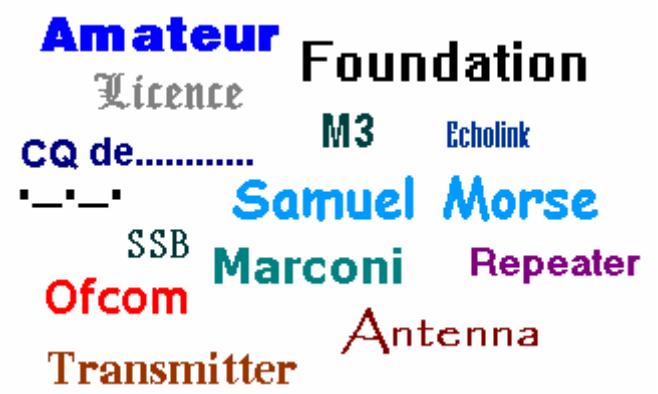
The United Kingdom Amateur Radio (Foundation) Licence Examination Guide



How to successfully complete the written examination and practical.

Jonathan Smyth 2IØJVI © 2007

Contents

Introduction

Thank you for taking the time to read this. This publication contains the same information as the PowerPoint Presentation of the same title. It is intended as an alternative to those who do not use or have access to PowerPoint facilities.

Like the PowerPoint Presentation, this document lays out what information is required through a series of "lessons", however, unlike the PowerPoint it also includes extracts from the Syllabus for the Foundation Licence Exam, which can be downloaded from the RSGB Tutors' Site[1]. Updates will be made to the Syllabus from time to time and so it is wise to ensure that you have a current version.

This is not designed to take people away from studying for the various Licence Examinations through Radio Clubs or Societies. The author strongly encourages this, as you have invaluable access to a tutor who can answer questions, I daresay much more satisfactorily than this document can! It is also recommended to obtain the "*Foundation Licence Now!*" publication from the RSGB. You can also check how well you are getting on at Hamtests, a UK Online based learning environment run by Radio Amateurs for Radio Amateurs[2].

Above all, have fun and enjoy the hobby. We all had to start somewhere…

Good Luck!

Jonathan Smyth 2IØJVI
September 2007

[1] www.rsgb.org.uk/tutors
[2] http://www.hamtests.co.uk

Lesson 1 - Amateur Radio

1a.1 *Recall that the amateur licence is for self-training in radiocommunications and is of a non-commercial nature.*

Amateur Radio is a scientific and technical hobby, and is exclusive in the fact that Amateur Radio Operators are the only users of the Electromagnetic Spectrum to allowed under International Law to design, construct and use homemade equipment. Unlike broadcast radio, it is non-commercial in nature, and this is exemplified in the conditions to which each holder of a UK Amateur Radio Licence is bound.

There are different facets to Amateur Radio. Some people prefer Morse code, whilst others prefer to integrate the Internet with radio using a variety of computer programs such as: Echolink, CQ100, CQFone, APRS and many others.

Lesson 2 - Licensing Conditions

2a.1 *Recall the types of UK Amateur Licence.*
Recall that more advanced classes of amateur licence exist and that they allow greater facilities and the ability to design /modify transmitting equipment.
Recall that many other countries do not currently accept the UK Foundation Licence.

Prior to the introduction of the Foundation, Intermediate and Advanced Amateur Radio Licences in the early 2000s, the UK operated with a system of a "Class A" and "Class B" licence, where class A licence holders had passed the mandatory 12 WPM Morse Test and as a result were permitted access to frequencies below 30MHz (i.e. HF) as well as above 30MHz whilst "Class B" Licence Holders were only permitted to transmit above 30MHz.

In order to make the hobby more accessible, it was decided that a 3 tier licensing system should be implemented. However, due to the nature of our licensing system, most countries do not acknowledge the Foundation and Intermediate Licences, except under a few very exceptional circumstances. A few countries are considering implementing a similar structure to the UK and it remains to be seen whether this may change the situation.

From then, has evolved the Foundation, Intermediate and Advanced Class Licences, designed to facilitate more people into Amateur Radio. Aspiring Amateur Radio Operators begin at Foundation Licence level once they have passed the required examination and practical. As this is the lowest level of UK Amateur Radio Licence, there are more restrictions on each licensee than there are for the higher level Licensees.

Licensees then progress to the Intermediate Licence where more privileges (such as higher power (50W) and new frequency allocations) are granted, due to the greater depth of Technical knowledge required for the examination. Finally Licensees progress to the Advanced Licence (which is now the equivalent to a Class A or Class B licence due to their amalgamation), which gives access to 400W, and all UK Amateur Frequency Allocations.

2b.1 *Recall the format of the current Foundation, Intermediate and Full call signs.*
Recall that secondary identifiers are used but be able to state only those for the Foundation licence.

For your exam, you need to be aware of the format of each class of UK Licence. You should study the table below, as you will be asked a question on it, and will only ask about Foundation Licensees.

Class of Licence	**Prefix**	**Secondary Regional Identifier**	**Number**	**Suffix**
Foundation	M	D I J M U W	3	3 letters
Intermediate	2	D E I J M U W	0 1	3 letters
Advanced	M (G)	D I J M U W	0 1 5(0-8)	3 letters

You should also learn the table of Regional Secondary Identifiers below.

Regional Identifier	**Country in UK**
D	Isle of Man
E (only in Intermediate Licence)	England
I	Northern Ireland
J	Jersey
M	Scotland
U	Guernsey
W	Wales

You should be also aware that if a station normally lives in Northern Ireland, and holds the callsign MI3AAA, he/she could travel within the UK and simply change the Regional Identifier. For example, if he/she were travelling in the Snowdonia National Park (in Wales) he/she should simply adjust the callsign to be MW3AAA with the appropriate suffix at the end. (You are technically not required to know them now, but you should at least be aware of them!)

Add-on Suffix	**Examples of when it is to be used**
/A	When operating from a friend's shack, i.e. from a place with an address or Postal (zip) Code
/M	When operating on the move e.g. in a car or boat (only on Inland waterways such as lakes or NON-TIDAL rivers). Note if you are sitting in a car, or sitting on a bicycle you are still technically "/M"!
/MM	When on open sea / on seawater e.g. a tidal river. RESERVED EXCLUSIVELY FOR ADVANCED CLASS LICENSEES!
/P	When operating from a place without a proper address or Postal (zip) code e.g. in a field.

2c.1-2c.9 *Licence terms and conditions.*

For ease of display, the Licence Terms that you require are listed in the table below. You should learn them – these are amongst the ones with which you will have to abide when you obtain your licence! A Sample Licence is available on the Ofcom website[3].

Item	Condition of Licence
Transmission of callsign	Each station **must** transmit the callsign as is on the "Section 1" of your licence: 1. During "CQ" Calls 2. When changing Transmission Frequency 3. When establishing Contact with another UK OR Foreign Amateur 4. At least every 15 minutes during a "long QSO" 5. By the same type of modulation used for the QSO 6. On the same Frequency as the one, on which your are communicating
Messages	You are only permitted to send messages to other Amateurs (UK or Foreign), which are not menacing in character or offensive in any way and ONLY on the allocated bands in the Foundation Schedule.
Codes	You are **not permitted** to render your messages unintelligible to other Radio Users (Amateur or Other) by the use of "secret codes". You **may** only use codes that are officially recognised by Ofcom (the "Q Codes" and a few others), and as long as they facilitate the communication between participants.
Broadcasting	You are **not permitted** to use your radio station for any business matters, whether in personal or public interest.
Use of the Station	A Foundation Licensee may personally use his/her own station without supervision. Consequently a Foundation Licensee may permit the use of his/her station to another UK or Foreign Amateur provided that either Ofcom or the Foreign Administration has not revoked their licence.
User Services	Under certain circumstances, a Foundation Licensee may permit the use of his/her Radio Equipment by a User Service, during any operation conducted by the User Service, or the Licensee, if authorised by the User Service may use the station to transmit messages on their behalf.
Changes in Personal Information	You are required by Law to notify Ofcom, either in writing or via the Ofcom online Licensing Service if: 1. Any of your details change (e.g. name [in the case of a marriage], address, telephone number etc) as soon as possible before/after it has happened. 2. At least every 5 years after the date of issue

[3] http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/amateur/Licences

	of the licence. Failure to notify Ofcom of changes in the licence will result in revocation.
Inspection, Variation and Shut down of your Station	1. Individuals duly authorised by Ofcom have the right to inspect/examine and test your station, where it is the opinion of the Person that a situation exists, to ensure the Radio Equipment is used in accordance with the Licence. 2. Any Person, duly authorised by Ofcom, has the right to demand that you modify/restrict the use of your station, and either temporarily or permanently shut it down where they are of the opinion that a breach of the licence has occurred or the Radio Equipment is contributing to Undue Interference. 3. Ofcom may vary your licence, and if it is varied you will be issued with a "Notice of variation" to which you must abide until which times as Ofcom removes the conditions in writing.
Schedule to the Licence	You must be fit to understand and use the Schedule to the Licence ("Table A") and be able to identify frequencies that are permitted and power restrictions that must be abided by.

A Clause above mentioned the term "User Services". A User Service is any member of: *"The British Red Cross, St John Ambulance, St Andrew Ambulance Association, the Woman's Royal Voluntary Service, the Salvation Army, any Government Department/Agency, any "Category 1" Responder and any "Category 2" Responder as defined in the Civil Contingencies Act 2004."*

You are <u>not</u> required to know these (however it does no harm to be familiar with them now, as they will form a larger part of the Intermediate and Advanced Courses)!

Lesson 3 – Technical Basics

3a.1 *Identify the units of, and abbreviations for Potential Difference (Voltage), Current, Power and Resistance.*
Note: Prefixes milli, kilo and Mega may be used.

For the examination, and for future reference you need to be aware of some prefixes, units and symbols of some electrical parameters, and these are in the table below (which should be learnt!)

Parameter	**Unit of Measurement**	**Symbol**
Potential Difference	Volt	V
Current	Ampere	A
Power	Watt	W
Resistance	Ohm	Ω (Greek Letter 'Omega')

You should also be aware that there are some prefixes which can be applied to the parameters in the above table, which can increase or decrease the number, and these are listed in the table below (which should also be learnt for the exam and future reference!)

Prefix	**Symbol**	**Ratio of parameter:1**
milli…	m e.g. mV ("Millivolts")	**10^{-3}:1** or 0.001:1
kilo…	k e.g. kW ("Kilowatts")	**10^{3}:1** or 1000:1
Mega…	M e.g. MΩ ("Megaohms")	**10^{6}:1** or 1000000:1

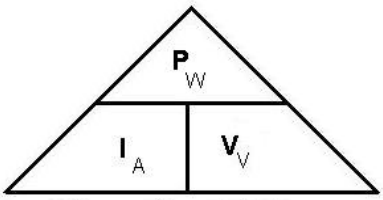
3b.1 *Recall the relationship between Potential difference (Voltage), Current and Power. (P=VI, I=P/V, V=P/I) Calculate the unknown quantity given the numerical value of the other two.*

For the Foundation Examination, you should be aware of some relationships that are found in Circuits (they are currently on the GCSE Physics Syllabus-no more depth is required than that!) The first one is referred in the GCSE Physics Specification as the "Power Law", P=IV.

Using the above equation, it is possible to calculate an unknown value given the other 2 values, by simple substitution into the equation. However, as shown by the syllabus extract you need to be able to transpose the equation of the form P=IV into the other 2 shown. Thankfully, there is quite a simple way of doing this, using a "formula triangle".

To use this method, cover the letter which you need to find and then do as the triangle says e.g. cover P, the I and V are beside each other = multiply. If you cover I, then you are left with P/V hence you divide P by V.

Remember that this method only works if the triangle is drawn correctly, as shown below.



Power = Current x Voltage
Current = Power / Voltage
Voltage = Power / Current

Where P = Power (W)
I = Current (A)
V = Voltage (V)

3b.2 *Recall that resistance is the opposition to current flow.*

Resistance is a measure of how difficult it is for a current to flow. The symbol in equations for resistance is 'R' and it is measured in Ohms, which is given the Greek letter Omega, Ω. The higher the resistance in a circuit, the less that the current will flow and conversely, the lower the resistance, the more current will flow around the circuit.

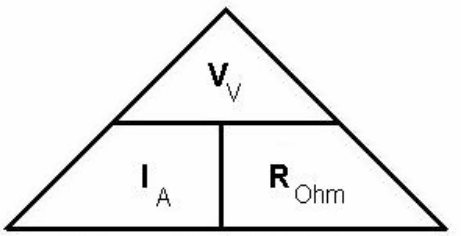
Also, if the voltage is increased, there will be a higher current so; clearly there is some sort of relationship between current, voltage and resistance…

3b.3 *Recall the relationship between Potential Difference (Voltage), Current and Resistance. (V=IR, I=V/R, R=V/I) Calculate the unknown quantity given the numerical value of the other two.*

As we previously discussed, there appears to be a relationship between current, voltage and resistance. The relationship was actually determined by George Simon Ohm in 1826 and it is:

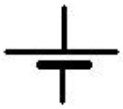
$$\text{Current (I)} = \frac{\text{Voltage (V)}}{\text{Resistance (R)}}$$

This is more commonly expressed as "V=IR", which like the Power law, can be shown by using a formula triangle, as shown below. It employs the same method of use to determine an unknown parameter given the 2 known ones, and again it will only work if drawn correctly!



Voltage = Current x Resistance
Current = Voltage / Resistance
Resistance = Voltage / Current
Where V = Volts (V)
I = Amps (A)
R = Resistance (Ohms)

3b.4 *Recall that a battery provides Potential Difference (Voltage) at its terminals and that a circuit is needed to allow current to flow.*



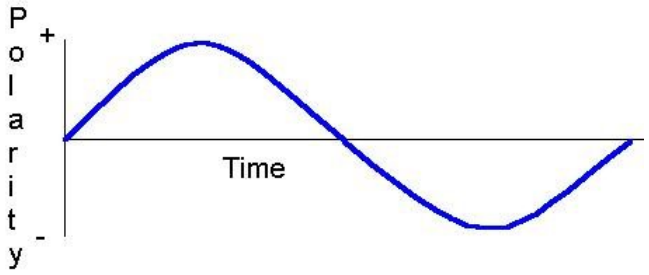
The above symbol is the circuit symbol for a 1-cell battery. The long end represents the positive side whilst the shorter and fatter side represents the negative terminal of the battery. Due to the difference in the polarities of the battery's terminals, the electrons will flow from the negative terminal to the positive terminal, causing a current to flow. The term 'potential difference' is simply refers to the differences in polarities of the terminals in terms of the voltage, and in order for a current to flow, there has to be a 'full circuit' between both terminals of the battery.

3b.5 *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.*

In some circuit components (e.g. a bulb) it does not matter which way they are connected in a circuit, however for others it does matter. Such components are: Light Emitting Diodes, Integrated Circuits, Capacitors, diodes and meters (such as voltmeters). If these components (and a few others) are not correctly inserted, observing the correct polarities it will usually result in damaging the component so that it can no longer be used.

3b.6 *Recall what is meant by the abbreviations DC and AC.*

AC or 'Alternating Current' is different from DC ('Direct Current), which usually can be found in mains power supplies, and batteries, because it is constantly changing direction/ polarity, as can be seen on the drawing below.



In terms of ease of generation, it is much easier to generate an AC voltage, because all that is required is basically a magnet, a coil of wire and a method of storage/use e.g. a bulb. DC is much more difficult to produce, and is required the use of a transformer and some method of rectification to produce a DC waveform instead of an AC waveform. The methods of doing this are covered at the Intermediate and Advanced Courses.

3b.7 *Identify the circuit symbols shown in Table 1 (at back of Syllabus.)*

For this section, you are required to be familiar with the following table (it should be committed to memory!)

Description	Symbol
Cell	
Battery	
Fuse	
Lamp	
Resistor general	

Description	Symbol
Switch s.p.s.t.	
Antenna	
Earth	
Microphone	
Loudspeaker	

3c.1 *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- 15kHz
Recall the range of frequencies for audio communication 300Hz-3kHz.
Recall the frequency bands for HF, VHF, and UHF radio signals.

Frequency relates to the number of cycles that occur in a period of time, which is usually in seconds. If you can recall the AC waveform from 3b.6 you should recall that there was 1 complete wave. If the timescale were measured over 1 second, there would have been 1 wave in 1 second. This means that the frequency of that particular wave was 1Hz – Hertz (Hz) referring to the frequency.

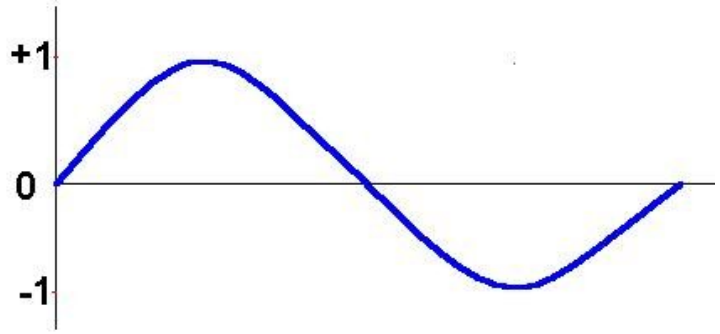
On older radios, the frequency dial may be measured as c/s (cycles per second), this relates to cycles per second, which was used prior to the introduction of the Hz as a measure of frequency. 1 c/s and 1Hz are the same thing.

If you look on the back of a television, it should say that the mains voltage is 230V AC at 50Hz- this frequency is the number of times that the polarity of the current changes per second. In different countries, not only will the mains voltage be different, but the frequency at which it is generated will also be different. For example, continental Europe has a mains voltage of 220V AC at 50Hz, whilst in the USA the mains voltage is 110V AC at 60Hz. (You should not confuse the UK mains voltage with the mains voltage of continental Europe for the exam! The UK Mains voltage is 230V AC at 50Hz.)

RF or 'Radio Frequency' waves are much higher in frequency that audio waves- typical radio waves are in the kilohertz (kHz) or even megahertz (MHz), that is thousands or millions of cycles per second. For your own information, any electromagnetic wave (radio, light, x-rays, gamma rays etc) travel at 300,000,000metres per second ($3x10^8$m/s). Using this is it possible to calculate the wavelength of a wave, as we shall find out later.

Whilst radio waves are typically in the kHz or MHz, the frequencies involved for hearing and audio communication are usually much less in value. The typical range of frequencies that we can hear is between 100Hz and 15kHz, however as we get older the difference between these frequencies decrease. This is how people usually get 'hard of hearing', although it can be due to other factors. AF (audio Frequency) Frequencies are typically between 300Hz-3kHz, and the closer it gets to 3kHz, the higher the pitch will be.

In Lesson 4 we will be dealing with modulation and the constituent parts of the transmitter and receiver. At this stage you should be aware that sine waves are produced by the oscillator and are then modulated. A sine wave is shown below- polarity is on the vertical Y-axis and time is on the horizontal X-axis.



You also need to be aware that different ranges of frequencies are named according to their respective frequencies. Those that you need to know for the exam are shown in the table below.

Frequency Range	**Band**	**Name**
300kHz-3MHz	MF	Medium Frequency or "Medium Wave band"
3MHz-30MHz	HF	High Frequency or HF Band
30MHz-300MHz	VHF	Very High Frequency or VHF Band
300MHz-3000MHz	UHF	Ultra High Frequency or UHF Band

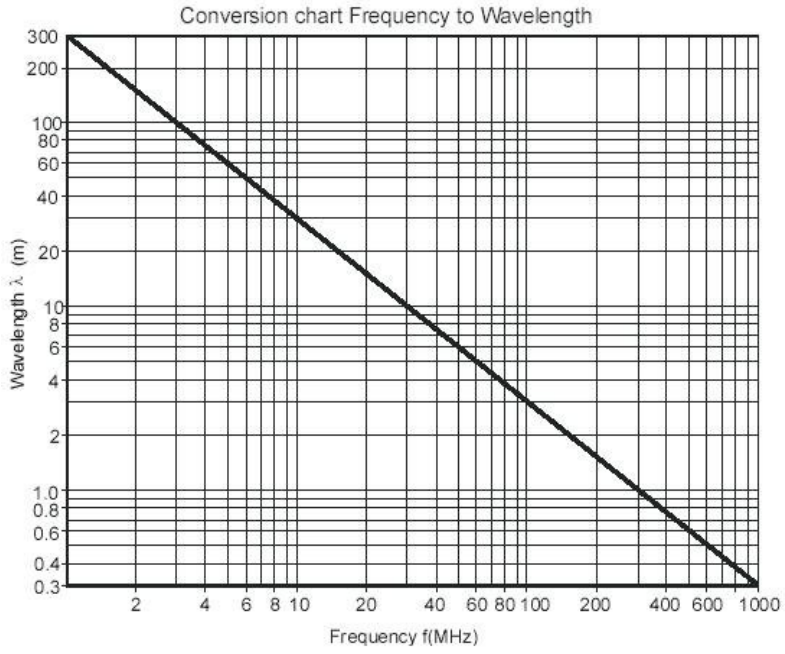
3c.2 *Understand that frequency bands are allocated for particular use, e.g. broadcasting, aeronautical, maritime and amateur.*

You have to be aware of the fact that Amateur Radio Operators are not the only users of the Radio Spectrum, and the table overleaf should be understood, however there is no need to memorise it as there will be a copy of it in the exam (even if there is no question on it!)

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 & SPACE RESEARCH
138·0-144·0 MHz	LAND MOBILE
144·0-146·0 MHz	AMATEUR & 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

3c.3 *Understand the relationship between frequency (f) and wavelength (λ). Use a graph to convert from one to the other. Note: calculations are not required.*

The wavelength of a wave is the distance between the same point on 2 consecutive waves. At this level you do not need to know the equation for calculating this (V= λ x f), as you will be provided with a copy of the graph below for calculating the parameter (this is required at Intermediate level). You should when using the graph, try to estimate the value as best you can and choose the nearest value to the one which you have obtained using the chart.



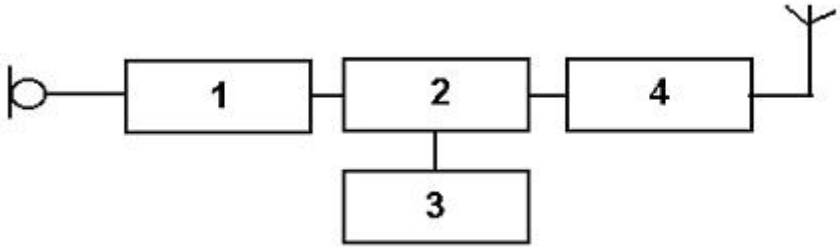
Lesson 4 - Transmitters & Receivers

The transmitter is an important piece of equipment in any Radio Amateur's Shack – it generates the radio waves used for communication. If it is poorly constructed or any other problem arises, it has the potential to interfere with other users of the Radio Spectrum – some of which might not necessarily be Radio Amateurs! It is therefore of vital importance that you are familiar with how your transmitter works and, if necessary be able to rectify the problem (if in doubt - turn it off and seek advice as to how to correct the fault / problem.)

A simple transmitter contains a method of generating the correct Radio Frequency and an aerial (you may be familiar with the term "antenna" – both words are synonymous i.e. they mean the same thing.) Sending messages from your transmitter is a fairly simple concept – it involves switching the transmitter "on" and "off" in a predetermined way, such as the sending of Morse Code (CW). The advent of Voice and Pictures (either as Slow Scan TV or Fast Scan TV) meant that another way had to be found of placing the voice / picture onto the signal to be transmitted. This lead the way to the introduction of a device called a "modulator".

4a.1 *Identify the items in a simple transmitter block diagram and recall their order of interconnection: Microphone, audio (microphone) amplifier stage, frequency generation stage, modulator stage, RF power amplifier stage, feeder and antenna.*

In the block diagram below, is shown a simple transmitter. Bear in mind, that you can be asked to label in the correct order (or the order in which the examiner(s) specify) the boxes numbered 1-4.



For your exam, you need to be aware that the boxes are labelled in the order 1-4 as follows:

1. Audio Stage
2. Modulator
3. Frequency Generator (oscillator)
4. RF Power Amplifier

Where the following symbols are for an Aerial and Microphone respectively.

4b.1 *Recall that the frequency generation stage(s) (e.g. oscillator(s)) in a transmitter defines the frequency on which the transmitter operates. Recall that incorrect setting of these stages can result in operation outside the amateur band and interference to other users.*

When somebody transmits, the signal from the microphone to the Audio Stage is fairly weak, and this results in the amplification of the signal at Box 1. Box 3 is the Oscillator / Frequency Generator which produces the frequency of operation of the transmitter. It is important to ensure that this stage is designed carefully so as not to radiate unwanted signals on other frequencies.

Transmission on another unintended frequency will result in the other station not being able to hear you, but also you may transmit on a band that may not be allocated to the Amateur Service – Ofcom forbids this (stated in the Terms, Provision and Limitations of the Foundation Licence). This is also the reason why Foundation Licensees are not permitted to construct their own equipment – this is exclusively reserved for Intermediate and Advanced Licensees who have been properly trained and have been examined on construction and the associated consequences.

4b.2 *Recall that the audio (or data) signal is modulated on to the radio frequency 'carrier' in the modulation stage of the transmitter. Recall that modulation is by varying the amplitude or frequency of the "carrier", resulting in AM or FM modulation modes. Recall that speech can be carried by AM/SSB or FM and that data may be transmitted by means of suitable audio tones generated in a radio modem or TNC (terminal node controller).*

The Modulator (box 2) takes the signals from boxes 1 and 3 and mixes them to produce a modulated radio signal. Modulation is the process of getting the audio signal superimposed onto the radio signal before it is radiated at the aerial. The signal before the addition of the audio signal is called a "carrier". There are 2 ways which to modulate the carrier: one is Amplitude Modulation (AM) and the other is Frequency Modulation (FM). In AM, the amplitude of the waves is varied in time with the audio signal, whereas in FM the frequency of carrier in time with the audio signal.

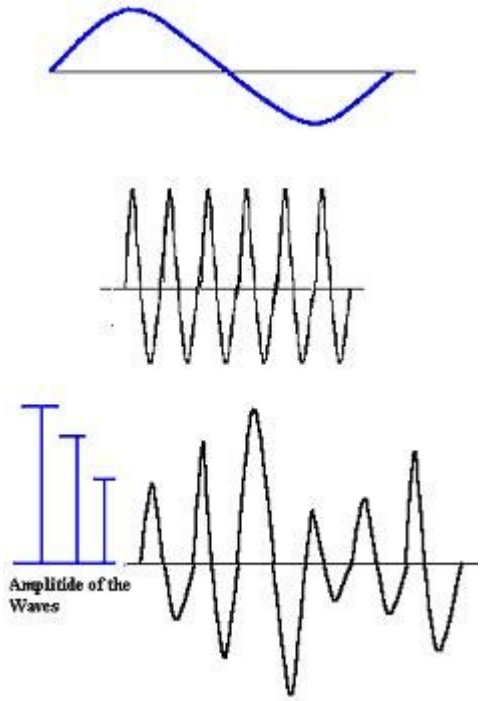
In AM, the top of the waveform is the signal originating at the Microphone. The carrier is the high frequency waves of constant amplitude. This process of Modulation produces waves of the same frequency as the carrier, the but their respective amplitudes vary with the audio signal.

In FM, the top of the waveform below is the signal originating from the Microphone. The steady high frequency wave is the carrier. FM produces a modulated wave of constant amplitude but with the frequency varying in time with the signal from the microphone. The frequency does not vary much, and the radio receiver is tuned to the centre of the frequency variations of the signal.

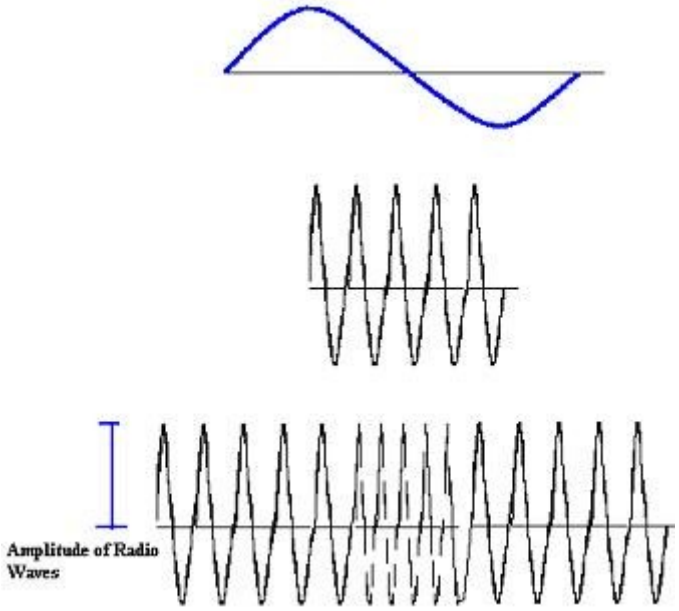
You should also be aware that speech can also be carried by other modes (e.g. SSB) and that data modes such as PSK31, RTTY or AX25 Packet require the use of a Terminal Node Controller (TNC). This device generates audio tones from the data and feeds then to the modulator for radiation.

4b.3 *Identify drawings of an RF carrier and amplitude modulated, frequency modulated and CW radio signals. Understand the terms carrier, audio waveform and modulated waveform.*

In each of the diagrams for AM and FM below, the blue wave is the carrier, the second wave is the audio waveform and the third wave is the modulated waveform.

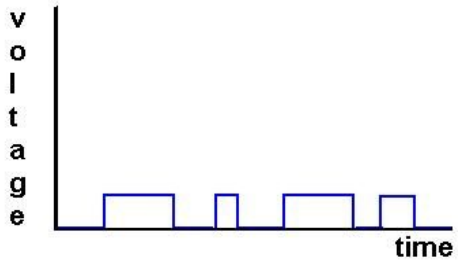


Amplitude Modulation



Frequency Modulation

You also need to be aware of what a CW (Morse Code) signal looks like. In the diagram below, it shows the on and off keying of the carrier for the letter C, indicated by the voltage changes.



4b.4 *Recall that the power amplification of the radio signal is carried out in the final stage of the transmitter. (RF power amplifier).*

The signal produced by the Modulator is not strong enough to be radiated so it is amplified at Box 4 (RF Power Amplifier) where it then goes to the aerial and is radiated.

4b.5 *Recall that the RF power amplifier output must be connected to a correctly matched antenna to work properly and that use of the wrong antenna can result in damage to the transmitter.*

It is of vital importance that the RF power Amplifier of a transmitter be connected to a correctly matched aerial at all times. If it were to be connected to an incorrectly matched aerial, it could cause serious damage to the transmitter as a whole (presented by the high SWR and high feedpoint

impedance, the details of which only required for the Intermediate and Advanced Licence Examinations).

4b.6 *Understand that excessive amplitude modulation causes distorted output and interference to adjacent channels. Understand that excessive frequency deviation will cause interference to adjacent channels. Recall the need to ensure that the microphone gain control (where fitted) is correctly adjusted.*

Excessive AM will make the peaks in the modulated carrier too large and will reduce the troughs (bottom parts of the wave) to 0. This distorts audio making it raspy and rough to the listener. It will also cause interference to radio receivers tuned to adjacent channels, which is important to avoid! Excessive FM is also undesirable and may also cause interference to adjacent users, as well as producing poor quality audio signals for the intended listener! As previously stated, it a condition of your licence that you must not cause "undue interference" to other radio users, whether they are Radio Amateurs or not!

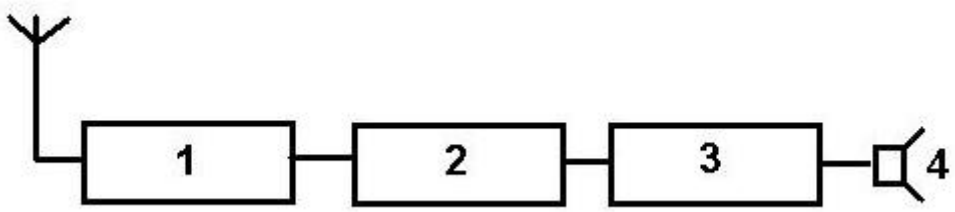
Care must be taken not to "over modulate" with either FM or AM i.e. to have too strong a signal from the microphone and audio stage feeding the modulator. Either shouting into the microphone or turning the microphone gain up too far most frequently causes this. Consider it as the same effect as turning up the volume full on a pair of headphones- the audio is mostly not comprehendible and it is clearly noticed the further the other station is from you. Most people will alert you to a problem with your audio if it is prevalent – it may just require a slight adjustment of the microphone gain!

4c.1 *Identify the items in a simple receiver block diagram and recall their order of interconnection: antenna, feeder, radio tuning and RF amplification, detection/demodulation, audio amplification and loudspeaker or headphones.*

The receiver must pick up the weak radio signals, select the right signal from thousands of others, where it should then be amplified and the data (audio / picture) retrieved from the modulated waveform and presented in a suitable form.

The stages 1-4 in the block diagram overleaf show each stage in a receiver, and are labelled as follows:

1. Tuning & RF Amplifier
2. Detection
3. Audio Amplifier
4. Loudspeaker / headphones



4d.1 *Recall that tuning of receiver is carried out in first stages of the receiver.*

The radio signal is picked up by the aerial, and passes to the feeder, which changes the radio wave into electrical signals on the feeder and this enables the signals to travel to the input of the receiver. In Box 1, the "wanted" signal is selected and the RF amplified to bring it to a suitable level.

4d.2 *Recall that detection/demodulation (recovery of the original modulating signal) is carried out in the second stage of the block diagram and that audio amplification is achieved in the third stage of a receiver.*

Box 2 contains the detector that recovers the original modulated signal- usually an audio signal but you should be aware that it might be data or video as well! The Audio Amplifier (Box 3) ensures that the audio signal is strong enough to drive the loudspeaker. The wanted radio signal is selected by tuning the receiver to the correct frequency (shown on the dial as a digital or analogue readout).

For your general information, tuned circuits (composed of a capacitor and an inductor) achieve this however you will only be expected to know about this in the Intermediate Course. Also, transistors can amplify the signal making it strong enough to use, but it is sufficient for the Foundation Exam to know that circuits in Box 1 perform this function.

The type of detection used must complement the method of modulation being used by the transmitter, otherwise you wont be able to hear anything! Try this out using a HF radio on 3.7MHz, with the Mode switch turned to LSB. Tune around until you can find a comprehendible signal. Now change the mode to AM/FM. What happens? If done correctly, the comprehendible signal observed on 3.7MHz should now not be comprehendible - this is due to the different types of Modulation and detection in use- they are not complementary!

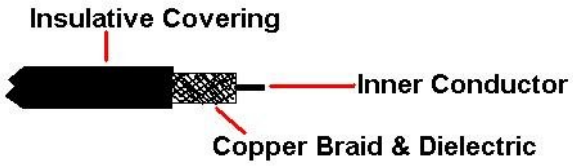
Different modes are discussed in more detail elsewhere and during the practical training. To put it very simply, the correct mode needs to be chosen to correctly recover the original audio / other signal. The technical details are discussed in even greater depth at the Intermediate and Advanced Levels.

Lesson 5 – Feeder & Antenna

5a.1 *Recall the correct cable to use for RF signals and that coaxial cable is most widely used because of its screening properties.*

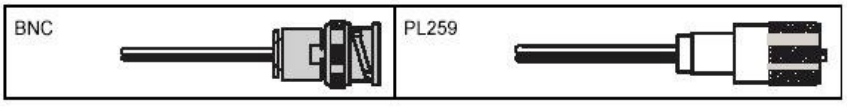
Any wire that is to carry an RF current must be properly screened to ensure that the current is confined to the cable and does not induce current in any other structures that may run alongside the cable. This lead to the introduction of coaxial cable which is designed so that the signal travels along the inner conductor and is prevented from radiating the RF energy by the use of the outer braid and dielectric, which also make up its structure. A dense braid demonstrates a good quality coaxial cable, whereas a poor quality coax has a very thin and wispy braid network on the dielectric. The dielectric is the plastic spacer between the copper braid and the conductor of the coaxial cable.

It is interesting to note (although not required for your exam) that coaxial cable comes in many different sizes (diameters), and are usually assigned names such as RG213, RG58U etc. Also, Coax can come with different characteristic impedances, however for the Foundation Exam you are only required to know the structure of coaxial cable and be able to explain why it is used, in terms of screening.



5a.2 *Recall that the plugs and sockets for RF should be of the correct type and that the braid of coaxial cable must be correctly connected to minimise RF signals getting into or out of the cable. Identify BNC and PL259 plugs.*

Over the evolution of Amateur Radio, people have developed ways of ensuring that the signal travelling through the cable does not escape or suffer interference from other signals outside the cable. For the Foundation exam, you are required to be familiar with the 2 most common RF connectors in use: the PL-259 and the BNC-259 (a diagram of each is shown below).



When fitting RF connectors to Coaxial cable it is of vital importance that the braid does not come in contact with the centre pin of the connector to which the conductor is soldered – it may cause a short between the conductor and the braid. To rectify the mistake, should it happen, it is necessary, if easier, to unsolder the conductor and remove the cable from the plug. The braid should then be tidied up (i.e. by removing any stray fragments of the braid) and inserting the coax into the plug again and soldering the conductor to the centre pin (this creates a continuous shield for the conductor ensuring the signal does not escape at the plug).

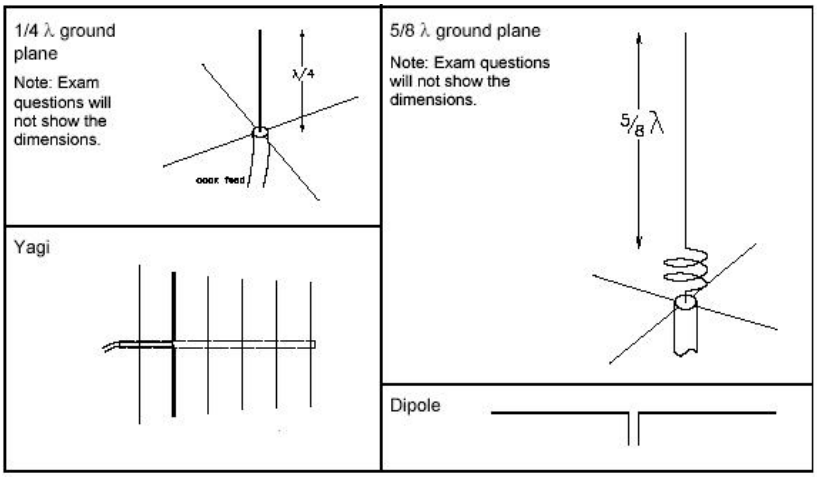
You will be required to demonstrate that you can fit an RF connector to a piece of coaxial cable for the Intermediate Licence Practical assessment, however at this level it suffices to know the theory of fitting a plug and what to do if there is a short between the conductor and the copper braid.

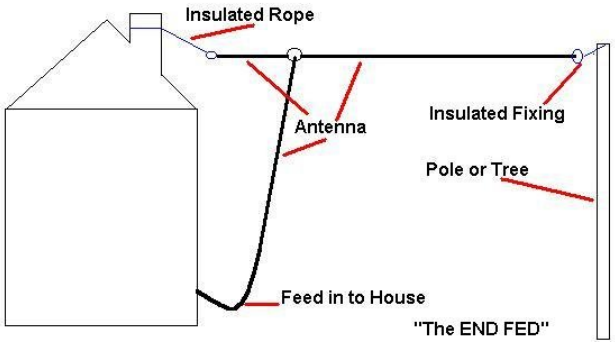
5b.1 *Recall that the purpose of an antenna is to convert electrical signals into radio waves (and vice-versa) and that these are polarised according to the orientation of the antenna, e.g. a horizontally oriented antenna will radiate horizontally polarised waves.*

For the Foundation Exam you have to know what an aerial (or antenna) does, i.e. its function. An aerial converts the electrical signals from the feeder into radio waves that are radiated from the elements of the aerial and vice versa. Depending on what way the aerial is positioned it may radiate horizontally or vertically, thus giving way to horizontal or vertical polarisation.

5b.2 *Identify the half-wave dipole, 1/4 wave ground plane, Yagi, end-fed wire and 5/8 wave antennas. Understand that the sizes of HF and VHF antennas are different because they are related to wavelength, though they operate on the same basic principles. Understand that the 1/2 wave dipole has a physical length approximately equal to a half wavelength of the correct signal.*

For the Foundation Exam you need to be familiar with a few aerials, and you may be asked to name then in the exam. Those that you need are shown in the diagrams overleaf.





The respective sizes of VHF and HF aerials are quite different due to the fact that they are related to wavelength as opposed to frequency- VHF aerials being typically much smaller than HF aerials, yet both VHF and HF aerials operate on the same basic principles – i.e. both aerials' sizes are related to the wavelength of the wave which will be transmitted.

A half wave dipole (also referred to as 'λ/2') dipole derives its name from the fact that the overall length of the aerial is equal to half of the full wavelength of the wave which is to be transmitted.

5c.1 *Understand that half-wave dipoles (mounted vertically), ground planes and 5/8 wave antennas are omni-directional.*

When ground plane, 5/8 wave and half wave dipoles (only ever VHF aerials as HF half wave dipoles are much too big to be feasible) are mounted in the vertical plane, they are said to be "omni-directional" – that is, they radiate well in all directions. Aerials which radiate equally well in all directions can also be called "Isotropic Radiators" and this is where, if you look on an aerial (particularly HF and VHF verticals) that the gain may be expressed as "dBi"- the gain is compared to an Isotropic Radiator.

You are not required to know about Isotropic Radiation, however it does no harm to be familiar with it now (the first sentence of the paragraph above will suffice for the exam).

5c.2 *Understand that a Yagi antenna is directional and has a gain because of its focusing ability.*

Yagi aerials (see 5b.2) are in common use for HF due to their ability to focus the RF into a "beam"- this is why sometimes you may hear people talking about a "beam antenna". The Yagi produces a beam of RF because it amplifies the signal in the direction of the beam and suppresses unwanted signals to the sides and back of the beam, ensuring that the most of the RF power is transmitted in the direction in which the aerial is pointing. Due to the beam of RF it is common to find Yagis on towers and attached to a rotator- a device that can turn the beam to a compass point: East, South West, North North East etc.

5c.3 *Recall that ERP is the product of the power to the antenna and its gain.*

The ERP or Effective Radiated Power of an aerial is the power supplied to the aerial multiplied by the gain of the aerial.

Unfortunately Gain of an aerial of often displayed in Decibels (dB), so to calculate the gain, use the following table as a rough guide to gain in terms of multiplication.

Gain (dB)	Gain (Times)
3	2
6	4
9	8
10	10

Calculate the ERP in each of the questions below.

1. 10W to antenna of 3dB gain
2. 50W to antenna of 10dB gain
3. 12W to antenna of 9dB gain
4. 5.5W to antenna of 6dB gain

5c.4 *Recall that the antenna system must be suitable for the frequency of the transmitted signal. Recall that if an antenna is not correctly designed for the frequency it will not match the transmitter and will not work effectively.*

An antenna system must be suitable for the frequency and wavelength of the waves to be transmitted. If this is not observed, serious damage may be done to the transmitter.

It is therefore of vital importance to ensure that the aerial is ½ wavelength, if it is a dipole, as some of the power may be reflected down the feeder and back into the transmitter.

5c.5 *Recall that at HF, where an antenna has not been designed for the particular frequency, an ATU (antenna tuning unit) improves the ability of the antenna to accept power from the transmitter. Recall that, when an antenna is not well matched to a transmitter, a matching unit, commonly known as an ATU (antenna tuning unit), is used to ensure that the transmitter can supply energy to the antenna without damage to the transmitter.*

At HF, the point raised in 5c.4 is not always feasible. As a result it is common in HF installations to have a device that can change the feed-point impedance to allow the power to de radiated by the aerial. This device is called an Antenna Tuning (or Matching) Unit – ATU (AMU). The aerial should be resonant on 1 band and for all others it may be somewhat of a compromise, so on all of the other bands the ATU should be used to ensure that as little of the power is reflected down the feeder as possible.

5d.1 *Understand the difference between balanced and unbalanced antennas and that a balun should be used when feeding an HF dipole with coaxial cable (which is unbalanced).*

Look again at the drawing of the half wave dipole. You should notice that it is electrically symmetrical - both legs of the aerial are the same length. However, the coaxial cable feeding the dipole is not electrically symmetrical - if it is connected directly to the dipole without a device to make it symmetrical, the screening properties of the coaxial cable will be upset as the RF will flow down the cable.

Therefore, where coaxial cable is to be used with a dipole it is necessary to include a balun- a device that makes the coaxial cable "balanced" with the dipole (balun derived from its proper term "balanced to unbalanced transformer"). It takes the signal from the coax and converts it to 2 signals suitable for feeding the dipole.

5e.1 *Recall that an SWR meter shows whether an antenna presents the correct match to the transmitter and is reflecting minimum power back to the transmitter.*

A Standing Wave Ratio (SWR) Meter can be used to measure the power flowing back down the feeder, allowing the operator to adjust the ATU until the Aerial System is matched and the reflected power to the transmitter is minimised.

5e.2 *Recall that a high SWR (measured at the transmitter) is an indication of a fault in the antenna or feeder (and not the transmitter). (Relate this to item 4b.5)*

A high SWR measured at the transmitter is usually an indication that there is a fault with the aerial or the feeder. If this is the case, it must be rectified before transmitting as this can cause serious damage to the aerial system. Birds or wind can cause damage as can, vehicles that may come into contact with the aerial system as a result of their overall height.

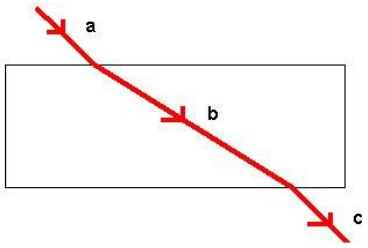
5f.1 *Recall that a "dummy load" is a screened resistor connected instead of an antenna to allow the transmitter to be operated without radiating a signal.*

A dummy load is a carefully constructed resistor, which is capable of absorbing all of the power from the transmitter and presenting a good match so that no power is reflected. To prevent, or at least minimize radiation, it must also be suitably screened. The main use is in HF systems to suitably match the aerial to the frequency of transmission without radiating a significant amount of power, thereby "tuning" on someone else's frequency, as we are all aware, it can be quite annoying to have somebody start to tune when we are in QSO with another station!

Lesson 6 – Propagation

6a.1 *Recall that radio waves travel in straight lines, unless diffracted or reflected.*

Like the rest of the waves of the Electromagnetic Spectrum, Radio waves travel in straight lines unless they are reflected off something or they are refracted- bent (just like a beam of light entering a glass prism). To understand refraction, look at the diagram below.



The red arrowed line represents the beam of light and the glass prism is represented by the rectangle. The beam of light enters the glass and due to the higher density of the glass the beam is bent to the left as it enters. The beam continues along this straight-line path and because of the difference in densities (in terms of the glass and the air) it speeds up when exiting the glass and is bent towards the right. Due to this, in theory sections 'a' and 'c' of this ray should be parallel.

6a.2 *Recall that radio waves get weaker as they spread out.*

Close to the transmitting aerial, the radio waves will be strong and so a nearby receiving aerial will have a strong signal. As the waves travel and spread out from the aerial they become weaker in strength and a receiving aerial will not have such as strong signal as the closer receiving aerial.

6a.3 *Recall that at VHF and UHF hills cause "shadows" and that waves get weaker in penetrating buildings but glass windows are more transparent to radio waves.*

Radio waves can penetrate buildings just like x-rays can penetrate flesh. Some of the energy is lost when a radio wave enters a building. The ability to penetrate radio waves very much depends on the frequency of the wave. At VHF and UHF, the wavelengths are very much shorter than HF wavelengths.

Loss in strength can occur as a result of hills- if you live in a hilly area (like the author) the television picture that you will have will not be very good- television transmitters transmit the television signal at UHF. It is common to have "ghosting" on the television picture in this situation due to the mountains providing a "shadow" for the signal by blocking a percentage of the transmitted signal.

At higher frequencies, if the wavelength is smaller than an opening, for example a window, then the wave will easily pass through the window and the signal will be stronger.

6a.4 *Recall that the range achieved at VHF/UHF is dependent on antenna height and a clear path and transmitter power. Understand that higher antennas are preferable to higher power as they improve both transmit and receive performance. Recall that outdoor antennas will perform better than indoor antennas.*

Range at either VHF or UHF is very much dependant on "line of sight"- the higher the aerial the better as this will not only increase the transmitted signal strength but also the received signal strength, meaning you should be able to hear more if you put your aerial higher. Another possibility to increase signal strength is to increase your transmitter power, however this can also cause interference, as we shall find out in the next few lessons. It is also important to understand that indoor aerials will not be as effective as outdoor aerials, as stated in the previous section (6a.3).

6a.5 *Recall that, at VHF/UHF, range decreases as frequency increases and that in general, VHF/UHF waves have a range not much beyond 'line of sight'.*

At VHF and UHF, range is affected by the frequency in use- 2m (144MHz) has generally a much larger range than 70cms (430MHz) and in general the range of the waves is not much further than the line of sight. This is another reason why it is important to try and get your aerial up as high as possible as this increases the line of sight of the aerial.

6b.1 *Recall that the ionosphere comprises layers of conductive gases at heights between 70 and 400km above the earth.*

As the name suggests, the Ionosphere is composed of layers (D, E, F_1 and F_2 to be exact) of ionised gas and other particles in the atmosphere and can be found to start 70kms above the earth.

6b.2 *Recall that on HF most communication relies on the waves being reflected by the ionosphere. Recall that HF can provide worldwide propagation depending on how well the ionosphere bends the waves back to the earth. Recall that this varies with frequency, time of day and season.*

HF is the most common section of the radio spectrum to use the Ionosphere for communication. Typically signals, and in particular HF, are bounced off the ionosphere and this is what helps the range to be increased. The range of a HF signal is dependant on a few factors to do with the Ionosphere.

At different times in the day, the ionosphere will bend waves at different rates meaning that (typically) during the day distances may be relatively large and at night they may be even greater due to the increased ionisation of the F layers. In such circumstances it is possible to QSO with Australian or US Amateurs on 80m where during the day and in the evening it only supports short distances to the rest of the UK and Europe. Frequency also has a role, but the other major influence is the time of the year- the bands above 10MHz "close" (stop supporting communication) earlier in the winter than they do in the summer.

Also the "sunspot Cycle" has another major impact on HF Propagation. Each Cycle lasts around 11 years and in the Sunspot Maximum, the bands above 21MHz are usually open and support communication. (This does not mean that they are never open during Sunspot Minima! Occurrences referred to as "Sporadic E" affect these bands above 21MHz (21MHz, 24MHz, 28MHz, 50MHz, 70MHz and 144MHz) often resulting in short "openings" due to Ionospheric Propagation in the E layer (hence the name Sporadic E).

Lesson 7 – EMC

You should pay particular attention to this lesson as a whole, as it is stipulated in the terms of your licence that you must not cause undue Interference to either yourself or others around you. As a result of this questions on Electromagnetic Compatibility are always asked and therefore will come up in your exam!

7a.1 *Recall that electromagnetic compatibility (EMC) is the avoidance of interference between various pieces of electronic equipment.*

Electromagnetic Compatibility is defined as the avoidance of interference between two pieces of Electrical Equipment.

7a.2 *Recall that radio transmitters can cause interference to nearby electronic and radio equipment.*

Radio transmitters can cause interference to other radio receiving devices and electronic items that are not intended to receive radio waves but are, nonetheless upset / suffer because of them, due to the transmitted RF finding its way into circuitry that is not intended to have RF flowing around it.

7a.3 *Recall that radio receivers can also suffer from interference from local sources.*

It is not just household appliances which can suffer from Interference- Amateur Radio Installations, and in particular receivers can also suffer – if you live in a rural area, at some times of the year it is common for Farmers to install Electric Fences on their land to divide up grazing pasture. The pulses of electricity used to maintain the electric fence often interfere with local radio and TV reception (usually in the form of a rhythmic beating noise.)

7a.4 *Recall that interference occurs through local radio transmissions being conveyed to the affected equipment through pick up in house wiring, TV antenna down-leads, telephone wiring etc., and (particularly at VHF/UHF) by direct pick-up in the internal circuits of the affected equipment.*

There are several ways of how interference can be conveyed into electrical Equipment. Any piece of wire connected to anything is capable of conveying RF Interference from one place to another. The most common is for the RF to be picked up by the mains wiring. The typical house today has approximately, in total several hundred metres of wire,

including coaxial cable and telephone wire (if it was placed end to end) and consequently the chance of RF getting into the wire is quite high.

Also another method is through the TV downlead. Most homes have a masthead amplifier on their aerial (also known as a "booster") and these are often wideband in coverage and so it can be received at this point and travel down the coax lead from your TV aerial into the television itself. It is more common at VHF and UHF (2m and 70cms respectively) for RF to be able to enter the affected equipment directly.

7b.1 *Recall that EMC problems can be minimised by siting antennas as far away from houses as possible, as high as possible, and using balanced antennas at HF. Recall that, at HF, (horizontal) dipoles are less likely to be a problem and that end-fed wires present significant EMC problems. Recall that information on the avoidance of interference by the correct choice and siting of antennas and suitable operating procedures is readily available from several sources.*

Where possible, Amateur Radio Aerials should be sited as far from houses as possible to reduce the possibility of interference to yourself or others around you. It is also a good idea to try and use balanced aerials such as dipoles to also reduce the possibility of interference and for maximum effect they should be as high above the ground as possible. In this respect, a CFD (Centre Fed Dipole) is much more desirable than a "OCFD" (Off Centre Fed Dipole / End Fed Dipole) as typically end fed wires are typically prone to causing EMC problems often due to the close proximity of the radiating element to nearby property. A Balun will need to be used if the feeder is coaxial cable.

Should you have any concerns about EMC or require any assistance with problems that have arisen, help is available from the RSGB EMC committee or from Ofcom. Both Organisations produce leaflets on typical EMC problems and possible solutions.

7b.2 *Recall that the more power a station runs, the more likely it is to cause interference. Recall that some types of transmission are more likely to cause interference to TV, radio and telephones than others. Recall that SSB is the one of the poorest in this respect. FM, CW (Morse) and the some of the HF data modes (such as PSK31) are much better.*

As you should expect, the more power that you run, the chance of causing problems due to EMC will be greater. Similarly, some modes of operation are more likely to cause problems

than others – the typical systems being affected usually are TV, radio (domestic) and telephone lines.
Single Side Band (SSB) operation is one of the poorest modes of communication for not affecting domestic systems, often causing clipping of sound and sometimes a superimposition of an unintelligible voice coming through.

Whilst SSB is one of the worst, FM, CW and some of the HF data modes are much better often because their levels of transmitted power are fairly constant.

7c.1 *Recall that the ability of any piece of electronic or radio equipment to function correctly in the presence of strong RF signals is known as "immunity". Recall that fitting suitable external chokes and filters in mains or TV antenna leads can increase the immunity of most types of equipment. Recall that the filters should be fitted as close to the affected device as possible.*

"Immunity" is the ability of electronic equipment to function correctly in the presence of RF signals. Immunity can be enhanced when suitable external chokes and other filters are fitted correctly to electronic equipment. The most common filters are "Band Pass Filters", "Low Pass Filters", "High Pass Filters" and a "Ferrite Ring". Each filter mentioned does a slightly different job, which you only need to be aware of at the Intermediate stage of training. When the use of filters is employed, they should, to be effective, be placed as close to the affected device as possible.

7c.2 *Recall that anything fitted to the mains wiring must be properly made for the purpose. Understand that homemade filters (other than ferrite rings) are potentially dangerous. Recall that information about the purchasing, making and fitting of chokes and filters is readily available from several sources.*

For the Exam you need to be aware that anything fitted to mains supplied items of electrical equipment, must be specifically designed for the purpose, as components rated for mains voltage must be used. Making your own filters, at this stage is potentially very dangerous and as a result it is not recommended for you to do so. Information about filters and filters available to purchase can be made available by the RSGB upon request. Filters are also available from most Amateur Radio Dealers.

7c.3 *Recall that the function of the RF earth connection in an HF amateur station is to provide a path to ground to minimise RF currents entering the mains earth system and causing interference to other electronic equipment.*

RF in the mains electrical supply can be avoided by the use of an RF earth. An RF earth consists of a copper rod (no less than 3 feet / 100cms in length) driven into the ground close to the point where the feeders enter the house/building. This is then connected to a heavy gauge wire directly to the "GND" terminal of the transmitter. In conjunction with the RF earth, a ferrite ring should be used, all 3 mains leads – live, neutral and earth – need to be filtered. This is done by winding approximately 20 turns of the mains flex around the filter (you may need to use several rings to get 20 turns).

7d.1 *Recall that EMC problems have the potential for causing neighbour disputes. Understand the need for diplomacy, the sources of advice available and the role of the local office of Ofcom.*

EMC problems have the potential to cause disputes with neighbours. In order to resolve these disputes, it is useful to ensure a co-operative approach from both parties. Goodwill can often help in determining the cause quickly and remedying it.

However, there are some cases where it may be necessary to involve the local office of Ofcom. Here Ofcom will ask both parties to keep logs of the interference so the case can be established. Normally the Amateur Station will be inspected – it is a friendly and helpful inspection just to ensure that everything is OK. You should note that this instance is the only case where UK Amateurs are required to keep a logbook of all transmissions- the formal licence condition removed in December 2006.

Lesson 8 - Operating Practices & Procedures

8a.1 *Understand why one should listen before calling and then ask if the frequency is in use.*

It is common courtesy to listen on a frequency before starting to call CQ. This ensures there are no QSOs already taking places on the frequency. If you hear somebody then it is courtesy to use a frequency elsewhere on the band. The period if listening should be used again.

Alternatively you can ask: "Is this frequency in use please" and give your callsign immediately after "please". It is better to ask twice or 3 times if no answer is received, and if no answer is received after the third time, then there are no QSOs taking place. (You are reminded that you are required by Ofcom to identify yourself when first transmitting.)

8a.2 *Recall how to make a CQ call.*

CQ Calls on VHF/UHF tend to be more straightforward than those on HF. VHF and UHF bands are segmented into 12.5kHz or 25kHz spaced channels, whereas on HF there is no channelisation. Also, on VHF / UHF there are allocated frequencies specifically for calling CQ- you should make use of these. A CQ Call for VHF may be of the form "CQ CQ CQ 2IØJVI calling CQ". It is rather short due to the fact that no tuning needs to be done by the stations who may be going to reply to it.

On HF it is a different story- CQ calls need to be much longer to give stations time to tune your signal and also to tune their aerial systems to your frequency of transmission. Consequently, a CQ call on HF (e.g. 14.250MHz) may be "CQ CQ CQ CQ CQ 20 metres CQ 20 metres, 2IØJVI 2IØJVI 2IØJVI calling CQ 20 metres and listening". This long CQ call gives the stations listening time for tuning.

8a.3 *Understand the need to move off the calling channel (when on VHF/UHF) once contact is established.*

When you have successfully established contact on the calling channel it is of vital importance that you find a free frequency as quickly as possible so you can leave the frequency free for other stations to use.

8a.4 *Recall the phonetic alphabet.*

Particularly on HF, where you may be in QSO with a foreign station who does not have as good a grasp of the English language as yourself, it is a good idea to use the Phonetic Alphabet to ensure that they receive information correctly. It is also a good idea to say "QSL" to which they shall reply "QSL" if they have received everything correctly, or else they shall ask you to repeat the part that they had difficulty with. For example:

"FØAAA from 2IØJVI. OK my name is Jonathan, spelt 'Juliet Oscar November Alpha Tango Hotel Alpha November' and my QTH is Coleraine, spelt 'Charlie Oscar Lima Echo Romeo Alpha India November Echo'. QSL? When using QSL to check whether the other station received your information, it is not necessary to use discourse markers such as "Go ahead" or "Over" as they understand that this usage is a question.

You should be familiar with the Phonetic Alphabet for future reference, and it is in the table below.

A	Alpha	**N**	November
B	Bravo	**O**	Oscar
C	Charlie	**P**	Papa
D	Delta	**Q**	Quebec
E	Echo	**R**	Romeo
F	Foxtrot	**S**	Sierra
G	Golf	**T**	Tango
H	Hotel	**U**	Uniform
I	India	**V**	Victor
J	Juliet	**W**	Whisk(e)y *
K	Kilo	**X**	X-ray
L	Lima	**Y**	Yankee
M	Mike	**Z**	Zulu

**Both spellings are acceptable*

8a.5 *Recognise the advisability and common practice of keeping a log and the items recorded.*

Prior to December 2006, Ofcom and the RA (Radiocommunications Agency) before it required all Amateur Radio Operators to keep a logbook of all transmissions that they ever made. This has now been done away with, however Ofcom will require a logbook to be kept should there be problems with Fault fining due to EMC.

Although this stipulation has gone, most of the Amateur Radio Operators in the UK still maintain a logbook of all transmissions due to posterity and also they are invaluable in the sending of QSL cards and obtaining awards. Logbooks are also still required to claim points in a contest.

Due to the present situation on the keeping of logbooks, while it is recommended but not legally necessary, it will not be examined at the Foundation Level.

8b.1 *Recall that repeaters are mainly intended to extend the range of mobile stations. Recall how to use a repeater and understand the need for an Access Tone or CTCSS and frequency offset.*

A Repeater is a connected Transmitter and Receiver, intended to re-transmit the signal picked up by the receiver. Due to the simultaneous nature of this system it requires a frequency offset because if it were to transmit and receive on the same frequency it would not hear anything. Its primary purpose is to extend the range of mobile and portable stations, thus repeaters are often located on prominent sites.

Ofcom has stipulated that UK repeaters are not to be opened simply by an FM carrier and consequently UK repeaters will have a 1750Hz Tone Burst and/or a designated CTCSS (Continuous Tone Coded Signalling System, also referred to in the USA as 'PL' tones) tone to open the repeater. CTCSS tones for each repeater/ region of the UK may be different- for example in Northern Ireland all repeaters have a 'H' transmitted after their callsign (e.g. GB3LY H etc) indicating that the CTCSS tone for activation of the repeater is 110.9Hz.

In some countries of the world, CTCSS tones are used to ensure that the people, who have paid a subscription to the repeater group can only use the repeater. If you have to use a repeater, try to do so when it is less busy, for example when most activity of the day is over. You also should always give priority to mobile stations requesting to use it. You should also check if your QSO could be continued on a simplex frequency- this can be checked by checking the input of the repeater (on 2m – 144MHz the input of the repeater is always 600kHz lower in frequency than the output frequency, e.g. GB3LY output is 145.600MHz so the input of GB3LY is 145.000MHz- the frequency you should be transmitting on of the repeater) to see if you can hear the station.

8c.1 *Recall why band-plans are used. Identify items on a published band-plan (e.g. calling frequencies and recommended modes).*

For the examination you need to be able how to interpret the band plans that will be supplied with your examination. You should be familiar with the permitted modes on each section of the band and be able to identify calling channels etc. Bandplans for the 2m and 20m bands can be found in Appendix IV.

8d.1 *Recall that connecting anything other than the supplied microphone (e.g. packet radio TNCs) to the transmitter requires correct operation of the PTT line and correct audio signal levels.*

Any auxiliary devices that may be connected to the transmitter (e.g. a TNC) requires to be wired correctly i.e. they correctly operate the PTT line of the transmitter and they have correct audio levels as the output levels typically are much too high and require being significantly reduced.

8e.1 *Demonstrate, using a VHF/UHF transmitter/receiver; correct tuning in to an amateur FM voice signal and a data signal such as packet. Read the signal strength meter (where fitted).*

On VHF and UHF, FM signals are typically "Channelised" – i.e. channels are found every 25kHz (and more increasingly 12.5kHz for FM repeaters) on different sections of the particular band. Other modes such as Packet can usually be found on their allocated sections of the band, every 1kHz or every 0.5kHz. It is important to tune them correctly- this can usually be determined using the pitch of the signal as an indicator- a high pitch means that the signal is off frequency, so tune in the direction that the pitch decreases.

It is also important to be able to read the signal meter (where fitted). On FM it is usual for signals to be of moderate strength as range is not great. When reading the meter, it is usual to read the point where the signal is steady, although some people choose, if the signal meter flickers above say 5 to give a report of the form "5 and 5 peaking 7".

8e.2 *Demonstrate correct operation of a VHF transmitter/receiver in simplex mode. Note: Controls used shall include frequency, squelch and, audio gain (volume). Recall the meaning of signal reports exchanged during a contact. Make a simplex radio contact and exchange signal reports.*

Operation on VHF FM Simplex is exactly the same as if a station was using a repeater, except there is no offset in Frequency between Transmit and Receive – the concepts are the

same. The Squelch should be adjusted so that the noise is just cut- don't set it too high or this may affect reception! Try to have the volume (or Audio Gain) as low as possible, but not too low so that you can't hear the other station(s)!

When transmitting it is always a good idea to allow a short break of usually a second or two between "overs" – this gives any other station (which may include distress signals [particularly on HF] a chance to transmit). You may have heard on repeaters that between overs there is a short Morse Letter transmitted e.g. T or K – this shows the listeners that the repeater has reset in readiness for the next transmission. You should allow this to happen, as some repeaters may shut down after a few minutes if this is not observed.

8e.3 *Demonstrate, using an HF transmitter/receiver, correct tuning in to an amateur SSB voice signal and a Morse signal. Read the signal strength meter.*

The main difference between HF and VHF/UHF is that HF bands are non-channelised and consequently the tuning of stations must be more careful. Stations often transmit on frequencies such as "14.212MHz" or "14.2135MHz".

Use the tuning technique described in 8e.1. Reading the signal meter on a HF transceiver can often be a little hard- stations are often subject to fading, manmade or natural interference so therefore stations tend to give conservative reports or else give everyone a "5 by 9" report as a standard.

8e.4 *Demonstrate correct operation of an HF transmitter/receiver in an SSB contact. Note: Controls used shall include frequency, the RIT (clarifier), audio gain (volume), RF gain, microphone gain and antenna tuner (ATU). Make an HF SSB voice contact and exchange signal reports.*

The same procedure should be applied here as to VHF/UHF FM, allowing gaps in transmissions and use of the controls- some of which are sometimes specific to HF.

It is particularly important to speak clearly and slowly (but not too slowly) so that other stations, who may not necessarily have a good command of English, are able to understand what you are saying (although this problem can be rectified through the usage of "Q Codes".)

The Clarifier (Receiver Incremental Tuning) can help receive a station who may drift slightly due to instability of their VFO. The RF and Microphone gain should only be adjusted

where necessary- excessive gain of either can result in your transmitted signal being unintelligible- stations will often tell people who have this symptom to check their settings.

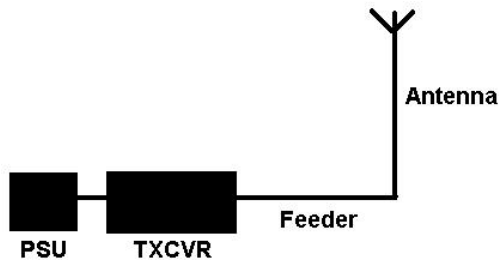
8e.5 *Demonstrate a CQ call on VHF/UHF, making a contact and initiating a change of frequency (QSY) off the calling channel.*

CQ calls on VHF/UHF are generally a lot shorter than those on HF, as simplex ranges are limited and most people do not need to tune systems in order to contact you. It may be sufficient to give your call 2 or 3 times: "CQ 2metres CQ CQ CQ 2IØJVI 2IØJVI calling CQ".

If stations miss any bit of a callsign they may come back to you saying "the 2IØJ station, this is GI4…". Calls such as these are made on the calling channels, e.g. 145.500MHz and after contact has been established it is necessary to change frequency to leave the frequency clear by moving elsewhere within the simplex region of the band.

8f.1 *Demonstrate connecting a transmitter/receiver to a power supply, antenna and feeder. This part of the syllabus is carried out as a practical*

A system comprising a Power supply, Transceiver, feeder and antenna should be set up according to the diagram below, where "PSU" = Power Supply (Unit) and "TXCVR" = Transceiver.



8f.2 *Demonstrate, using a 1/2 wave dipole antenna with adjustable elements, that the SWR varies as the length of the elements are varied. Set up the dipole for minimum SWR.*

You are also required to show that the element lengths in a dipole can cause differences in SWR. You should not adjust the dipole lengths whilst a transmission is taking place, as this can cause RF burns.

The dipole should be set up for minimum SWR (as close to 1 as possible), and when this has been demonstrated to the assessor, the dipole elements should either be lengthened or shortened to show how this affects the SWR- it should increase it!

Lesson 9 – Safety

9a.1 *Recall that high voltages carry a risk of electrocution and high currents carry a risk of overheating and fire*

You should be mindful that voltages can electrocute- 230V is quite sufficient in order to kill a person (if the conditions regarding earthing of the person are correct). High currents can cause fires- the mains supply cables are typically much larger as regards the diameter of the core due to the fact that larger currents typically flow around them than the currents present in domestic appliances. It is also worth mentioning that if you are using retractable extension leads, you should unwrap the entire lead before using it- this reduces the risk of fire due to overheating of the cable.

9a.2 *Recall why mains powered equipment should have a safety earth. Recall that special care is needed with earthing arrangements if your house has PME. Recall that details of PME earthing can be obtained from the local electricity supply company and are covered in a separate leaflet.*

Mains power appliances should be earthed, as this is a safety feature designed to protect the user should a fault develop.

Protective Multiple Earthing (PME) is an earthing system often found in housing built later than 1970. In it all metal work, such as water pipes etc is bonded together. Consequently this can provide some problems for Amateur Radio Operators in terms of the use of an RF earth. You are not required to know about PME in any greater detail and you should be aware that information is available from your electricity supply company.

9a.3 *Recall that correct fuses must be fitted to all electrical equipment and that this is in the live wire of mains powered equipment and according to the manufacturers' instructions in low voltage equipment.*

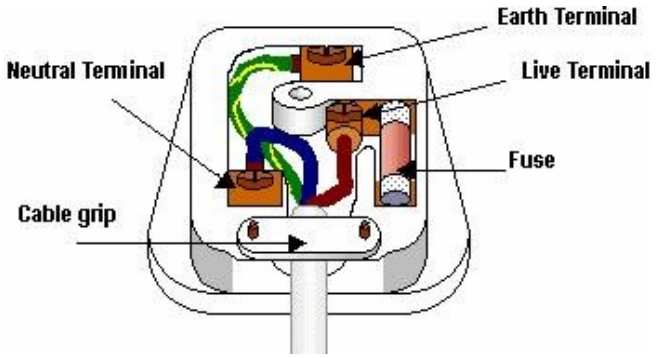
The correct type of fuse must be fitted to all electrical equipment – a fuse is another safety feature found that helps protect the user if a fault develops. The correct fuse ratings can be found on any literature that the manufacturer provides with their product. Fuses for plugs typically come in 1A, 5A or 13A, the lowest possible value should be used e.g. a lamp has a typical current of 3.5A flowing. The fuse in the plug should therefore be 5A.

9a.4 *Recall only working inside equipment that is disconnected from the mains.*

A Foundation Licensee should not carry out work inside electrical equipment. Any work that is done, the particular appliance must be unplugged from the mains to ensure that electrocution is not possible.

9a.5 *Recall the correct way to wire a 3-pin mains plug.*

At this stage it is not required for Foundation Licensees to be able to wire a plug, but you should recognise a safe plug from one that is not safe. You should study the diagram below (a better version is available in "*Foundation Licence Now!*" by Alan Betts.



9a.6 *Understand the need for a clearly marked switch to turn off all station equipment in case of emergency.*

It is common practice, and indeed advisable to use a single switch to cut the powers to all of the equipment to ensure no accidents occur due to electrocution. This switch should be clearly marked and shown to all persons.

9b.1 *Recall that, in the event of an accident involving electricity, the first action is to switch off the power. Recall that the casualty must not be touched unless the power has been switched off.*

In the event of an Electrocution the first act should be to cut the electrical supply in a safe manner. If this is not possible the casualty should moved using an insulated material such as a wooden broom handle etc. The reason why the casualty should not be moved until the electrical supply has been cut as humans are electrical conductors and by touching the person, you could do damage to yourself as well.

9c.1 *Understand the reasons for not having wires trailing across the floor, trip hazards and the risk of frayed insulation.*

These points are simply to do with common sense- wires over the floor can result in injury and frayed insulation can result in electrocution.

9c.2 *Recall that elevated wires and antennas must be suitably located and secured.*

This simply is conveying the idea that wires and aerials must be suitably secured to prevent injury from falling on top of someone.

9c.3 *Recall that antennas and feeders should not be sited close to overhead power cables.*

Antennas and feeders must not be located close to overhead power cables due to the fact that both the electrical supply cables and aerials are metallic and therefore conduct electricity and as a result it may cause an accident if the two were to touch.

9c.4 *Recall that antenna erection is potentially hazardous and that it is advisable to have someone to help you. Understand the need for at least one adult to be present.*

When erecting aerials or working at height it is always advisable to have another person with you, and this is especially true if you are using ladders. The other person should stand on the bottom rung of the ladder to prevent it from slipping (they should also have a hard hat on!) Younger Licensees should not attempt to put up aerials by themselves, but they should ask their parent(s) / Guardian(s) or some other responsible adult for help.

9c.5 *Recall that antenna elements should not be touched whilst transmitting and should be mounted to avoid accidental contact. Note: this does not apply to low powered devices such as hand-held equipment.*

Antennas conduct RF and it can give an electric shock. Consequently all antennae should not be touched whist a transmission is taking place. For safety, transmitting antennae should be placed as far above ground as possible. Not only does this enhance reception of radio signals but this can also prevent injury, unless of course the antenna decides to come down…

9c.6 *Recall that particularly high antennas may need special protection against lightning.*

Lightning chooses the lowest path of resistance to ground, and for some people this may mean that the lightning "chooses" an antenna to flow through. Consequently it is advisable to have any metallic poles to which the antenna may be attached earthed at their base to prevent damage being done. If possible, for example in the use of a tower, the tower should be lowered to the ground, if no earth is present) until the lightning passes.

9d.1 *Recall that excessive volume when wearing headphones can cause damage to hearing.*

Did you know that it is easier to cause hearing damage by using headphones than it is to cause hearing damage using a loudspeaker? Headphones can be beneficial but the volume should be as low as possible to prevent damage to hearing.

Also, headphones should not be worn when servicing equipment as they may "complete the circuit" causing an electric shock.

Lesson 10 – Morse Code

10a.1 *Demonstrate that [the candidate] is able to send correctly by hand, and to receive correctly by ear, texts in Morse code.*

For the Foundation Licence you are required to be able to send and receive Morse Code. Do not worry, as this is an informal assessment where you can ask the assessor to send at any speed you want.

This exercise is in the form of a QSO between to Amateurs and will consist of between 20 and 30 characters. It is permissible to transcribe the Morse being sent in dot-dash format and transcribe it to letter/number form after it has been completed. You do not need to worry about procedural characters such as "K", "KN" or "BT". An example of a receiving assessment is:
"M2ABC de M0XYZ Tx here is a kit"

When it comes to transmitting, it is the same format as the receiving exercise- the assessor may invite the candidate to resent incorrectly sent characters. It should also be noted that a copy of the Morse Alphabet is provided and that this assessment is the only Morse Assessment required at any of the 3 stages of UK Amateur Licensing.

A .–	J .–––	S ...	2 ..–––
B –...	K –.–	T –	3 ...––
C –.–.	L .–..	U ..–	4 ....–
D –..	M ––	V ...–	5 .....
E .	N –.	W .––	6 –....
F ..–.	O –––	X –..–	7 ––...
G ––.	P .––.	Y –.––	8 –––..
H	Q ––.–	Z ––..	9 ––––.
I ..	R .–.	1 .––––	0 –––––

Appendix I - The Examination

The Foundation Licence Examination consists of 25 multiple choice questions with 4 responses – the correct one, one that could be interpreted as being correct to those who have not studied and 2 completely ludicrous answers. There are no trick questions.

You have 45 minutes to complete the exam, and it is suggested that you read through the examination paper once before putting pen to paper to get your brain "ticking over". You should also have some form of Photographic Identification – with your name, address, photograph and personal signature before you are permitted to sit the examination.

Then you should start answering the questions in numerical sequence, leaving those that you are not sure about until the end. Try to leave at least 10 minutes for this purpose. There are no penalties for guessing apart from a possible deduction of mark if the answer is wrong…

The exams are usually marked immediately after the examination has ended, and results are available after all of the examination scripts have been marked and the paperwork is completed. Candidates are adjudged simply "pass" or "fail". Instructors are under no obligation to give the individual marks when they give the results slip, although most do tend to give out individual marks so that the candidates recognise where they went wrong.

Appendix II - Sample Questions

1. An Amateur Radio Operator receives a Morse code signal on 145.650MHz. It is most likely

A [] A Repeater
B [] Somebody transmitting Morse Code
C [] A distress message
D [] A User Service

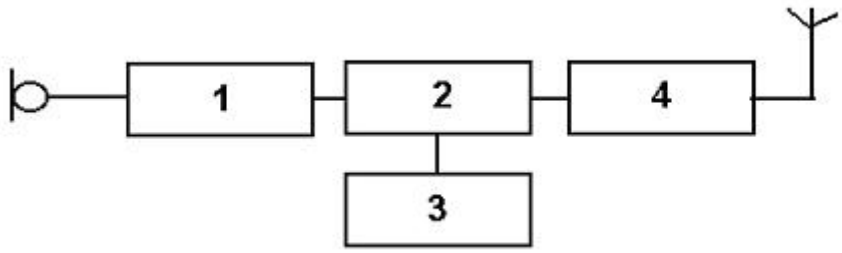
2. It is important not to be near transmitting antennae whilst a transmission is in progress because

A [] It might damage the antenna
B [] It could cause an RF burn
C [] It might impede the transmission
D [] It may cause a high SWR reading

3. A Power supply produces 10A at 13.8V DC. What is the output power in milliWatts (mW)?

A [] 1380mW
B [] 690mW
C [] 138mW
D [] 69mW

4. Name the block diagram units (in numerical order) of the diagram below.



A [] Audio Stage, Modulator, Oscillator, RF Power Amplifier
B [] Audio Stage, RF Power Amplifier, Oscillator, Modulator
C [] Frequency generator, Power Amplifier, Modulator, Antenna
D [] RF Amplifier, Detector, Audio Amplifier, Loudspeaker

5. Radio waves travel in

A [] Wavy lines
B [] Straight lines
C [] Straight lines unless refracted or reflected
D [] Wavy lines unless refracted or reflected

6. An Amateur Radio Station identifies itself as “M3ABC”. This station is

A [] An Intermediate Class Licensee living on the Isle of Man
B [] A Foundation Class Licensee living in England
C [] A Novice Class Licensee living in Northern Ireland
D [] An Extra Class Licensee living in England

7. A hand held radio uses a 9V Battery and draws 0.5A on transmit. What is the resistance?

A [] 1.8Ω
B [] 18Ω
C [] 180Ω
D [] 9Ω

8. On what frequency is the FM Calling channel on 2 metres?

A [] 145.600MHz
B [] 145.500MHz
C [] 145.550MHz
D [] 145.800MHz

9. In the diagram below, what type of plug is shown?

A [] PL259
B [] BNC259
C [] SMA
D [] N Type

10. Which of the following statements is correct?

A [] As frequency (in MHz) increases, λ decreases.
B [] As frequency (in MHz) decreases, λ decreases.
C [] As frequency (in MHz) increases, λ increases.
D [] there is no relationship between frequency and λ.

The correct answers to the questions above are as follows:

1	2	3	4	5	6	7	8	9	10
A	B	A	A	C	B	B	C	A	B

Appendix III - What to do once you've passed…

Prior to the examination you should have registered with Ofcom's Online Licensing Service[4]. It is a good idea to do this as it takes up to one week for you to receive your username by post. After the examination you should wait at least one week (although results are usually received by Ofcom no later than three to four days after the examination) before applying for your licence. You will require the results slip (providing that you passed the examination) so you can quote your Candidate Number for the examination.

If you have difficulties with the Ofcom system, consult their help documents – these hold answers to the most common questions. Failing this, phone the Licensing Centre, in London, for assistance.

It is possibly a good idea to hook up with a local club- their expertise and help can be very beneficial to newly licensed stations, in various matters.

It may also be helpful to go over the section on Operating Practices and Procedures (Lesson 8) particularly on the topic of using repeaters and VHF in general. If you digress onto HF and would like somebody to talk to, you are most welcome to contact me via email or using the "contact me" form on my webpage[5].

The Foundation Licence is not intended to be the last Licence Examination that you take – it is merely a starting point. At some stage in the future I will produce a similar production for the Intermediate and Advanced Licence Examinations.

Good Luck in whatever facet of the hobby you choose!

[4] http://www.ofcom.org.uk/licensing/olc
[5] http://www.2i0jvi.dreamhosters.com

Appendix IV - Bandplans for Exam (20m & 2m)

14MHz (20m)	**Licence Notes:** Amateur Service: Primary, Amateur Satellite Service (14.000-14.250) Primary Power Limit: 26dBW PEP Modes: Morse, Telephony, RTTY, Data, Fax, SSTV
IARU	*UK Usage*
14.000 CW only	**14.000-14.060** CW only Contest preferred segment **14.060** QRP
14.070 Digimodes (and CW)	No digimode mailbox or forwarding **14.089-14.099** AX25 packet preferred frequencies
14.099 Beacons only	**14.099-14.101** Reserved exclusively for beacons
14.101 Digimodes (& Phone & CW)	*Digimode mailbox and forwarding* **14.101-14.112** AX25 packet preferred frequencies
14.112 Phone (and CW)	**14.125-14.300** SSB Only contest preferred segment **14.230** SSTV/fax calling Frequency **14.285** QRP
14.350	

144MHz (2m)	**Licence Notes:** Amateur & Amateur Satellite Services: Primary Power Limit: 26dBW PEP Modes: Morse, Telephony, RTTY, Data, Fax, SSTV Unattended Beacons: Only for DF Contests
IARU	*UK Usage*
144.000 EME (SSB/CW)	**144.000-144.035** Moonbounce Only
144.035 CW only	**144.050** CW Calling Frequency **144.100** MS CW ref Frequency – Note 1 **144.140-144.150** CW FAI/EME Working
144.150 SSB & CW only	**144.150-144.160** SSB FAI/EME Working **144.175** Microwave talk-back (UK) **144.195-144.205** SSB Random MS **144.250** GB2RS and QRS CW **144.260** Emergency Comms. Priority **144.300** SSB Calling Frequency **144.390-144.400** SSB Random MS
144.400 Beacons	
144.490 Guard band	
144.500 All Modes-non channelised	
144.800 Digital modes	
144.990 Guard Band	
145.000 FM Repeater Inputs	**145.000-145.175** RV48-RV62 Repeater inputs (12.5kHz spacing)
145.200 FM Simplex Channels	**145.200-145.575** V16-V46 Simplex Channels (25kHz spacing) *145.500 – FM Calling Channel*
145.600 FM Repeater Outputs	**145.600-145.775** RV48-RV62 Repeater Outputs (12.5kHz spacing)
145.800 Satellites	
146.000	

Appendix V - Notes

This space can be used for making some notes.