Radio Society of Great Britain

Advancing amateur radio since 1913

Amateur radio syllabus - all levels

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Section 1 – Licensing conditions and station identification

Nature of amateur radio, types of licence and call signs

Foundation	Intermediate	Full
1A1 *1*		
Recall that the amateur licence is for self-training in radio communications and is of a non-commercial nature. Business use and commercial advertising is not permitted.		
1A2 *1*		*1*
Recall the meaning of various types of Amateur Licence (Foundation, Intermediate, Full), and identify their Call signs, including Regional Secondary Locators and optional suffixes /A, /P, /M and /MM. Recall the meaning of 'Main Station Address', 'Alternative Address', 'Temporary Location' and 'Mobile'. Recall that the Foundation and Intermediate Licences do not permit operation of the Radio Equipment from a Vessel at Sea. Recall that airborne operation within the UK is not permitted at any Amateur Licence level. *Note: The optional club secondary locators are not examined.*		Identify the types of UK licence and the format of all call signs in use including regional secondary locators, and all suffixes but not (in this section) club, special event and contest call signs.
1A3 *1*		
Recall the Foundation Licence does not permit the on-air use of own design and modification of transmitting apparatus and that these privileges are available to holders of Intermediate and Full licences.		

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
1A4 *1*	*1*	
Recall that the Licensee must give immediate notice to Ofcom of any change to the Licensee's name, Main Station Address or mailing address. Recall that the licensee must confirm that the details shown on the licence remain valid at least once every five years. Recall that the licence can be revoked by Ofcom for breaches of licence conditions or for non-confirmation of licence details.	Recall the conditions related to Variation to and Revocation of Amateur Licences; i.e. failure to advise change of name, address and confirmation of licensee details.	
1A5 *2*		*1*
Recall the requirements for station identification. Note: For the purposes of the examination this includes identifying when there is a change of: • frequency • mode or type of transmission, including change of digital protocols • supervisor • Regional Secondary Locator.		Understand the requirements for Station identification. Note: For the purposes of the examination this includes identifying when there is a change of: • frequency • mode or type of transmission, including change of digital protocols • operator unless under supervision • supervisor • Regional Secondary Locator.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Operators and supervision

1B1 ***3***	***1***	***2***
Recall that only the licensee, or another UK licensed amateur operating under his or her supervision, may use the Radio Equipment. Recall that the call sign of the supervisor is used to identify the station and operation is in accordance with the supervisor's licence. Recall that in certain circumstances the licensee may allow the equipment to be used by a member of a User Service. Recall that only a Full Licensee may supervise on air operation by a candidate on a Foundation Training Course. *Notes:* *The term 'Radio Equipment' (in initial capitals) is a defined licence term meaning the equipment used and identified by the operator's call sign. If a visiting amateur uses the radio equipment with his own call sign, it is his/her Radio Equipment.* *The Nature of the circumstances and identity of the User Services are not examinable.*	Recall that an Intermediate Licensee may operate the Radio Equipment of any other UK licensed amateur under that person's direct supervision using the supervisor's call sign, and obeying the terms of the supervisor's licence. Understand the meaning of direct supervision, duties of the supervisor and need for the operator to comply with the licence. *Note: The term 'Radio Equipment' (in initial capitals) is a defined licence term meaning the equipment used and identified by the operator's call sign. If a visiting amateur uses the radio equipment with his own call sign, it is his/her Radio Equipment*	Understand the requirements when delegating supervisory responsibilities and the permitted uses and conditions.
1B2	***1***	***2***
	Recall that an Intermediate Licensee may (with permission) use another amateur's radio equipment unsupervised, but using the call sign and conditions of his or her own licence. Recall that it is then regarded as his/her Radio Equipment because his/her call sign has been given in identification. *Note: The term 'Radio Equipment' (in initial capitals) is a defined licence term meaning the equipment used and identified by the operator's call sign. If a visiting amateur uses the radio equipment with his call sign, it is his/her Radio Equipment.*	Understand the meaning and identification of a Disqualified Person and the meaning of 'reasonable grounds to believe is not a Disqualified Person'. Understand the meaning of Radio Amateurs pass certificate. Understand the meaning of a recognised training course. Understand the duties of a supervisor during use by non-UK licensed persons. Understand the procedure for sending messages by non-licensed persons (greetings messages).

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Messages

1C1 *3*	*2*	*3*
Recall the requirement to send messages only to other amateurs.	Recall that in an International disaster messages may be passed, internationally, on behalf of non-licensed persons. Recall that non-amateur stations involved in international disaster communications may also be heard on amateur frequencies. Recall that transmitting for general reception, that is to anybody who may be listening, is not permitted other than for CQ calls or when in a group or network of several amateurs with whom communication has been established. Understand the licence requirements for net operation.	Understand the requirements relating to the content of messages and who messages may be sent to. Understand the circumstances when messages, including encrypted content, may be sent. Understand the distinction between the use of codes and abbreviations and encryption. Understand that people of all ages and backgrounds participate in amateur radio and that messages must not cause offence, particularly in the context of relevent legislation including the Wireless Telegraphy (Content of Transmission) Regulations Act and the Communications Act (2003).
1C2 *3*	*2*	*3*
Recall that secret codes are not permitted except under very specific circumstances. Understand that Morse code is not a secret code and that it is only secret codes which obscure the meaning of the Message that are prohibited.	Recall that the licensee may pass messages on behalf of a User Service and may permit a member of the User Service to use the Radio Equipment to send messages. Recall the identity of the User Services. Recall that, except under the direction of a member of a User Service who may obscure the message to retain confidentiality, all transmissions must be in plain language. *Note: It is only necessary to remember the User Services named in the licence and that the Police, Fire, Ambulance and Coastguard are included in the 'Category 1 and 2 responders' along with local government.*	Understand the Licence requirements in respect of the receipt of messages from amateurs on non-UK frequencies. Understand the Licence requirements in respect of recorded and re-transmitted messages.
1C3 *3*		
Recall that transmitting for general reception, that is to anybody who may be listening, is not permitted other than for CQ calls or when in a group or network of several amateurs with whom communication has been established.		

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Apparatus, inspection and closedown

1D1 *4*	*3*	*4*
Recall the Licensee must carry out tests from time to time to ensure that the station is not causing Undue Interference to other radio users. Recall that a person authorised by Ofcom has the right to inspect, require the modification, closedown or restrict the operation of the Radio Equipment.	Recall that transmissions from the station must not cause undue interference to other radio users. Recall that the Licensee must reduce any emissions causing interference, to the satisfaction of a person authorised by Ofcom. Understand that this may include a reduction in transmit power or any other action required to reduce emissions to an acceptable level.	Understand the requirements for clean and stable transmitters and the need to control transmitted bandwidth. Understand the need to avoid Undue Interference to other wireless telegraphy. Understand the need to conduct tests from time to time to ensure that the station is not causing Undue Interference to other radio users. Understand the need to have equipment for the reception of messages on all frequencies and modes in use for transmissions. Understand the role of Ofcom in cases of Undue Interference.
1D2 *4*	*3*	
Recall that to assist interference identification a person authorised by Ofcom may require the Licence holder to keep a log of all transmissions made over a specified period of time.	Recall the occasions for mandatory log keeping. Understand circumstances in which modification or cessation of operating of the station may be required. Understand circumstances in which modification of transmitting equipment may be required.	

Unattended and remote control operation

1E1	*4*	
	Recall that the licensee may conduct unattended operation of a Beacon, for the purposes of direction-finding competitions, or for digital communications provided operation is consistent with the terms of the Licence. Recall that unattended operation does not include providing for general use by other amateurs.	

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1E2	***4***	***5***
	Recall that the licensee may conduct Remote Control operation of the main station in a manner consistent with the terms the Licence. Recall that the Remote Control link must be by radio in an amateur band, limited to 500mW pep e.r.p. maximum transmit power. Recall that the Remote Control link should be above 30MHz. Recall that the Remote Control link must be failsafe to avoid unintended transmissions and adequately secure to ensure the station remains compliant with the terms of the Licence. Recall that Remote Control operation does not include providing for general use by other amateurs.	Recall that the Licensee may use any communication link for the purposes of Remote Control of the main station. Recall that if the Remote Control link is in an amateur band that the licence requirements for the link are the same as the requirements for the main station. Recall that a link in an amateur band should be above 30MHz. Recall that a link in an amateur band must not be encrypted.
	<u>CEPT and international</u>	
1F1 ***4***	***5***	***6***
Recall that other Administrations (foreign countries) do not routinely recognise the Foundation Licence.	Recall that other Administrations (foreign countries) do not routinely recognise the Intermediate Licence.	Understand the requirements for operation by individual UK Licensees abroad under the CEPT Recommendation T/R 61-01 and T/R 61-02. Understand this facility does not extend to club or reciprocal licences. Understand the purpose and function of the CEPT Harmonised Amateur Radio Certificate (HAREC). Recall that many countries will offer reciprocal licences to UK amateurs with a HAREC Full licence and that operation is in accordance with the host country's rules.
1F2		***6***
		Understand the requirements for operation whilst Maritime Mobile and meaning of Maritime Mobile and Vessel at Sea. Understand the requirements of permission to install and operate, Radio Silence and Log Keeping. Identify the 3 ITU regions and recall that the frequencies are given in the ITU Radio Regulations.

Licence schedule

1G1 5	6	7
(HF) Identify relevant information in the schedule to the Foundation licence. *A copy of the schedule will be available during the examination.*	(HF) Identify relevant information in the schedule to the Intermediate licence. *A copy of the schedule will be available during the examination.*	(HF) Identify relevant information in the schedule to the Full licence. *A copy of the schedule will be available during the examination.*
1G2 ***6***	***6***	***7***
(VHF) Identify relevant information in the schedule to the Foundation licence. *A copy of the schedule will be available during the examination.*	(VHF) Identify relevant information in the schedule to the Intermediate licence. *A copy of the schedule will be available during the examination.*	(VHF) Identify relevant information in the schedule to the Full licence. *A copy of the schedule will be available during the examination.*

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Section 2 – Technical aspects

Fundamental theory

2A1 *7*	*7*	*58*
Understand that the flow of electrons is an electric current. Recall that that a conductor allows electrons to flow easily and that an insulator does not. Recall that metals such as copper and brass are good conductors, as is carbon. Plastics, rubber, glass and ceramics are regarded as insulators. Recall that water is a conductor and that current can flow across wet insulators. Recall that the unit of electric current is the Ampere (Amp). Recall that the unit of electrical potential is the Volt.	Recall that components have tolerances, and that the measured value of a component may not precisely agree with its marked value.	Understand component tolerances and the effects they may have in circuit operation.
2A2 *7*		
Recall that a circuit is needed to allow current to flow, and that circuit will include a source of electrical energy. Recall that current in all parts of a series circuit has the same value. Recall that the potential differences across items in parallel are the same.		

Power

2B1 *7*		*8*
Recall that power is measured in Watts (W). Recall that a current through a resistor results in conversion of electrical energy to heat energy in the resistor. Understand that Power (Watts) in a circuit is the product of the Potential Difference (Voltage) and the Current (Amps) ie $P=V\times I$ Calculate the unknown quantity given the numerical value of the other two.		Solve series/parallel resistor circuits to calculate currents, voltages, resistances and power given appropriate values. This may include the use of series/parallel formulae, Ohm's Law and power. Equations include $P=V^2\times R$ and $P=I^2\times R$

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Resistance

2C1 *7*	*7*	
Understand that resistance is the property of a material that opposes the flow of electricity. Recall that the unit of resistance is the Ohm (Ω). Recall that the current (I) through a resistor (R) is proportional to the voltage (V) across that resistor. Use Ohm's law to calculate the value of any one of the three quantities (voltage V, current, I and resistance R) given the other two. Understand that where a supply feeds more than one component or device the total current is the sum of the currents in the individual items.	Understand circuits comprising series and parallel connections of resistors and cells. Calculate the value of any one of the three quantities (V, I or R) given the other two. Calculate the combined resistance of two or three resistors in parallel. *Resistors of different values may be used in series or parallel or combined series parallel circuits.* *The formula for parallel resistors will be provided.* *The prefixes milli and kilo may be involved for some of these calculations.*	
2C2 *7*	*8*	
Understand that the sum of the voltages across a number of resistors in series equals the supply voltage.	Understand that two or three resistors can be arranged to act as a potential divider and apply the formula.	
2C3 *7*	*8*	
	Understand the difference between potential difference (PD) and electromotive force (EMF) Understand the concept of source resistance (impedance) and voltage drop due to current flow.	
2C4 *7*		
Recall that polarity must be correct for electronic circuits to function correctly, or damage may be caused.		

Reactive components

	Foundation	Intermediate	Full
2D1		***9***	***9***
		Recall that a capacitor normally consists of two metal plates separated by an insulating material and that its capacitance is measured in Farads. Understand that a capacitor can store an electric charge, and that its ability to store a charge (capacitance) depends upon the area of the plates, their separation and the nature of the material between the plates (the dielectric).	Understand the factors influencing the capacitance of a capacitor; area and separation of the plates, permittivity of dielectrics and formula $C=k \times A/d$. *Recall that the Coulomb is the quantity of electricity, Q, given by current × time and that the charge on a capacitor is given by* $Q = V \times C$.
2D2		***9***	***9***
		Understand and apply the formulae for calculating the combined values of two or three capacitors in series and in parallel.	Recall that different dielectrics are used for different purposes, e.g. air, ceramic, mica and polyester; and that with some dielectrics, losses increase with increasing frequency.
2D3		***9***	***9***
		Recall that some capacitors eg electrolytic are polarised and must be correctly connected to avoid injury, damage or destruction.	Understand that capacitors have a breakdown voltage and that they need to be used within that voltage.
2D4		***10***	***10***
		Understand the relative movement of a conductor in a magnetic field will induce a voltage across the ends of the conductor. Recall that a current passing through a wire forms a magnetic field around the wire. Recall that an inductor is normally a coil formed of a number of turns of wire to concentrate the magnetic field and that inductance is measured in Henries. Recall that an inductor is able to store energy in its magnetic field. Recall that the ability to store energy is known as inductance, which depends upon the number of turns of wire on the coil and its dimensions.	Understand the term 'self-inductance' and recall that a 'back EMF' is produced as current flow changes in an inductor. Recall that different magnetic materials, used as cores for inductors, have an impact on the efficiency and power handling capability of the device.

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2D5		***10***	
		Understand and apply the formulae for calculating the combined values of two or three inductors in series and in parallel.	
2D6		***10***	
		Recall that the inductance of a coil increases with increasing number of turns, increasing coil diameter and decreasing spacing between turns. Understand the use of high permeability cores and slug tuning.	
2D7			***11***
			Understand the rise and fall of current in an LR circuit and that the time constant $\tau = L/R$. Understand the rise and fall of voltage in a CR circuit and that the time constant $\tau = C \times R$.

AC theory

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2E1	***8***	***11***	
	Understand what is meant by Direct Current (DC) and Alternating Current (AC).	Understand that by repeatedly charging and discharging in alternate directions, a capacitor can pass alternating currents, but cannot pass a direct current.	

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2E2	***8***	***11***	
	Identify the sine wave as a graphical representation of the rise and fall of an alternating current or voltage over time. Recall the frequency of the mains supply – 50Hz. Recall the range of frequencies for normal hearing – 20Hz -15kHz. Recall the range of frequencies for audio communication – 300Hz - 3kHz. Recall that radio frequencies can range from below 30kHz to beyond 3000MHz. Recall the frequency bands for HF, VHF and UHF radio signals. Understand the meaning of the abbreviations RF and AF.	Understand the sinusoidal curve as a graphical representation of the rise and fall on an alternating current or voltage over time and that both the frequency and the amplitude must be specified. Recognise the graphical representation of a square wave. Recall that the time in seconds for one cycle is the Periodic Time (T) and the formula T=1/f and f= 1/T where f = frequency in Hertz and T = time interval in seconds. Recall the concept of phase difference between two signals, and that it can be expressed in degrees.	
2E3		***11***	***12***
		Recall that the potential difference across and current through a resistor are in phase. Recall that the power dissipated in a resistive circuit varies over the cycle. Recall that the RMS current or voltage in an AC circuit is equal to the current or voltage of a DC supply that would result in the same power dissipation. Recall that the RMS value of a sinusoidal waveform, Vrms = 0.707×Vp (peak Voltage). Perform relevant calculations. Recall that the term 'Reactance' describes the opposition to current flow in a purely inductive or capacitive circuit where the phase difference between V and I is 90°.	Understand that current lags potential difference by 90° in an inductor and that current leads by 90° in a capacitor. Understand the formulae for the reactance of a capacitor or inductor in terms of the frequency and component value. Calculate the unknown term given the other two.

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2E4		***12***	***12***
		Recall that the ratio of the RMS potential difference to the RMS current as the capacitor stores energy in its electric field is called the reactance of the capacitor and is measured in ohms. Understand that the reactance of a capacitor depends on the frequency of the alternating current and that the reactance falls as the frequency rises. Identify the graph of reactance against frequency for the capacitor.	Understand the use of capacitors for AC coupling (DC blocking) and decoupling AC signals (including RF bypass) to ground.
2E5		***12***	***12***
		Recall that an inductor will take time to store or release energy in its magnetic field. Recall that the ratio of the RMS potential difference to the RMS current as the inductor stores energy in its magnetic field is called the reactance of the inductor and is measured in ohms. Understand that the reactance of an inductor depends on the frequency of the alternating current and that the reactance rises as the frequency rises. Identify the graph of reactance against frequency for the inductor.	Understand the use of inductors for DC decoupling (AC blocking).
2E6		***12***	***12***
		Recall that in a circuit comprising resistors and capacitors or inductors (or both) a current will result in energy transfer into heat in the resistors and energy storage and release in the capacitors or inductors. Recall that in such a circuit the ratio of the overall potential difference to current is termed ‘impedance’ and that this name denotes an opposition to both energy transfer and energy storage in the circuit. Recall impedance is measured in ohms. *Note: Phase and vector notation is NOT included at this level.*	Understand that impedance is a combination of resistance and reactance and apply the formula for impedance and current in a series CR or LR circuit.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2E7 ***8***	***13***	***12***
Understand the relationship between frequency (f) and wavelength (λ). Recall the units for frequency (Hz) and wavelength (m). *Both the f λ graph and the velocity of radio waves will be given in the Reference Booklet.*	Recall and manipulate the formula $v = f \times \lambda$ Calculate frequency or wavelength given the other parameter. *The velocity of radio waves will be given in the Reference Booklet.*	
2E8	***13***	
	Understand that where a conductor is carrying an RF signal which has a wavelength comparable to the length of the conductor that the magnitude and direction of the current and voltage at any point in time will vary in a sinusoidal manner along the length of the conductor.	

<u>Digital signals</u>

2F1 ***9***	***14***	***13***
Recall that analogue signals are constantly changing in amplitude, frequency or both. Recall that digital signals are a stream of finite values at a specific sampling interval. Recall that digital signals can be processed by a computing device with suitable software.	Recall that digital signals with more bits and/or increased sampling rate enables a more accurate representation of the analogue signal. Recall that the error introduced by sampling the analogue signal to produce the digital signal is a form of distortion Recall the effect of increasing data rate on bandwidth requirements. Recall that the sampling rate needs to be at least twice the frequency of the analogue signal to adequately capture the detail of the analogue signal being sampled. Recall that the minimum sampling rate is known as the Nyquist rate.	Understand that analogue to digital conversion can generate a false image of the signal if frequencies are present above the Nyquist rate. Recall that these false images are known as aliases. Understand that anti-aliasing filters are used to avoid this occurring.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2F2 *9*		*13*
Recall that an Analogue to Digital Convertor (ADC) is a device used to sample an analogue signal and produce a digital representation of it. Recall the meaning of the term ADC. Recall that a computing device is required to process digital signals. Recall that a Digital to Analogue Convertor (DAC) is a device used to represent a digital signal in analogue format. Recall the meaning of the term DAC.		Recall that digital signals in the time domain can be depicted in the frequency domain by using a mathematical operation known as a Fourier Transform (FT). Recall that a Fourier Transform takes digital signals in the time domain and calculates the amplitudes and the frequencies which comprised the original signal.

Transformers

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2G1	*15*	*14*
	Understand that a simple transformer consists of two coils of wire sharing the same magnetic field. Recall that it may have an iron core to concentrate the field. Understand that at higher frequencies (e.g. RF and IF) a ferrite core, rather than an iron core, is used for improved efficiency. Understand that energy is transferred from one coil to the other by changes in the field when alternating current is used, and that this does not happen with constant direct current. Understand that an alternating potential difference (such as the mains) can be stepped down using fewer turns of wire on the secondary coil than the primary and can be stepped up using more turns on the secondary than on the primary. Understand that the output from a transformer will always be an alternating current. *Note: Appreciation of the impedance change is not required.*	Understand the concept of mutual inductance. Understand and apply the formulae relating transformer primary and secondary turns to primary and secondary potential differences and currents. Understand the impedance change in a transformer and apply the formula relating transformer primary and secondary terms to primary and secondary impedances. Recall that different magnetic materials, used as cores for inductors and transformers, have an impact on the efficiency and power handling capability of the device.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Tuned circuits and resonance

2H1	***16***	***15***
	Recall that a series or parallel circuit of a capacitor and inductor together forms a tuned circuit. Recall, using graphical methods, that at resonance the reactance of the capacitance will equal the reactance of the inductance, XC = XL.	Apply the formula for the resonant frequency of a tuned circuit to find values of f, L or C from given data.
2H2	***16***	***15***
	Recall that, at their resonant frequencies, series tuned circuits present a low impedance, whereas parallel tuned circuits present a high impedance. Identify the response curves of impedance vs frequency for series and parallel resonant circuits.	Recall the equivalent circuit of a crystal and that it exhibits series and parallel resonance. Recall that crystals are manufactured for either series or parallel operation and will only be stable and correct on the marked frequency when used in the intended manner.
2H3	***16***	
	Recall that the energy stored in the capacitor and inductor in a tuned circuit can transfer from one to the other at a particular frequency, known as the resonant frequency. Recall how the resonant frequency depends on the value of capacitance and inductance. *Note that candidates must know that increasing L or C reduces the resonant frequency and vice-versa. Knowledge of the resonant frequency formula is not required.*	

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2H4		***16***	***15***
		Recall that selectivity of a tuned circuit is the ratio of the bandwidth of the circuit (that is the range of frequencies the circuit will accept) to the resonant frequency. Recall that the Q factor of a tuned circuit is an indication of the selectivity of the tuned circuit.	Understand the concept of the magnification factor Q as applied to the voltages and currents in a resonant circuit. Recall that voltages and circulating currents in tuned circuits can be very high and understand the implications for component rating. Apply the formula for Q factor given circuit component values. Recall the definitions of the half power point and the shape factor of resonance curves. Apply the equation for Q given the resonant frequency and the half power points on the resonance curve.
2H5		***16***	***15***
		Identify the circuits of simple low pass, high pass, band pass and band stop (notch) filters and their response curves. Recall, using graphical methods, the concept of the cut-off frequency. Recall that electro-mechanical resonators, such as crystals, can be used in filter circuits.	Understand the meaning of dynamic resistance, R_D. Apply the formula for R_D given component values. Understand the effect of damping resistors in a tuned circuit.
		<u>Semiconductor devices</u>	
2I1		***17***	***16***
		Recall that a diode will conduct current in one direction only. Recall that a diode junction has a depletion layer and that a voltage must be applied to overcome this and allow current to flow (forward bias). Understand the use of a diode to produce direct current from an alternating current known as rectification.	Recall that a Zener diode will conduct when the applied reverse bias potential is above its designed value and identify its V/I characteristic curve.

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2I2		***17***	
		Recall that a variable capacitance diode behaves like a capacitor when reverse biased and that the capacitance of a reverse biased diode depends on the magnitude of the reverse bias.	
2I3		***17***	***16***
		Understand that a bipolar junction transistor is a three terminal device (emitter, base, collector) in which a small base current will control a larger collector current and this enables the transistor to be used as an amplifier. Understand that the ratio of the collector current to the base current (IC/IB) is the current gain ß or hFE of the transistor. Understand that if the variation in the base current is large enough the collector current can be turned on and off and the transistor behaves as a switch. *Note: the student is not required to recall transistor configurations. Circuits shown will be an npn transistor connected in common emitter mode.*	Understand the basics of biasing NPN and PNP bipolar transistors and field effect transistors (FET) (including dual gate devices). *Note: Circuits shown will be an npn transistor connected in common emitter mode.*
2I4		***18***	***17***
		Recognise the circuit of a simple common emitter amplifier. Calculate the value of the collector resistor to set the collector voltage midway between V supply and 0V given the base current and transistor gain β. Understand in simple terms how a (current) signal at the base causes a larger current signal at the collector and resulting change in instantaneous collector voltage.	Identify different types of small signal amplifiers (e.g. common emitter (source), emitter follower and common base) and explain their operation in terms of input and output impedances, current gain, voltage gain and phase change.
2I5		***18***	***17***
		Recall that semiconductors must be provided with the correct DC voltages and currents to allow them to function and that this is termed biasing. *Note that calculations are not required.*	Recall the characteristics and typical circuit diagrams of different classes of amplifiers (i.e. A, B, A/B and C).

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2I6	***18***	***17***
	Recall that a transistor can be used to generate audio and radio frequencies by maintaining the oscillations in a tuned or frequency selective circuit. Distinguish between a crystal oscillator and a variable frequency oscillator (VFO) based on a tuned circuit. *Diagrams will show the Colpitts oscillator with the transistor in emitter follower mode. Students are not expected to recognise other types of oscillator.*	Understand the feedback requirements to sustain oscillations in an oscillator.
2I7	***20***	
	Recall that many individual semiconductor devices may be built on a common substrate and packaged as an integrated circuit (IC). Recall that ICs may provide complete circuit functions, including, amplifiers, oscillators, voltage regulators and digital processing chips in a single package. *Questions will be limited to the IC applications shown above.*	
	<u>Cells and power supplies</u>	
2J1 ***8***	***19***	
Understand that a battery is a combination of cells (usually in series). Recall that a battery provides electrical energy from stored chemical energy and has a Potential Difference across its terminals. Recall that a non-rechargeable (primary) battery, once discharged, or any unwanted battery, must be properly disposed of. Understand that a rechargeable (secondary) battery has a reversible chemical process.	Recall that different technologies used in cells give different terminal voltages. Recall that battery capacity (stored energy) is measured in Ampere-hours (Ah).	

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
2J2		***19***	***18***
		Recall the circuit diagrams and characteristics of different types of rectifier and smoothing circuits (i.e. half wave, full wave and bridge).	Understand the function of stabilising circuits and identify different types of stabilising circuits (i.e. Zener diode/pass transistor and IC). *Note: questions on the characteristics of individual components are covered in other parts of this syllabus, e.g. 2H3. This subsection is on complete circuits.*
2J3		***19***	***18***
		Understand that in a rectifier circuit a capacitor can store a charge during the conducting part of the cycle and release it during the non-conducting part, providing a smoothing effect and a smoother DC output. Identify the AC and rectified (pulsed DC) waveforms.	Understand the need for rectifier diodes to have a sufficient peak inverse voltage (PIV) rating and calculate the PIV in diode/capacitor circuits.
2J4		***20***	***18***
		Identify discrete component and integrated circuit linear power supplies and understand the basic principle of their operation. Recall the relative merits of linear and switched mode power supplies. Size, efficiency, heat, input and output voltage, RFI, cost & weight.	Understand the basic principles and operation of a switch mode power supply, at block diagram level.

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Section 3 – Transmitters and receivers

Transmitter concepts

3A1 *10*		
Recall that the function of a radio transmitter is to send information from one place to another using electromagnetic radiation/wireless technology. Recall that the process of adding information to a radio frequency carrier is known as modulation.		

3A2 *10*	*21*	*19*
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 achieved by varying the amplitude or frequency of the carrier, resulting in AM or FM modulation modes. Recall that information can be carried by AM, SSB or FM. Recall that data may be transmitted by modulating the carrier using suitable audio tones, commonly two or more, generated by an audio interface such as a computer sound card.	Recall the meaning of depth of modulation for amplitude modulation. Recall the meanings of wide band and narrow band frequency modulation. Recall the meaning of the term Peak Deviation.	Recall the meaning of Modulation Index and its effect on the number of FM sidebands.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
3A3 ***10***	***21***	
Recall that when radio frequencies are modulated (mixed) with an audio frequency the new frequencies that are generated are called sidebands. Recall that amplitude modulated signals contain two sidebands and the carrier. Recall that a SSB modulated signal contains only one sideband.	Understand that single sideband (SSB) is a form of amplitude modulation where one sideband and the carrier have been removed from the transmitted signal. Understand that SSB is more efficient than AM or FM because power is not used to transmit the carrier and the other sideband. Understand that a second advantage is that the transmitted signal takes up only half the bandwidth, e.g. 3kHz not 6kHz. Recall that : • AM uses less bandwidth than FM • SSB uses less bandwidth than AM • CW uses less bandwidth than SSB. • Digital modes may use less bandwidth than any of the above.	
3A4 ***10***		
Identify diagrams representing audio, an RF carrier, amplitude modulated, frequency modulated and CW radio signals. Understand the terms carrier, audio waveform and modulated waveform. *Note: Table 2 shows appropriate diagrams.*		

<u>Transmitter architecture</u>

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
3B1 ***11***	***21***	***19***
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.	Recall and understand the block diagrams of CW, AM, SSB and FM transmitters.	Understand the block diagram of an SSB transmitter employing mixers to generate the final frequency. Understand the block diagram of an FM transmitter employing either frequency multipliers or mixers to generate the final frequency.

Ref	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
		Oscillators	
3C1	***11***	***21***	***20***
	Recall that the oscillator in a simple transmitter sets the frequency on which the transmitter operates. Recall that incorrect setting of this stage can result in operation outside the amateur band and interference to other users.	Recall and understand the relative advantages and disadvantages of a crystal oscillator and a VFO. Recall that the resonant frequency of the tuned circuit in a VFO determines the frequency of oscillation.	Recall the effect and the importance of minimising drift.
3C2		***21***	***21***
		Recall that the frequency stability of an oscillator can be improved by rigid mechanical construction, screening the oscillator enclosure, a regulated DC supply and a buffer amplifier immediately after the oscillator circuit. Understand that a lack of stability (drift) may result in operation outside the amateur bands. Recall that most modern oscillators are digital synthesisers, which are very stable and are based on a crystal reference.	Recall the block diagram of a Phase Locked Loop (PLL) frequency synthesiser and the functions of the stages (i.e. oscillator, fixed divider, phase detector, LPF, voltage controlled oscillator and programmable divider). Recall how sinusoidal waves may be produced by direct digital synthesis and the block diagram of a simple synthesiser. Recall that increasing the number of bits in the synthesiser will increase the purity of the signal.
3C3		***21***	***21***
		Recall that digital signals can be used to generate audio and RF signals by Direct Digital Synthesis (DDS). Recall the meaning of DDS. Recall that a Direct Digital Synthesiser generates audio and RF signals from pre-set digital values held in a memory, or Lookup Table.	Recall the block diagram of a typical DDS system. Recall the function of the Clock, Lookup Table, DAC and LPF in a DDS block diagram.
		Frequency multipliers	
3D1			***22***
			Understand that frequency multipliers use harmonics to generate frequencies above an oscillator's fundamental frequency (e.g. in a microwave transmitter).

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
	Microphone amplifiers and modulators	
3E1 *11*	*22*	*22*
Recall that the microphone amplifier *amplifies the signal from the microphone to the level required to drive the modulator* and limits the audio frequencies to those required for *communication*. Recall the need to ensure that the microphone gain control (where fitted) is correctly adjusted.	Recall that a Balanced Modulator is used to produce two sidebands whilst suppressing the carrier.	Understand the operation of AM, SSB and FM modulators. Calculate the bandwidth of such transmissions.
3E2	*22*	*22*
	Understand that an SSB filter is a Band Pass Filter that will only allow one sideband to pass to the Power Amplifier. Recall that in an analogue transmitter, SSB filters are normally constructed from a number of quartz crystals or other resonators.	Identify typical sideband filter circuits and calculate relevant frequencies.
3E3	*22*	
	3E3 Recall that a variable capacitance diode can be used in an oscillator to produce frequency modulation (FM).	
	RF power amplifiers	
3F1 *11*	*22*	
Recall that the power amplifier stage increases the power of the modulated RF signal to the final output level.	Understand the concept of the efficiency of an amplifier stage and estimate expected RF output power for a given DC input power, given the stage's efficiency.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
3F2	***22***	***23***
	Recall that RF power amplifiers can produce harmonics of the wanted signals and that suitable filtering is required to avoid harmonic radiation.	Understand the need for linear amplification and identify which forms of modulation require a linear amplifier. Identify simple RF transmitter PA circuits. Understand the meaning of linearity as applied to a circuit or amplifier. Understand how distortion of a single frequency signal can produce harmonics of that frequency. Understand how distortion of two (or more) frequencies can produce harmonics and intermodulation products of the input frequencies.
3F3 ***11***		***23***
Recall that the RF power amplifier output must be connected to a correctly matched load to work properly and that use of the wrong antenna can result in damage to the transmitter.		Recall the function of the main components of a PA circuit, i.e. collector load, bias, input circuit, output filter and matching.
3F4		***23***
		Understand the implications for PA rating of different types of modulation and the effects of speech processing, with particular regard to peak to average power ratios.
3F5		***23***
		Recall the function of automatic level control within the power amplifier circuit and when using an external power amplifier. Recall the function and use of a manual RF power control.

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
		Transmitter interference	
3G1	***11***		***24***
	Recall that excessive amplitude modulation causes distorted output and interference to adjacent channels. Recall that excessive frequency deviation will cause interference to adjacent channels.		Understand that over-modulation distorts the modulating signal resulting in harmonics of the audio which causes excessive transmitted bandwidth. Understand that over-drive of the RF power amplifier can also result in excessive transmitted bandwidth.
3G2		***23***	***24***
		Recall that oscillators, mixers and amplifiers can produce harmonics which are multiples of the fundamental frequency. Recall that harmonics can cause interference to other amateur bands and other radio users.	Understand the need to drive external power amplifiers with the minimum power required for full output and how overdriving may cause harmonics and/or spurious intermodulation products.
3G3		***23***	***24***
		Recall that a filter is a device that blocks some frequencies and passes others. Understand the effects of low-pass, bandpass and high-pass filters. Interpret their frequency/amplitude diagrams. Understand that a low-pass filter, a band-pass filter and a band stop (notch) filter can minimise the radiation of harmonics.	Understand ways to avoid generating harmonics e.g. use of push-pull amplifiers, and avoiding high drive levels. Recall that transmitters may radiate unwanted mixer products and identify suitable remedies. Understand the use of low pass, band pass and band stop (notch) filters in minimising the radiation of unwanted harmonics and mixer products.
3G4		***23***	***24***
		Understand that too fast a rise and fall time of the transmitted RF envelope of a CW transmitter may cause excessive bandwidth (key clicks) and that this can be minimised by suitable filters in the keying stage. Recognise a diagrammatic representation of rise and fall time.	Recall that unwanted emissions may be caused by parasitic oscillation and/or self-oscillation and identify suitable remedies.
3G5		***23***	***24***
		Recall the cause and effect of ‘chirp’ and identify suitable remedies.	Understand how frequency synthesisers may not produce the intended frequency. Identify appropriate measures to prevent off-frequency transmissions.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Receiver concepts

3H1 *12*		
Recall that the function of a radio receiver is to recover information sent from one place to another using electromagnetic radiation/wireless technology. Recall that the process of recovering information from a modulated radio frequency signal is known as demodulation.		
3H2 *12*	*24*	
Identify the items in a simple receiver block diagram and recall their order of interconnection: Antenna, feeder, wanted signal selection and RF amplification, demodulation/detection, audio amplification and loudspeaker or headphones. *See table 2.*	Understand the block diagrams of the crystal diode receiver, and direct conversion receiver. Understand the functions of the RF amplifier, demodulator (detector), and audio amplifier as used in an analogue receiver.	
3H3	*24*	*25*
	Recall that a receiver's ability to detect weak signals is known as its sensitivity. Recall that very strong signals can overload a receiver and cause distortion to the audio output.	Understand that overloading a receiver causes intermodulation products and that those close to or within the wanted signal bandwidth limit the ability of the receiver to detect weak signals. Recall that the dynamic range of a receiver is the difference between the minimum discernible signal and the maximum signal without overload. Recall that dynamic range is expressed in decibels.
3H4	*24*	
	Recall that a receiver's ability to reject frequencies outside the wanted signal bandwidth is known as its selectivity. Understand the limitations of tuned circuits in selecting wanted frequencies and the effect of the Q factor of tuned circuits. *See also Section 2H4.*	

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
		Superheterodyne concepts	
3I1		***25***	***25***
		Understand the need for and advantages of the superheterodyne architecture	Understand the block diagram of superheterodyne and double superheterodyne receivers and the functions of each block.
3I2		***25***	***26***
		Recall that the intermediate frequency is the sum of or difference between the RF and local oscillator frequencies.	Understand the function of a mixer, the generation of the Intermediate Frequency (IF) and other mixer products.
3I3		***25***	***26***
		Recall that a superheterodyne receiver uses a fixed IF stage to enable good selectivity and that mixing ahead of the IF enables multi-band reception. Understand that tuned circuits in RF and IF amplifiers select the wanted signal. Identify the tuned circuits in the circuit of an IF amplifier.	Understand the advantages and disadvantages of high and low intermediate frequencies and the rationale for the double and triple superhet. Understand that for given RF and IF frequencies, there is a choice of two possible local oscillator (LO) frequencies. Understand the reasons for the choice and calculate the frequencies. Understand the origin of the image frequency and calculate the frequency from given parameters.
3I4			***26***
			Understand the operation of an IF amplifier and the IF transformer. Understand the concept of two LC tuned circuits utilising transformer coupling. Identify critical and over-coupled response curves. Understand how the gain of an IF amplifier can be varied, how this may cause distortion and how the effects of the distortion are avoided.
3I5			***26***
			Recall the source and effects of phase noise. Recall the unit of measurement is dBc/Hz.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
RF amplifiers and external pre-amplifiers		
3J1		***27***
		Recall the operation of the RF amplifier. Understand that external RF preamplifiers do not always improve overall performance and will reduce the dynamic range. Understand why, at HF, this loss can be as much as the gain of the preamp but that at VHF and above a low noise pre-amp is beneficial. Understand why most benefit is gained by locating the pre-amp at the antenna. Understand that overloading will cause intermodulation products and spurious signals.
Demodulation		
3K1 ***12***	***26***	***28***
Recall that the detector/demodulator stage recovers the original information from the modulated signal. Recall that the audio amplifier ensures the recovered modulation is strong enough to drive headphones or a loudspeaker.	Understand how a diode detector will recover the audio from amplitude modulated signals. Understand that to generate the audio from CW signals a beat frequency oscillator (BFO) is used; for the recovery of single sideband audio a carrier insertion oscillator (CIO) and product detector are used and for the recovery of FM audio a discriminator is used. Identify the waveforms produced in a diode AM detector.	Understand the operation of basic analogue AM, CW, SSB and FM demodulator circuits and the function of the limiter for FM.
Automatic gain control (AGC)		
3L1	***26***	***28***
	Understand that the automatic gain control (AGC) of a receiver operates by sensing the strength of the received signals at the detector and adjusting the gain of the IF and sometimes the RF amplifiers to keep the audio output level fairly constant. Recall that the AGC signal can also drive a signal strength meter (S-meter).	Understand the source and use of an AGC voltage. Recall that the speed of the AGC response can be adjusted on both attack and decay.

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

SDR transmitters and receivers

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
3M1	***12***	***27***	***29***
	Recall that the SDR receiver takes in all electromagnetic signals from the antenna and digitises this input for processing in software. Recall that a mathematical operation enables all the signals to be sifted into separate frequency components. Recall that the required signal is selected using a filter defined in software. Recall that demodulation is carried out in software. Recall that Software Defined Radio (SDR) receivers convert incoming signals to digital format and then perform filtering and demodulation on the signal using software and that SDR transmitters generate modulated radio signals using software	Recall that SDR software uses a mathematical function called a Fourier transform which sifts the composite signal into its constituent independent frequencies for processing. Recall that this can also be used to provide a spectrum or waterfall display. Recall that digital filters can be much more selective than analogue filters.	Recall that analogue and digital signals are transmitted by some form of amplitude and/or frequency/phase modulation. Recall that amplitude and frequency/phase modulation can be portrayed on a phasor diagram. Understand that to fully capture the information contained in the amplitude and phase of the signal that the position of the phasors must be resolved as the values on two axes at right angles.
3M2		***27***	***29***
		Recall the meaning of the time domain and the frequency domain. Understand how signals in the time domain may also be viewed in the frequency domain. Identify for some simple harmonic waves, the spectrum obtained using the Fourier transform. (*Waves composed of one and two Harmonics will be examined*).	Recall that mixing the RF or IF signal with two local oscillator signals 90 degrees different in phase will produce an in-phase (I) and quadrature (Q) component which can be digitised allowing all forms of modulation to be demodulated entirely by mathematical processes in a PC or using dedicated hardware. Recall that this technique is the basis of SDR (software defined radio) receivers. Recall that these techniques can also be used to create complex modulations for use in transmitters. Recall that if sampling is carried out directly on the RF signal the extraction of I and Q components and subsequent demodulation may be carried out entirely by mathematical processes.
3M3		***27***	
		Recall the different elements that make up the functions of an SDR (block diagram).	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Transceivers

3N1			***30***
		Understand that transceivers normally share oscillators between the transmitter and receiver circuits; and they may use common IF filters to limit both the transmitter and receiver bandwidths and that they also use common changeover circuits. Recall the function and use of the RIT control.	
3N2			***30***
		Understand that using a transverter enables operation on frequency bands not covered by the primary transceiver equipment. Calculate appropriate frequencies used in trasnsverter operation. Recall that transverters generally require low power drive. Understand the need for extra care to avoid transmitting out of band when using a transverter. Recall that transverters require the correct interfacing with the primary equipment to control sequencing and prevent hot switching. Understand the techniques of RF sensing and PTT (push-to-talk) transmit receive switching.	

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Section 4 – Feeders and antennas

Feeders

Ref	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
4A1	***13***	***28***	
	Recall the correct cable types to use for RF signals and that coaxial cable is most widely used because of its screening properties. Identify Twin Feeder & Coaxial as types of feeder. Understand that twin feeder is balanced having equal and opposite signals in the two wires. Understand that coaxial feeder is unbalanced with the signal on the centre conductor surrounded by a screen.	Understand the equal and opposite currents flowing in a balanced feeder cause equal and opposite fields around the two conductors. Understand that these fields cancel out, but that nearby objects can cause an imbalance that makes the feeder radiate RF energy. Recall that a rectangular waveguide must have its larger dimension greater than λ/2 for the signal to travel.	
4A2	***13***	***28***	
	Recall that some RF energy is converted to heat in feeders so they exhibit loss. Recall that feeders cause loss of signal strength on both transmit and receive; the longer the cable, the greater the loss. Recall that feeder loss increases with frequency and that low loss feeders (lowest dB per unit length) should be used at VHF and UHF.	Recall that twin feeder usually has lower loss than coaxial cable. Recall that loss is measured in dB. Understand the relationship between RF output power, feeder loss and power delivered to the antenna. Calculate the unknown quantity given the other two. *Feeder loss will be in multiples of 3dB and 10dB*.	
4A3		***28***	***31***
		Recall that feeders have a characteristic impedance which depends upon the diameter and spacing of the conductors. Recall that this impedance determines the ratio of the RF RMS potential difference to the RF, RMS current in a correctly terminated feeder. Recall that for amateur use 50Ω coaxial feeder is normally used; that coaxial cable for TV and satellite receivers has a different impedance of 75Ω. Recall that balanced feeder is commonly available from 75Ω to 600Ω. Recall that correctly terminated means correctly connected with a resistive load equal to the cable characteristic impedance.	Understand that the velocity factor of a feeder is the ratio of the velocity of radio waves in the feeder to that in free space and that the velocity factor is always less than unity. Recall that the velocity factor for coaxial feeder with a solid polythene dielectric is approximately 0.67 or 2/3. Perform calculations involving velocity factor, physical length, electrical length and frequency.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
Baluns		
4B1 ***13***	***28***	***31***
Recall the difference between balanced and unbalanced antennas and that a balun should be used when feeding a dipole with coaxial cable (which is unbalanced).	Recall the construction and use of choke type baluns.	Recall the construction and use of transformer, sleeve and choke type baluns. Identify the circuits of 1:1 and 4:1 transformer baluns.
Antenna concepts		
4C1 ***14***		
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.		
4C2 ***14***	***29***	
Understand the concept of an antenna radiation pattern. Identify the polar diagrams for the half wave dipole and Yagi antennas. Identify the directions of maximum and minimum radiation. Understand that half-wave dipoles (mounted vertically), λ/4 (quarter wavelength) ground planes and 5/8 λ antennas are omni-directional. *Note – only dipole and Yagi antennas will be examined for radiation pattern.*	Understand the front-to-back ratio of an antenna. Understand the beam width of an antenna. Understand that radiation patterns exist in three dimensions.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
4C3 *14*	*29*	
Understand that antenna gain is due to its ability to focus radiation in a particular direction. Recall that a Yagi antenna typically has a higher gain because of its improved focussing ability. Recall the gain of an antenna is normally expressed relative to a half-wave dipole and measured in dB (Higher dB value is a higher gain). Recall that the directional power is expressed as Effective Radiated Power (ERP) and that this apparent power increase is known as gain. Recall that ERP is calculated by multiplying the power applied to the antenna feed point by the gain of the antenna. Calculate ERP given antenna input power and antenna gain. *Note: dB conversion table (3, 6 & 10) will be provided.*	Recall that an isotropic radiator is a theoretical antenna that radiates equally in all directions. Recall the Effective Isotropic Radiated Power (EIRP) is based on an isotropic antenna reference rather than a dipole and is expressed in dBi. Recall that a half-wave dipole has a gain, in its optimum direction, of 2.15dBi	
4C4 *14*	*29*	
Recall that VHF and UHF signals will normally be received most effectively when the transmitter and the receiver have the same antenna polarisation and that this is less important at HF because the polarisation may change during ionospheric reflection.	Recall that the angle at which the radio wave leaves the antenna is known as the angle of radiation and that longer distances normally requires a lower angle of radiation. Recall the effect of the ground on the angle of radiation.	
4C5 *14*	*29*	
Recall that the connection point of the feeder to the antenna is called the feed point. Recall that at the design frequency the feed point has an impedance that should match the impedance of the feeder and the transmitter. Recall that the feed point impedance of an antenna is related to the dimensions of the antenna and the wavelength of the applied signal. Recall that if the feed point impedance of the antenna does not match that of the feeder, energy will be reflected back down the feeder; the proportion reflected depending upon the degree of mismatch.	Recall that the current flowing into an antenna is related to the feed point impedance and the potential difference of the applied signal. Recall that an antenna will only present the correct feed point impedance when fed with the frequency for which it is designed. Recall that a centre fed half-wave dipole has a feed point impedance of 73Ω in free space and that under practical conditions (e.g. due to ground proximity effects) this will be approximately 50Ω when used at its designed frequency.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
	Types of antenna	
4D1 *14*	*30*	*32*
Identify the half-wave dipole, λ/4 (quarter wavelength) ground plane, Yagi, end-fed wire and 5/8 λ (five eighths wavelength) 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 λ/2 (half wavelength) dipole has a physical length approximately equal to a half wavelength of the correct signal.	Recall that a three-element Yagi has a half-wave driven element, a reflector that is slightly longer than the driven element and a director that is slightly shorter than the driven element. Recall that Yagi antennas may have more than one director.	Recall the equation for calculating wavelengths and apply an end factor correction when calculating the approximate physical lengths of simple dipoles and end fed antennas.
4D2	*30*	*32*
	Recall that an antenna trap is a parallel tuned circuit and understand how it enables a single antenna to be resonant and have an acceptable feed-point impedance on more than one frequency. Recall that this technique may be extended to multi-element antennas such as Yagis.	Recall the current and voltage distribution on the centre fed dipole and λ/4 ground plane antennas. Recall the feed point impedances of centre fed half-wave dipoles, quarter-wave and loaded 5/8 λ verticals, folded dipoles, full-wave loops and end feed λ/4 and λ/2 antennas. Recall the effect of passive antenna elements on feed point impedance and the use of folded dipoles in Yagi antennas.
	Standing waves	
4E1 *15*	*31*	*33*
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. Recall that if the antenna does not match the feeder that some power from the transmitter will be reflected back towards the transmitter causing Standing Waves.	Understand that the signal reflected back down the feeder will combine with the waves travelling up the feeder from the transmitter leading to the formation of standing waves. Recall that both forward and reflected signals are subjected to feeder loss. Recall that the reflected signal will change the input impedance of the feeder so that it is no longer the characteristic impedance and the feeder will not then present the correct impedance to the transmitter.	Understand that the standing wave ratio (SWR) is a measure of the signal travelling back down the feeder expressed in terms of the standing waves caused by the reflected signal voltage (or current).

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
4E2	***15***		***33***
	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. Recall that a high SWR, measured at the transmitter, is an indication of a fault in the antenna or feeder and not the transmitter. Recall that the transmitter may be damaged in the presence of a high SWR much greater than 2:1.		Recall that return loss is the ratio of the forward signal power to the return signal power; normally expressed in dB. Understand that a low SWR equates to a high return loss and a high SWR equates to a low return loss.
4E3			***33***
			Understand that the loss in the feeder will reduce the SWR and increase the return loss as measured at the transmitter and that the SWR at the antenna is unaffected. Recall that Return Loss at transmitter = Return Loss at antenna + 2x (feeder loss).
		<u>Antenna matching units</u>	
4F1	***15***	***31***	***34***
	Recall that where an antenna has not been designed for the frequency being used, the feed resistance will change resulting in a mismatch and that an Antenna Matching Unit (AMU), also sometimes referred to as an ATU, can correct the mismatch and is used to ensure that the transmitter can supply energy to the antenna without damage to the transmitter.	Recall that a transmitter is designed to transfer energy into a specific impedance. Understand that an antenna matching unit (AMU) can change the impedance presented to the transmitter and that an AMU does not tune the feeder or the antenna to resonance. Understand that if the AMU is located at the transmitter, it will have no effect on the actual SWR on the feeder between the AMU and antenna.	Understand that Antenna Matching Units (AMUs) can cancel reactive components of the antenna system feed point impedance (before or after the feeder) and can transform impedances to an acceptable resistive value. Identify typical AMU circuits i.e. T, Pi and L circuits.
4F2			***34***
			Understand that a quarter-wave length of feeder can be used as an impedance transformer. Apply simple examples of the formula $Z_o^2 = Zin \times Zout$.

Dummy loads

4G1 *15*	*31*	
Recall that a dummy load is a screened resistor of the correct value and a suitable power rating connected instead of an antenna to allow the transmitter to be operated without radiating a signal.	Recall that the resistor(s) used in a dummy load must be non-reactive and of a suitable power rating. Understand the use of a dummy load in fault finding.	

Plugs and sockets

4H1 *15*	*31*	
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, N, SMA and PL259 plugs as shown in Table 2.	Recall that in a correctly connected and terminated coaxial cable the RF field only exists within the cable and is not affected by objects outside the cable. *Note that correctly connected means screen and inner conductor continuity through any plug and socket.*	

Section 5 – Propagation

Radio propagation: key concepts

5A1 ***16***		***35***
Recall that radio waves normally travel in straight lines. Recall that they can be refracted, diffracted and reflected. Recall that radio waves get weaker as they spread out.		Recall that under free space conditions e-m waves spread out according to an inverse square law of power flux density and that the electric field strength, measured in volts/metre, drops linearly with distance. *Note: Numerical calculations required at item 6E1 only*
5A2 ***16***	***32***	
Recall that VHF and UHF signals normally pass through the ionosphere and at these frequencies propagation is within the troposphere situated below the ionosphere.	Understand the meaning of ground wave, tropospheric (space) wave, sky wave, skip distance and skip zone (dead zone).	
5A3	***32***	
	Recall that the ground wave has a limited range due to absorption of energy in the ground and that the loss increases with increasing frequency.	
5A4	***32***	***35***
	Recall that electromagnetic radiation comprises both an electrical field and a magnetic field. Recall that the two fields are always at right angles to each other and that the direction of propagation is at right-angles to both fields. Recall that it is the plane of polarisation of the electric field that defines the polarisation of the electromagnetic wave.	Recall that an e-m wave comprises E and H fields in phase, at right angles and at right-angles to the direction of travel. Recall that in circular polarisation, the polarisation of the wave rotates as it propagates, with either a right-handed (clockwise from behind) or left handed polarisation. Recall that this is often used for satellite communication where the orientation of the satellite is indeterminate. Recall that the transmit and receive antennas should have the same polarisation.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Ionosphere

5B1 *16*	*33*	*36*
Recall that the ionosphere comprises layers of ionised gases at heights between 70 and 400km above the earth. Understand that ionisation is caused mainly by ultraviolet rays from the sun.	Understand that the ionosphere comprises layers of ionised gases and that the ionisation is caused by solar emissions including ultra-violet radiation and charged solar particles. Recall the ionospheric layers (D, E, F1 and F2) and approximate heights.	Understand the effects of Solar flares and sun spots on propagation.
5B2 *16*	*33*	*36*
Recall that on HF most communication relies on the waves being refracted in the ionosphere. Recall that HF can provide world-wide propagation depending on how well the ionosphere refracts the waves back to the earth. Recall that this varies with frequency, time of day, season and solar activity. Recall that a band is said to be 'open' when it supports skywave propagation.	Recall that the level of ionisation changes with the time of day, the time of year, and according to the, approximately, 11-year sunspot cycle. Understand that the sunspot number is an indicator of solar activity and that more sunspots give better HF propagation as a result of increased ionisation. Recall that the highest frequency that will be refracted over a given path is known as the maximum usable frequency (MUF).	Recall that the highest frequency that will be refracted back to the transmitter is known as the Critical Frequency of Vertical Incidence (critical frequency). Recall that the maximum usable frequency (MUF) will be higher than the critical frequency. Recall, in general terms how the MUF varies over the 24 hour cycle and the variation in MUF from summer to winter.
5B3	*33*	*36*
	Recall that the F2 layer provides the furthest refractions for HF signals (about 4000km) and that the F layers combine at night. Recall that multiple hops permit worldwide propagation. Understand how fading occurs and its effect on the received signal. Recall that Short Path ionospheric propagation of HF signals is the most direct route around the earth. Recall that Long Path ionospheric propagation is where HF signals are received via the opposite route around the earth to the Short Path.	Recall that propagation where the signals are reflected vertically back from the ionosphere is known as Near Vertical Incidence Sky wave (NVIS). Recall that NVIS is a technique employed on some low frequency bands (e.g. 5MHz) to make contacts over relatively short distances.

5B4	***34***	***36***
	Recall that the D layer tends to absorb the lower radio frequencies during daylight hours and that it tends to disappear at night. Recall that the lowest frequency that can pass through the D-layer without significant absorption is the lowest usable frequency (LUF) Understand that if the D-layer absorption (LUF) occurs at frequencies higher than the MUF then no ionospheric propagation can occur.	Recall that the ionosphere can change the polarisation of a radio wave.
5B5	***34***	
	Recall that in addition to VHF, waves in the in the 24 MHz and 28 MHz upper HF band can also occasionally be significantly increased by refraction from highly ionised areas in the E layer (Sporadic E). Recall that the height of the E layer will support a single hop of up to about 2000km and that multi-hop propagation can occur.	
	<u>VHF and above</u>	
5C1 ***17***		
Recall that hills cause radio shadows and that signals become weaker as they penetrate buildings. 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. Recall that certain atmospheric conditions, i.e. sporadic E and atmospheric ducting, can increase the range of VHF and/or UHF signals.		
5C2 ***17***		
Recall that snow, ice and heavy rain can attenuate signals at UHF and above.		

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
5C3	***17***	***34***	***37***
	Recall that the range achieved at VHF/UHF is dependent on antenna height, antenna gain,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.	Recall that at VHF and above, multipath propagation can occur where signals are reflected off objects (such as a buildings or aircraft) and the reflected signal is received in addition to the direct, un-reflected, signal.	Recall that contacts at VHF and above can be made by reflecting signals off the lunar surface and that this is known as Earth-Moon-Earth (EME) propagation. Understand that as the moon is a poor reflector of radio frequency signals and is a long way from earth, EME contacts generally need high power and high gain antennas accurately pointed at the moon, and very sensitive, low noise receivers or the use of special low-signal strength modes to overcome the path loss. Recall that it is possible to make contacts on the VHF bands by reflecting signals off the ionised gases created during an Aurora and that this occurs at high Northerly and Southerly latitudes and that this is known as Auroral propagation. Recall that auroral ionised curtains form vertically in the ionosphere and that movement of these curtains cause rapid flutter on the signals.

<u>Other features</u>

	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
5D1			***37***
			Recall the Galactic Noise is random noise origination outside the earth’s atmosphere.
5D2			***37***
			Recall the factors affecting a link budget; transmitter power, feeder losses, antenna gains and path loss. Recall that path loss includes spreading loss and obstruction losses.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Section 6 – Electro magnetic compatibility (EMC)

EMC concepts

6A1 *18*	*35*	
Recall that electromagnetic compatibility (EMC) is the avoidance of interference between various pieces of electronic equipment.	Understand that all electronic equipment is capable of radiating and absorbing radio frequency energy. Recall that the basic principle of electromagnetic compatibility is that apparatus should be able to function satisfactorily in its electromagnetic environment and without causing undue electromagnetic disturbance to other apparatus in that environment.	
6A2 *18*	*35*	*38*
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 the immunity of a device can often be improved by screening and filtering power, signal and control leads.	Understand that the immunity of a device is affected by the nature of its installation and that poor installation of an otherwise good item of equipment can compromise its safe and compliant operation.
6A3 *18*	*35*	
Recall that radio transmitters can cause interference to nearby electronic and radio equipment.	Understand that transmitters in domestic environments may give rise to RF fields stronger than the agreed limits. Understand that transmitters in domestic environments are not normal situations and special measures may have to be taken.	
6A4 *18*	*35*	*39*
Recall that radio receivers can also suffer from interference from local and other sources.	Understand that new electronic equipment should meet the British Standards Institute immunity requirements but that existing equipment and poorly installed equipment may not.	Recall that some imported or home constructed electronic equipment may not meet relevant EMC standards. Recall that radio amateurs are not required to demonstrate compliance with EMC standards for equipment they put into service but remain responsible for complying with licence requirements regarding interference.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Sources of interference and their effects

6B1 *19*	*36*	*40*
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 AM and SSB modes are the poorest in this respect, CW (Morse), FM and some of the HF data modes such as PSK31 and FM are much better.	Recall that speech transmissions, particularly AM and SSB may cause speech like sounds in analogue radio, audio systems and telephones. Recall that FM transmission is more likely to mute or reduce the volume of the wanted signals (audio or RF).	Recall that items containing radio communication facilities such as cordless and mobile telephones and information technology communication equipment may produce sufficiently strong signals to cause short range interference but are otherwise generally satisfactory. Recall that imported devices and toys may not be compliant with the relevant regulations.
6B2	*36*	*40*
	Recall non-radio sources of interference and their effects: • Arcing thermostats • Vehicle ignition systems • Electric Motors • Computers and peripherals • Switch mode power supplies • Plasma TVs • Very high bit rate digital subscriber line (VDSL) equipment • LED lighting • Solar photovoltaic (PV) inverters Recall that this gives rise to various buzzing sounds on analogue radio receivers which can correlate with the nature and use of the interference source e.g. bursts of undesirable sounds when a thermostat opens or closes.	Understand that Blocking (or desensitisation) is an effect in a radio receiver where a strong, constant level interfering signal e.g. FM either swamps the wanted signal or drives the affected circuits out of their normal operating range such that the received audio or data is severely attenuated or muted. Understand that Cross-modulation is an effect in a radio receiver where the interfering signal is varying in strength e.g. AM or SSB such that the modulation on the interfering signal is added to the modulation on the wanted signal such that both may be heard with varying clarity.
6B3	*36*	
	Recall that interference to Digital Audio Broadcasting (DAB) may cause loss of signal (muted audio) and to digital televisions may cause the picture to freeze, appear to pixelate; that is break up into larger squares, become jerky or disappear.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Routes of entry

6C1 19	36	41
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.	Recall that direct pick-up in affected devices tends to be independent of the transmitted frequency.	Recall that amateur transmissions can enter audio stages via long speaker leads or other interconnections. Understand that any semiconductor or diode junction within an electronic device can rectify unwanted RF.
6C2	***36***	***41***
	Understand that some masthead and down-lead TV amplifiers are broadband, amplifying a wide range of frequencies, including amateur frequencies. Understand that this can result in overloading of the amplifier and/or the TV input.	Understand that many TV mast-head amplifiers are wide band devices and can suffer from cross-modulation and overload causing intermodulation and blocking, and may also overload the TV.
6C3		***42***
		Understand that amateur transmissions can be picked up by the intermediate frequency stages of TV and radio receivers. Understand the potential for image frequency interference to analogue and digital radio. Understand that television receivers and most broadcast radio receivers employ superheterodyne circuits and recall some typical frequencies used in radio and television receivers. • Medium Wave radio broadcast 526 - 1606kHz • VHF FM radio broadcast 87.5 - 108MHz • VHF DAB radio broadcast 174 - 230MHz • TV broadcast 470 - 790MHz • Radio IFs typically 455 - 500kHz and 10.7MHz. *Note: Current design digital TV receivers use a variety of Intermediate frequencies between 4 and 39MHz.*

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
6C4		***42***
		Recall that passive intermodulation products can be caused by corroded contacts in any metalwork, including transmitting and receiving antennas, supports and guttering.
	<u>Filtering and remedial measures</u>	
6D1 ***19***	***37***	***43***
Recall that the immunity of most types of equipment can be increased by fitting suitable external chokes and filters in mains or antenna leads. Recall that the filters should be fitted as close to the affected device as possible.	Understand that filters can be fitted in the leads from the power supply to the transmitter to help minimise RF energy entering the mains wiring. Recall the use of ferrite ring filters for minimising unwanted RF on antenna down-leads and mains leads to affected equipment. Recall and understand the use of high-pass or low-pass filters to reduce the level of HF and VHF amateur transmissions into other electronic equipment. Understand the use of mains filters to reduce RF, electric motor and thermostat interference to TV, radio and audio systems.	Understand the use of high, low, band pass and band stop (notch) filters of L, T and π configuration, including coaxial stubs as notch filters or traps, in improving the immunity of affected devices. Recall the use of ferrite beads or rings in internal and external filtering. Understand why a ferrite ring will attenuate common-mode currents without affecting the differential-mode wanted signal.
6D2	***37***	***43***
	Understand the meanings of common mode and differential mode currents and signals. Understand how a ferrite ring or choke can be used to attenuate common mode signals in twin wires and braid currents on coaxial cables.	Understand the construction and use of a typical mains filter. Identify a typical circuit of a braid breaking filter and a combined high pass/ braid breaking filter. Understand their use.
6D3	***37***	
	Recall how to use a suitable general coverage receiver to check for spurious and harmonic emissions from the station.	
6D4	***37***	
	Recall how to use a dummy load to check if interference is being caused by a radiated signal or leakage into the mains or other wiring.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Station design and antenna placement/general principles

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
6E1 *19*	*38*	*44*
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 can 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.	Recall how to interconnect the transmitter, microphone, power supply, SWR meter and band or low pass filters, using appropriate cables, to minimise EMC problems.	Recall that reducing field strength to the minimum required for effective communication is good radio housekeeping. Apply the formula for the field strength surrounding an antenna given the ERP and distance from it.
6E2 *19*	*38*	*45*
Recall that the function of the RF earth connection in an 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.	Recall what constitutes a good RF earth, its purpose and use.	Understand good RF grounding and bonding techniques. Understand the effects of inadequate RF grounding and bonding.
6E3	*38*	*45*
	Understand that siting a transmitting antenna close to mains wiring, TV or radio antennas and down-leads is a potential problem exacerbated by the use of a loft or indoor transmitting antenna	Recall that balanced antenna systems tend to cause fewer EMC problems than unbalanced antennas. Recall that balanced and unbalanced feeders should leave the antenna at right-angles to minimise coupling.

Station design and antenna placement/mobile installations

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
6F1 *19*		*46*
Recall that it is the vehicle owner's responsibility to ensure that any radio installation is compatible with the vehicles electrical and management systems and does not affect vehicle safety. Recall that the fact of the installation may have to be disclosed to the vehicle insurers. Recall that professional advice should be sought for all vehicle installations.		Recall that advice on mobile installations is the Federation of Communication Services UK Code of Practice for the installation of mobile radio and related ancillary equipment in land based vehicles.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
6F2 ***19***	***38***	***46***
Recall that any tests following mobile radio equipment installation should be done static with all vehicle electronic systems operating before any on-road tests are carried out.	Recall that when routing RF cables and mobile radio DC power leads within vehicles they should not be routed in parallel with the vehicle wiring loom and they should not be run near electronic control units. Recall that radio frequency energy can cause interference to vehicle electronic circuits, including audio systems, navigation systems, remote locking, alarms and engine fuel management systems particularly when operating equipment with an RF output of 10W or more.	Understand how to minimise the likelihood of stray RF currents entering the vehicle wiring and electronics.
6F3 ***19***	***38***	
Recall that vehicle ignition and battery charging systems can cause electrical interference to reception on mobile radio equipment.	Understand that mobile antenna location can affect the radiation field strength within the vehicle; e.g. wing or boot mounted antennas are likely to produce higher exposures than roof mounted antennas.	
	<u>Social aspects and testing</u>	
6G1 ***20***		***47***
Recall that EMC problems have the potential for causing neighbour disputes. Recall the need for diplomacy, the sources of advice available.		Recall the correct procedures for dealing with EMC complaints.
6G2 ***20***		
Understand that the station log will be of considerable assistance in dealing with complaints of interference, and that this is a good reason to keep a log of all transmissions. Understand the merits of both the amateur and the complainant keeping a log of the instances of interference. Understand the merit of conducting tests in co-operation with the complainant in instances of interference.		

Foundation licence syllabus		Intermediate licence syllabus	Full licence syllabus
6G3	***20***		
Recall the RSGB information leaflets on EMC and interference. Recall that advice is available from the RSGB EMC Committee and recall the role Ofcom in dealing with cases of interference.			
6G4	***20***		
Recall that transmitting into a dummy load is a good test for any unwanted RF being conducted out of the transmitter along its power supply leads and any connected interface leads and into the mains.			

Section 7 – Operating practices and procedures

Good operating practices and procedures

Foundation	Intermediate	Full
7A1 ***21***		***48***
Understand why one should listen on a frequency before calling and then ask if the frequency is in use.		Understand the reasons why some stations may use split Tx and Rx frequencies within a frequency band.
7A2 ***21***		
Recall how to make a CQ call on VHF/UHF FM and HF SSB.		
7A3 ***21***	***39***	
Understand the need to move off the calling channel when on VHF/UHF once contact is established. Understand the meaning of Centre of Activity.	Recall common international call sign prefixes; EI(Eire), F(France), I(Italy), JA(Japan), PA(Netherlands), VE(Canada), VK(Australia), W(USA), ZL(New Zealand).	
7A4 ***21***	***39***	
Recall the phonetic alphabet.	Recall that there are awards available for achievements which include: working continents, countries, islands, prefixes, locator squares and that variations may include certain frequency bands or low power. Recall that amateur radio contests require the exchange of information such as signal report, serial number and location. Recall that contests often have sections for different bands, power levels and modes.	
7A5 ***21***		
Understand the advisability and common practice of keeping a log. Understand why UTC is used for logging time. Recall that a log should detail the following information: date, time, mode, call sign of station worked for QSL and contest purposes.		

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
7A6 *21*		
Understand that the transmission of music and the use of offensive or threatening language whilst on the air are unacceptable in amateur radio. Understand how to respond to music or inappropriate language overheard or received from other stations.		
	<u>Band plans</u>	
7B1 *22*	*39*	*49*
Recall why band-plans are used. Identify items on a typical band-plan (e.g. calling frequencies and recommended modes). Recall that narrow band modes are at the lower end of most bands lower sideband operation normally occurs below 10MHz and upper sideband above 10MHz. Recall that transmissions on beacon frequencies must be avoided. *Note: For the purposes of the examination narrow modes are CW and data.* *A copy of the relevant Band Plans will be provided.* *The Band Plans supplied for examination purposes will be a typical plan and need not be one in current use. The Reference Booklet containing the examination plan is available on the RSGB web site.*	Recall that band plans are produced by the IARU. Recall that the band plans state that: • no SSB operation should take place in the 10MHz (30m) band • no contests shall be organised in the 10MHz (30m), 18MHz (17m) and 24MHz (12m), bands • transmissions on satellite frequencies should be avoided for terrestrial contacts. *Questions on beacon and satellite frequencies will be limited to the 14MHz (20m) and 144MHz (2m) bands and a copy of the relevant Band Plans will be provided.* *The Band Plan supplied for examination purposes will be a typical plan and need not be one in current use. The Reference Booklet containing the examination plan is available on the RSGB web site*	Identify items on a typical band-plan (e.g. centre of activity, band width and recommended modes). *Questions will be limited to the 5MHz (60m) and 472kHz (600m) bands and a copy of the relevant Band Plans will be provided.* *The Band Plan supplied for examination purposes will be a typical plan and need not be one in current use. The Reference Booklet containing the examination plan is available on the RSGB web site.*
7B2 *22*		*49*
Recall that frequency bands are allocated for particular use, e.g. broadcasting, aeronautical, maritime and amateur. Recall the frequency bands for HF, VHF, and UHF radio signals. Recall that some amateur bands are shared with or adjacent to other spectrum users. Identify items on a provided chart of spectrum users.		Recall that band plans in other countries and IARU regions may not align with the UK band plan.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
	Repeaters	
7C1 ***22***		
Recall that repeaters are mainly intended to extend the range of mobile stations. Recall how to use a repeater and understand the requirements for using a CTCSS tone on analogue repeaters and the concept of frequency offset. Recall the purpose and operation of repeaters and the correct procedures in using them e.g. offsets on 2m analogue repeaters; time-out and reset tone; voice procedures. Recall that simplex operation on repeater frequencies should not take place.		
	Connecting input devices to transmitters	
7D1 ***23***		
Recall that connecting anything other than the supplied microphone to the transmitter requires correct operation of the PTT line and that the audio signal levels are correct.		
	Codes and abbreviations	
7E1	***40***	
	Recall the meaning and the reason for use of the Q codes: QRM, QRN, QRO, QRP, QRT, QSB, QSL, QSO, QSY, QTH.	
7E2 ***23***		
Recall the meaning of the RST code, the number of divisions of each of the three items, and their order of merit.		

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
	Digital interfaces	
7F1 *23*		
Recall that there are digital voice (DV) and digital data (DD) modes available and that different systems may not be compatible. Recall that appropriate radio equipment is needed for each of these digital systems. Recall that DV radios may embed the call sign and this will need to be considered if using borrowed equipment.		
7F2 *23*	*40*	
Recall that users of Digital Voice (DV) should check that the channel is not in use by other modes. Recall that users of FM should check that the channel is not in use by other modes. Recall that such checks are not 100% reliable.	Recall that several types of transmissions can be generated and received with the use of a personal computer and a suitable interface. Recall minimal distortion can be obtained by careful adjustments between the DAC interface and the transmitter. Recall other programs running on the PC that is handling the transmitter or receiver audio may cause interference e.g. warning beeps and alerts.	
	Satellites	
7G1 *23*	*40*	
Recall that amateur satellites operate in allocated frequencies within the bands. Recall that terrestrial operation on satellite frequencies should not take place.	Recall that satellites orbit the Earth at heights above 250km, and understand that amateur satellites are moving in relation to the Earth and will only be above the horizon at certain times.	
7G2	*40*	
	Recall that the up-link and down-link frequencies are generally in different amateur bands and that details are published by amateur organisations. Recall that the transmitting station must be able to receive both the up-link and down-link signals.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
7G3	***40***	
	Understand that amateur satellites can only be used when they are above the horizon at both the sending and receiving stations, and that the movement of the satellite will cause frequency variation, known as Doppler shift, on the received signal, which must be allowed for when selecting operating frequencies.	
7G4	***40***	
	Understand that satellites have a very limited power supply, derived from solar panels, and that excessive up-link power may result in wasteful and unfair use of the satellite's power.	
	Special events	
7H1		***49***
		Recall the purpose of special event stations and the format of their call signs. Recall the process for obtaining a special event call sign.

Section 8 – Safety

Electricity

Foundation		Intermediate	Full
8A1	***24***	***41***	***50***
Recall that high voltages carry a risk of electrocution and high currents carry a risk of overheating and fire.		Understand that large or high-voltage capacitors can store dangerous electric charges and must be discharged before working on equipment. Recall that large value resistors can be used to provide leakage paths for these stored charges.	Recall that lethal voltages in excess of 70 Volts are common in thermionic valve equipment and that live circuits may be exposed as soon as the equipment case is removed.
8A2	***24***	***42***	***50***
Recall why mains powered equipment should have a safety earth. Recall that where a safety earth has been fitted that it must not be removed. Recall that special care is needed with earthing arrangements and that the District Network Operator responsible for the physical supply to your premises must be consulted before making changes such as an RF earth.		Understand that all exposed metal surfaces should be properly earthed.	Recall that in PME systems the main earth terminal is connected to the neutral of the electricity service at the consumers' premises and that all metal pipes and fittings within the premises are also connected to the PME bonding point. Recall that under severe fault conditions PME systems have the potential to cause fatal electric shocks and/or fires in amateur radio stations. Recall that the RF earth in an amateur station should be connected to the PME bonding point in accordance with the District Network Operator's requirements or the IET Wiring Regulations to maintain safety under fault conditions.
8A3	***24***		
Recall the correct way to wire a 3-pin mains plug.			

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
8A4 *24*	*42*	
Recall that fuses to be fitted in accordance with manufacturer's instructions. Recall that a fuse is a thin wire designed to melt, breaking the circuit, when passing an excessive current. Recall that the reason for a blown fuse needs to be properly investigated.	Recall that equipment mains fuses may be of a special type, such as quick blow or slow blow to allow for an initial surge of current and that the specified type must be fitted. Understand that a fuse must be correctly rated for proper protection, and, in the absence of manufacturer's instructions, to select an appropriate fuse. *For mains: current = power/230 where 230 is the nominal mains voltage.*	
8A5 *24*		
Understand that an RCBO (Residual Current Circuit Breaker with Overcurrent protection) will give better protection against electric shock than relying solely on a conventional fuse which only protects against excessive current. *Note: The candidate should appreciate that an RCBO will detect currents to earth of about 30mA whereas a fuse will only blow at several amps and only when the fault is a short circuit (L-N or L-E).* *The candidate should also appreciate that contact with both live and neutral may case fatal injury.* *The mechanics of RCBO operation (differential current sensing) is not examinable.*		
8A6 *24*	*41*	*50*
Recall only to work inside equipment that is disconnected from the power source. Recall why it is important to follow manufacturer's instructions for servicing equipment.	Understand that working on live equipment must only be done if it is not practicable to do otherwise and if the risks and appropriate precautions are fully understood.	Understand that no work should be undertaken on live equipment unless it is not practicable to do otherwise. Understand that suitable precautions must be taken to avoid electric shock.

Foundation licence syllabus		Intermediate licence syllabus	Full licence syllabus
8A7	***24***		
Understand that all equipment should be controlled by a clearly marked master switch, the position of which should be known to others in the house or club. Recall that, in the event of an accident or fire 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.			
8A8	***24***	***42***	
Recall that some batteries can supply very high currents which can be hazardous if subjected to short circuit. Recall that battery charging must be in accordance with manufacturer instructions and that lithium batteries in particular can cause fire and explosion if not properly treated. Understand that different battery technologies require different charging techniques and must use the correct type of charger.		Understand that vehicle batteries are a source of very high currents which can start a fire and that battery contents are corrosive. Understand that explosive hydrogen gas can be given off when charging batteries and that ample ventilation is required.	

Using tools

8B1	***25***		
Recall that eye protection must be worn when using tools to prevent eye damage from small metal particles (swarf).			
8B2	***25***	***43***	
Recall that all tools, including power tools, can be hazardous and should be handled with care and appropriate precautions taken.		Understand that screwdrivers, drills, saws and files must be handled with care. Understand that fingers should always be behind the blade of hand tools.	
8B3		***43***	
		Understand that any items being drilled, sawn or filed must be securely held in a vice or similar device to prevent them slipping or rotating.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
8B4	***43***	
	Understand that any locking keys, and/or chuck keys, must be removed before using a power tool such as a drill to prevent the key being ejected at high speed.	
8B5	***43***	
	Understand that using a centre punch will help prevent a drill bit slipping.	
8B6	***43***	
	Understand the reasons why a bench-mounted pillar drill is safer than a hand-held drill.	
8B7 ***25***		
Recall that eye protection must be worn when soldering to prevent solder or flux from splashing into the eyes. Recall that a soldering-iron stand must be used to avoid skin contact with the hot bit of the iron when not in use. Recall that soldering work stations must be well ventilated to avoid inhalation of solder fumes, which can cause breathing problems particularly to asthmatics.		
	<u>Working at height</u>	
8C1 ***25***		
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.		

Foundation licence syllabus		Intermediate licence syllabus	Full licence syllabus	
8C2	***25***			
Recall that a ladder should be used at the correct angle (4:1 height-to-base ratio). Understand that ladders must be adequately secured to prevent them slipping. Understand why it is important not to overreach from a ladder, to prevent falling off.				
8C3	***25***			
Understand why, when working at height, a tool belt or similar device to carry tools should be used, and that it will help prevent falling objects. Understand the need to wear hard hats when working at height or when others are working at height.				
		Working with RF		
8D1	***26***			***51***
Recall that the main health effect of exposure to electromagnetic radiation is heating of body tissue and that the eyes are particularly susceptible to damage.			Recall that the International Commission for Non Ionising Radiation Protection (ICNIRP) produces guidance for exposure to Radio Frequency fields. Understand it is not advisable to exceed the recommended safe exposure levels and that this is particularly applicable at locations open to the public.	
8D2	***26***			
Recall that guidance on safe levels of RF radiation is available from government and international bodies, Public Health England and the International Commission on Non-Ionising Radiation Protection (ICNIRP).				
8D3	***26***			
Recall what a waveguide is and why it is unwise to look down a microwave frequency waveguide or to stand close to or in front of high-gain antennas as they may be in use.				

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
8D4 ***26***		
Recall that antenna elements and other conductors carrying RF should not be touched whilst transmitting. Recall that antennas should be mounted where people will not come into accidental contact with them. *Note: this does not apply to low powered devices such as hand-held equipment.*		
	<u>Lightning</u>	
8E1 ***26***	***41***	***51***
Recall that particularly high antennas may need special protection against lightning. Recall that the local authority building department will be able to offer advice.	Recall that limited protection of equipment against the build-up of static charge can be obtained from gas discharge arrestors, spark gaps and bleed resistors.	Recall that thunderstorms carry heavy static charges. Understand that the static charge from thunderclouds can ionise the air to form a low resistance path to ground, enabling a very high current to flow as a lightning strike. Understand the risks to human life, domestic property and electronic equipment associated with a direct strike and/or the build-up of static charges. Understand that there is little that can be done to protect an amateur station from a direct lightning strike, but that good static discharge systems can prevent dangerous static charges building up on antenna systems during thunderstorms. Understand that disconnecting antenna feeders from radio equipment also reduces the risks.
	<u>Working mobile and portable</u>	
8F1 ***26***		
Recall that elevated wires, masts and antennas must be suitably located and secured. Recall that antennas and feeders must not be sited close to overhead power cables. Recall that a lethal electric shock can result from antennas and ladders coming into contact with or attracting arcing from overhead lines.		

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
8F2 *26*		
Understand the reasons for not having wires trailing across the floor, trip hazards and the risk of frayed insulation.		
8F3 *26*		
Recall that excessive volume when wearing headphones can cause damage to hearing.		
8F4 *26*		*52*
Recall that operating in temporary premises and/or outdoors can introduce new hazards e.g. overhead power lines, temporary mains connections, trailing cables, damp ground. Recall the additional safety precautions that should be taken whilst operating in temporary premises and/or outdoors e.g. risk assessment, cable routing, protection, correct fusing, use of RCBO's, no adjustments or repairs to live equipment. Recall that advice should be sought where you are unsure.		Understand that operating in temporary premises and/or outdoors can introduce new hazards i.e. overhead power lines, inadequate electrical supplies, trailing cables, damp ground, and excessive field strengths. Recall the additional safety precautions that should be taken whilst operating in temporary premises and/or outdoors i.e. site survey, cable routing/protection, correct fusing, use of RCBOs, no adjustments or repairs to live equipment. Recall that mains supplies in other countries may be of a different voltage or frequency; utilise different plugs and sockets and that UK specified equipment may not be suitable or hazardous if connected and used.
8F5 *26*		*52*
Recall that safety is everybody's responsibility and that one must be alert to any potentially unsafe circumstance, warn others and report the matter to the appropriate person. Recall this equally applies in your own 'shack' and when entertaining visitors.		Understand that operating when mobile or maritime mobile can introduce new hazards i.e. insecure equipment, long/flexible antennas, accidental shorts to earth, lack of attention to driving, RF induction into vehicle control circuits. Recall the additional safety precautions that should be taken whilst operating mobile and/or maritime mobile i.e. secure equipment, cable routing/ protection, correct fusing, use of hands-free equipment, attention to good radio housekeeping.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
8F6		***53***
		Understand that a risk assessment should be performed when an activity could present a hazard to yourself or others. Understand that risk assessment involves identification of hazards and the measures to mitigate the risk. Recall a risk assessment needs to consider the likelihood of harm and the severity of that harm. Recall that the significant findings of risk assessments need to be recorded. Recall that risk assessment records are important in law and for insurance purposes. Risks should be expressed in understandable terms. Recall that appropriate insurances should be obtained for all amateur radio activities but in particular where the public could be involved.
8F7		***53***
		Understand the risks associated with the use of electrical generators, earthing, fuel stowage, refilling.

Section 9 – Measurements and construction

Measurements

9A1	***44***	***54***
	Recall the purpose of a multimeter and understand how to set the meter to the correct range and polarity before connecting to the circuit.	Understand the use of series multiplier resistors in analogue voltmeters and shunts in ammeters. Understand the effect of the test meter on the circuit under test.
9A2	***44***	
	Understand that a voltmeter is always connected in parallel with a component or circuit and that an ammeter is always connected in series with a component or circuit.	
9A3	***44***	***54***
	Understand the advantages and disadvantages of analogue and digital displays, and be able to read analogue and digital values.	Understand the effect of measurement tolerance, calibration accuracy and time related drift on frequency measurements and the allowances to be made for transmission bandwidths.
9A4		***55***
		Understand that signal generators and similar devices will have a source impedance and the effect on the signal level of attaching different load impedances. Recall that not all measuring equipment will have a 50Ω input impedance. Understand that the choice of measuring equipment may have an effect on the on the measurement result and on the object under test.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
9A5	***44***	***55***
	Understand the use of voltmeters and ammeters to determine the power applied to a circuit.	Understand that steady RF power may be determined by measuring the RF potential difference across a dummy load and that a steady audio signal, e.g. from an audio oscillator, will be required for AM and SSB measurements. Understand the meaning of peak envelope power (PEP) of an SSB transmission and that it may be determined using a peak reading power meter or an oscilloscope and dummy load.
9A6		***56***
		Recall the uses and limitations of crystal calibrators, digital frequency counters and standard frequency transmissions.
9A7		***56***
		Identify the circuit of an SWR meter using either a sense wire between the inner and outer conductors of a coaxial line or a current transformer and capacitive voltage tap. Understand in simple terms how this leads to an SWR reading on devices using a single meter, twin meters or cross-needle twin meter.
9A8		***56***
		Understand the purpose and basic operation of an oscilloscope. Calculate the frequency and voltage of a waveform from given data.
9A9		***56***
		Understand the purpose and basic operation of a spectrum analyser.. Identify the fundamental and harmonics on a typical spectrum analyser display.

9B1	Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
		Decibels	
9B1		***45***	***57***
		Recall that decibels are a power ratio. Recall that a power gain of 3 dB equates to doubling the power and 10dB equates to a power increase of times 10. Calculate the power gain or loss of various dB ratios based on 3 and 10dB and their multiples. This includes examples such as 25W is equivalent to 14dBW. Recall that dB gains and losses in a system can be added to find the total gain or loss in the system. Recall the meaning of: • dBW (comparison with 1 W) • dBi (comparison with an isotopic radiator) and • dBd (comparison with a half wave dipole).	Use the equations for decibel power, dB, dBW, dBm and voltage ratios dBV.
		Components	
9C1		***46***	***58***
		Recall the resistor colour code, colours 0 to 9 with gold as multiplier. Recall silver (10%) and gold (5%) as tolerance bands. Identify the value of a resistor between 1Ω and 9MΩ from the E12 series. Recall how to read both 4 band and 5 band resistors. Recall how to read components with a numeric marking of the format 4R7, 3k3 or for capacitors, 103. *Note: The resistor colour code will be provided and actual encoding or decoding of colours will be either 4 band or 5 band resistors.* *Candidates are not expected to know the values of the E12 series.*	Recall that temperature has an effect on the value of components. Those with negative coefficients will reduce in value as temperature rises whereas those with positive coefficients will increase in value. Understand the effect this will have on tuned circuits and remedial measures. *Questions may include simple calculations.*

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus

Construction

9D1	***46***	
	Recall that screening with thin metal sheet is effective in reducing unwanted radiation from equipment and/or between stages within equipment.	

Soldering

9E1	***46***	
	Understand that soldering is a method of joining metal wires and components using solder and a hot soldering iron.	
9E2	***46***	
	Recall that solder is a low melting point alloy and that many solders contain a flux to help the solder to flow and to prevent a layer of oxide forming on the surfaces to be joined.	
9E3	***46***	
	Recall that some metals are easier to solder than others.	
9E4	***46***	
	Understand that the tip of the soldering iron has to be cleaned to help remove any oxide and then tinned to prevent the oxide re-forming and to improve the conduction of heat to the joint. Recall the reason for tinning wires prior to soldering.	

Section 10 – Practical assessments

Operating

10A1

Demonstrate the ability to make a contact using a mode other than telephony.With the exception of hand sent Morse code, this contact must be made on air and include as a minimum:

- Tuning the radio and/or the computer system to the correct frequency,
- Selecting the correct mode,
- Setting the radio microphone gain and/or computer audio interface to correct levels and,
- Two-way exchange of call sign, signal report, location.

Where data modes are used, the candidate must type and send all information in real time.

Where hand sent Morse code is used:

Demonstrate ability to send correctly by hand, and to receive correctly by ear, text in Morse Code.

The receiving and sending test shall be conducted using text from the RSGB provided booklet.

The candidate may choose the character speed and spacing.

The candidate will be provided with a copy of the Morse Code both in code and alphabetical sequence during the assessment. Sufficient correct code must be exchanged for the content of the message to be understood.

Receiving test:

The candidate may, if desired, write down the dots and dashes for subsequent transcription and proceed one letter at a time. *The tutor may re-send characters if required*.

Sending test:

The candidate is permitted to make any necessary preparations prior to sending, including writing the Morse code for each character to be sent.

10A2

Demonstrate the ability to make a contact using SSB.
The contact must be made on air and include as a minimum:

- tuning the radio to the correct frequency, or section of the band;
- selecting the correct mode;
- setting the radio microphone gain to the correct level;
- check if the frequency is in use and make a CQ call;
- vacate the calling frequency if appropriate after establishing the initial contact;
- the two-way exchange must include call sign, signal report and location;
- ending the contact;
- recording all details of the contact in a log.

10A3

Demonstrate the ability to make a contact using FM simplex.
The contact must be made on air and include as a minimum:

- setting the radio to the correct calling frequency;
- selecting the correct mode;
- correct setting of the squelch control;
- make a CQ call;
- vacate the calling frequency after establishing the initial contact;
- check if the new (working) frequency is in use;
- the two-way exchange must include call sign, signal report and location;
- ending the contact;
- recording all the details of the contact in a log.

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
10A4		
Adjust the physical length of an antenna for lowest SWR. Note: The antenna elements are not to be adjusted whilst transmitting. Correct procedure for a radiating test shall be demonstrated. Assessment to be performed using a transmitter or transceiver, adjustable antenna and a SWR meter. Twin meter (fwd/ref) SWR meter or an SWR meter built into transceiver is acceptable.		
10A5		
Match an antenna system for lowest SWR in at least two bands using a transmitter or transceiver and a (manual) antenna matching unit.		

Construction

10B1		
Correctly connect up a station. To include as a minimum, mains PSU, amateur radio transmitter/receiver or transceiver, microphone or PC interface, external item (e.g. VSWR/Power meter, AMU, filter), feeder and antenna. Other accessories can be included as appropriate to local circumstances (e.g. external speaker).	Prior to carrying out constructional activities candidates should review the relevant safety features contained in the Foundation syllabus at 8a6, 8a7, 8a8, 8B and 8D.	
10B2		
Connect a battery, resistor and LED to show the LED lights when connected with the correct polarity and measure the current flowing. Calculate the values of resistor required given the battery voltage and specified LED current. Demonstrate that connecting another resistor of the same value in parallel with the existing resistor results in a doubling of the current in the LED. Explain the reason to the tutor.	Demonstrate the ability to make good solder joints. Joints can be using surface mount or through-hole components, tracked PCB, PCB pads, strip board, solder tags etc. A minimum of 5 good joints are required.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
10B3		
	Make a simple DC circuit comprising a power source, a switch, at least two resistors and two LEDs or bulbs. Circuit should be configurable for series or parallel use of the LEDs/bulbs. Joints need not be soldered.	
10B4		
	Demonstrate that a transistor can be used as a switch in a simple DC circuit. Measure base and collector currents and calculate gain.	
10B5		
	Build an amateur radio related project containing a selection of electronic components. Key requirements are sufficiently complex to demonstrate: correct selection of a variety of components, correct orientation and soldering of components, project must be complete and working as intended. Construction may be carried out either within a course or elsewhere, but the assessor must be satisfied that the bulk of the work is that of the candidate.	
10B6		
	Fit a suitable RF connector (such as PL259, BNC, N or other suitable RF connector type) to a piece of coaxial cable. Connectors may be soldered, crimped, compression or a combination.	
	Instrumentation and measurement	
10C1		
	Measure DC potential difference and current in series and parallel circuits.	

Foundation licence syllabus	Intermediate licence syllabus	Full licence syllabus
10C2		
	Measure the value of a number of resistors and compare with the component markings. A minimum of four resistors (at least one from each of the ranges: 1-99, 100-999, 1k-99k and ≥100k) must be correctly measured. (Any type of resistor is acceptable, a numeric or colour value scheme may be used).	
10C3		
	Determine the value of at least two resistors using measured values of V and I and compare with the marked component values.	
10C4		
	Demonstrate that a crystal oscillator is stable when subjected to reasonable temperature changes and mechanical shock.	
10C5		
	Demonstrate that a variable frequency (LC) oscillator is not very stable when subjected to reasonable temperature changes and mechanical shock.	
10C6		
	Find at least the 2nd and 3rd harmonics from an RF oscillator by using either a receiver or spectrum analyser.	
10C7		
	Demonstrate the reduction in harmonics by using a low pass filter or AMU, measured using either a receiver or spectrum analyser	

10C8

	Calibrate a variable RF oscillator using a receiver, frequency counter or spectrum analyser of known accuracy. Band edges and two intermediate points are required to be marked at zero beat. (Oscillator type, refer tutor guidance information).	