider the frequency of 144MHz. To determine the wavelength of a radio signal with the frequency of 144MHz:

- First locate 144MHz on the horizontal axis (frequency). You will see that this is about half way between 100MHz and the first division mark above (to the right of) 100MHz, which is 200MHz, where the green dashed line starts.
- Project this line vertically until it reaches the blue conversion or pivot line.
- Once it reaches the conversion or pivot line project it horizontally until it reaches the vertical axis (wavelength)
- Read off the point on the vertical axis (wavelength) where the line meets the vertical axis (wavelength), in this case 2m. Note that the wavelength is in metres (m)

A copy of this graph will be made available to all candidates in the exam but you will have to know how to use it.

Next Lesson
Transmitters and Receivers

Lesson 2 – Summary

At the end of this lesson you should be able to:

- Recall that a battery provides Potential Difference (Voltage) at its terminals and that a circuit is needed to allow current to flow
- Recall that the polarity of a battery is not relevant if a filament bulb is used, but that electronic circuits can be damaged by the wrong polarity
- Recall what is meant by the abbreviations DC and AC
- Identify the listed circuit symbols
- Recall the unit of frequency and understand the meaning of the abbreviations RF and AF
- Identify the graphic representation of a sine wave and recall that sine waves are produced by oscillators
- Recall the frequency of the mains supply – 50Hz
- Recall the range of frequencies for normal hearing – 100Hz to 15kHz
- Recall the range of frequencies for audio communication – 300Hz to 3kHz
- Recall the frequency bands for HF, VHF and UHF radio signals
- Understand that frequency bands are allocated for a particular use e.g. broadcasting, aeronautical, maritime and amateur
- Understand the relationship between frequency (f) and wavelength (λ). Use a graph to convert from one to the other. *Note: calculations are not required*